Acta Scientific Biotechnology

Volume 1 Issue 8 August 2020

Mini Review

Potential Role of Microbes in Insect, Human, Plant and Environment for Present and Future Perspective

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Received: February 22, 2020

Published: July 21, 2020

Abstract

After a very long adaptation and evolution, now microbes exist anywhere in the world. They are co-evolved with insect, plant and human/animal in different conditions which has possible benefits and least microbes become pathogen when the host had decline in the level of symbionts. Recently many research dealt with identification of microbes and production of useful compounds, enzymes, peptides and even antibiotics under selective pressure. Microbes are used as a disease marker in the recent era. In this review, we highlights the significance of microbes and their uncanny ability assisting with different host and environments.

Keywords: Biotechnology, Insect Symbiosis, Plant Microbe Interaction, Cancer, Dysbiosis, Enzymes, Gut Microbes.

Introduction

Microbes are the first form of living organism and omni present on earth originate before 3 to 4 billion years. Microbial ecosystem (host) are in different environmental niche and the microbes posses potential characteristics for various process such as degrading pollutant [1] or modifying complex substance to simple compounds, cycling the ratio of carbon and nitrogen in soil for plant growth and plant defence agent. The microbial enzymes are used in different industries like textiles, paper industry, pharmaceutical industries, food industries etc. The enzyme market globally in 2020 going to reach $7.2 billion and a CAGR of 5.8% expected during 2016 - 2023. The enzyme market globally reach a need of 6 to 7% every year [2,3]. Screening of potential microbes from different environment and utilizing it for human society in current demand is more important. The microbes utilized from different environment for the beneficial of human society are discussed in figure 1.

Insect gut microbes

Microbes play a broad symbiotic interaction in insects from beneficial to parasitic association. The main moto of symbiosis is mostly based on sharing nutrition or defence mechanism. The insect gut bacteria in tsetse-fly was studied in the earlier times of 20th century since it carries the vector for trypanosomal diseases. The trypanosome interaction with gut microbes are much interested to study in earlier times by Wigglesworth., *et al.* [4]. The understanding of host-microbe interaction mechanism become more important to develop strategies to inhibit transmittable diseases. The insect gut is big reservoir for microbes and their symbiotic interaction contribute to the growth and development of their host insect [5,6].

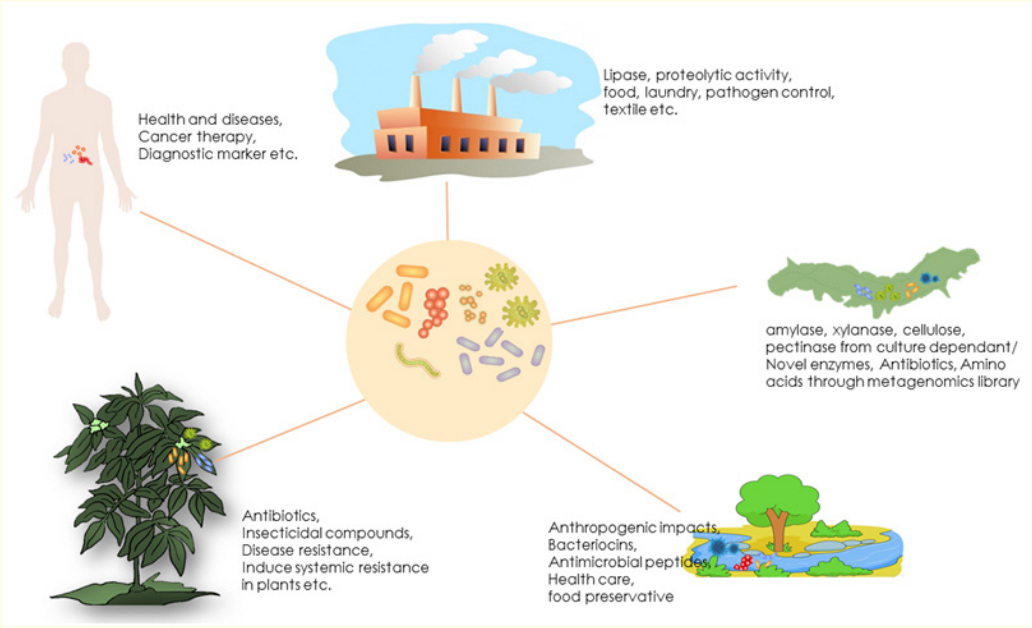

Figure 1: Microbes from environment have once adopted to different lifeforms, later become beneficial bacteria and promotes growth and metabolites to their symbiotic partner.

The gut bacteria community of termites are well documented in providing glucanase, mannanase, and cellulose which the insect relay on to degrade lignocellulose based plant biomass which are used in various industrial applications [7,8]. Many novel enzymes like amylase, xylanase, cellulose, pectinase from silkworm gut bacteria and their application in food, poultry and paper industries were studied [9-12]. Esterase are used in degrading natural materials and industrial pollutions and perfume productions. Similarly tannase from the bacteria *Enterobacter cloacae* strain 41 of *Gryllotalpa krishnani* gut could be used in tannery effluent degradation, food, and pharmaceutical industrial applications [13]. Apart from this, quorum sensing compounds which are important in microbial intracellular communication in pathogenic bacteria have become a significant area in microbial research are also identified in different insect. Study in cabbage white butterfly larval (*Pieris rapae*) midgut was done to understand the quorum sensing of expressed signals in a multispecies microbial community [14]. Apart from this, various microbes are used as probiotics (lactic acid bacteria; LAB) to improve the human health through dairy, food and beverage industries which earns billions of dollars every year [15]. A broad research must be carryout in different insect and animal gut to find more effective microbes for the benefit of human health and industry [16-18].

Revealed the world of unculturable microbes through metagenomic study

Recently, the screening of unculturable gut bacteria from several insect orders to obtain novel enzymes, antibiotics, amino acids etc. by preparing metagenomic libraries and accurate identification using advanced sequencing technologies such as genome sequencing, Next generation sequencing, Illumina HiSeq were explored. The role of insect gut microbes and their different role on different insect species such as *Rhynchophorus ferrugineus* [19], *Acrididae* sp., *Cerambycidae* spp., *Bombyx mori* [20], *Saperda vestita*, *Dendroctonus frontalis* [21], *Hyalomma anatolicum* [22], *Blattella germanica* [23], *Spodoptera littoralis* [24], *Plutella xylostella* [25] were well studied. The Illumina MiSeq sequencing of Silkworm gut bacteria revealed the presence of Proteobacteria, Firmicutes, Actinobacteria, Bacteroidetes and a unique fungus which belong to the phyla Ascomycota and Basidiomycota. The well-studied microbiota of

silkworm with previous findings of its physiology and genetics are more useful to manipulate the host microbes to improve its disease resistance, metabolism and improve economy of silk [26,27].

Impact of human gut microbes as a marker

Some of the gut microbes from human gut were studied deeply in recent times to find the correlation, their impact on health and diseases. The increased evidence on human gut bacteria involvement on cancer through dysbiosis in the human gut and these specific microbial communities are identified as a diagnostic marker in certain types of cancer [28,29] which are remarkable findings discovered by scientist to date. In this context, they reported that the loss of beneficial microbes leads to gut dysbiosis which shows a strong connection between gut microbes and health of human and animals. Dysbiosis in the healthy human affect the health and associated with diabetes, colorectal cancer (CRC), obesity. CRC case study have Fusobacterium association and it can be detected as fecal marker [30]. More research are need to be studied in order to understand the bacteria and human relationship to gain information related to microbe as advance marker in detecting diseases.

Significance of plant endophytic microbes

Some insect associated symbiotic microbes transmitting diseases to plants [31]. In natural, the plant endophytic microbes supressing the pathogenic microbes through unknown mechanism because, this endophytic bacteria are evolutionarily different from soil bacteria and their precise metabolic process help in plant growth and immunity. Plant growth promoting rhizobacteria are more specific group of microbes helps in plant growth and metabolism. *B. amyloliquefaciens* isolated from *Musa* sp. and *B. subtilis* from *Gossypium* sp. are analysed as plant associated and non-plant associated strain from same species, the evolutionary trait shows the difference in strain even though they are from same species. This shows the bacterial adaptation towards plants as a unique character [32]. The antagonistic role expressed from unique bacteria against fungus are studied in recent times to find a better ecofriendly tactic instead of synthetic fungicides. *Bacillus amyloliquefaciens* an endophytic bacteria from tomato plant is treated against *Fusarium oxysporum* f. sp. *lycopersici* a pathogen to tomato shows promising results in supressing fungus [33]. Still much research are progressing well in laboratory and under field trial against plant pathogen and pest in all over the world but agricultural industry is in an urgency for the product commercialization.

Microbes role in diverse environment

Microbes holds various strategies to overcome environmental stress which in produce cyst and spores, alters cellular membranes, autonomous enzymes for damage resistance [34]. More interestingly, the bacteria from river soil responds differently to anthropogenic impacts and provides an alternative indicator of stream health [35]. The soil microbes (*Pseudomonas aeruginosa*) producing bacteriocins are natural anti-microbial peptides and have possible application as food preservation and healthcare [36]. The microbes produce different enzyme under selected pressure in environment, these microbes are more efficient in producing enzymes and a key for pharma and food industries. A recent study in Brazil shows a promising approach in finding a potential lipolytic bacteria from a biological treatment system from a hotel. *Acinetobacter baylyi*, a popular genus is identified for lipase enzyme production [2]. Similarly, *Acinetobacter calcoaceticus* [37], *Acinetobacter* radioresistens strain CMC-2 [38], *Acinetobacter* sp. SY-01 [39], *Acinetobacter* radioresistens CMC-1 [40], and *Acinetobacter johnsonii* [41] are previously reported as an effective group of microbes in large scale lipase enzyme production. In resent research in proteolytic enzyme search, a *Thermococcus kodakarensis* homologous to *archaemetzincins* family shows proteolytic activity and apart from this many multiple applications like inhibiting various pathogenic microbes, can be utilized in food industry to increase shelf life of food by controlling food borne pathogens, can utilize as a additive in laundry detergent [42-44]. With this broad aspect of microbes and their role in different environment are more interesting to study. Research in Insect gut, Human digestive track, Plant-Bacteria interaction and microbes from different environment have a bright future of research scope for young scientist with a constructive prospect.

Conclusion

The microbes from different environment with a vast diversity holds both beneficial and harmful pathogens. In this many species are beneficial to humans in various aspects like bioremediation, biotechnology applications, environmental biomarkers, symbiosis with human-insect-plants. In this insect gut bacteria are targets for biotechnological applications, as they produce many metabolites which are use full in industries. Insect parasitic symbiosis is also more interested direction to be studied more for pest control aspects. Recent studies shows plant symbiotic bacteria shares metabolites, promotes plant growth and antagonistic behaviour against fungus infection in plant. Still there is no clear picture of this mutualism with microbes- plants, the major hindrance is identifying the specific endophytic microbes which are not easily be cultivable *in vitro*. The microbes as bio marker is also a remarkable approach to identify the disease as early as possible. Though microbes are capable of producing novel metabolites, enzymes, bioactive molecules their present need to society is abundant. A broad research in microbial ability using modern genomics could help us to understand more for future direction.

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