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Human Pathogens-The Plant and Useful Endophytes

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Introduction

Several human pathogens and plants can have close connection. A plant is not traditionally considered as a niche for human pathogen. But the literature data attest that many members of the family *Enterobacteriaceae* including pathogenic *Salmonella* and *Shigella* genus strains, *Vibrio cholerae* strains and the human opportunistic pathogen *Pseudomonas aeruginosa* were found on plants or inside plants.

Salmonella enterica strains have been isolated as endophytic colonizers of barley roots, spreading to the rhizodermis layers [1]. *Salmonella* not only passively survive, but also actively infects plants as alternative host [2]. Internalization of E. coli O157: H7 and Salmonella spp. in plants was presented by Deering et al. [3].

Enteric bacteria are able to colonize plants and use them as alternative hosts. Plants as reservoirs for human enteric pathogens have considered by Holden [4]. The ability of enteric pathogens to survive for prolonged periods of time on fruits and vegetables has been described by Natvig et al. [5] and also by Gagliardi and Karns [6]. Brandl has demonstrated the schematic diagram of the various sources of contamination of fruits and vegetables with human enteric pathogens [7].

Enteric pathogens develop novel niches on and within the plants, where they never were before as residents. The reports about the outbreaks caused by contamination of produce by human pathogens continue to rise Sivapalasingam et al. [8], Brandl [7] and Hirneisen et al. [9]. A link between recent outbreaks of gastroenteritis and the consumption of fresh produce rise was determined by Teplitski et al. [10]. Endophytic colonization of ready-to-eat-salad crops by enteric bacterial carries important public health implications. Enteric human pathogens, agriculture produce and public health risk are great concerns. Human pathogens acquire the ability to attack, infect, colonize, persist, multiply and survive on plants or inside the plants.

On the other hand, the plant is a niche for endophytic organisms that live within plant. Several groups of endophytic microorganisms have attractive commercial application.

The application of bacterial, fungal endophytes and actinomycetes as novel source of potentially useful compounds has been described by Rathod et al. [11]. Endophytes as potential sources of novel natural products for exploitation in agriculture and medicine have been presented by Guo et al. [12] and also by Mehanni and Safwat [13].

Antimicrobial activity of endophytic antagonists against several pathogens is determined. It is a broad research area today. *Streptomyces endophytes* against *Fusarium wilt* was isolated [14]. Antifungal activity of endophytic *Bacillus subtilis* and *Burkholderia* spp. against *Fusarium circinatum* was shown [15]. Fungal endophytes as unique plant inhabitants with great promises have been described by Aly et al. [16]. Antagonistic endophytic microorganisms against plant pathogens and against clean room pathogens were isolated from leaves and seeds of mistletoes. The authors indicate an interesting bio-resource to not only control plant pathogens, but also clean room pathogens [17].

Our research has shown that endophytic yeast *Rhodotorula rubra* strain TG-1 had significant inhibitory activity against many members of the *Enterobacteriaceae* family, against *Vibrio cholerae* and *Pseudomonas* aeruginosa strains. Some information about it can read on my website. Antimicrobial activity of TG-1 strain against several pathogenic fungal and bacterial plant pathogens including strains of *Fusarium* genus and *Xanthomonas malvacearum* has been described [18]. The inhibitory activity of yeast *Rhodotorula rubra* strain TG-1 against several pathogens of human infectious diseases and against several plant pathogens will be able to indicate about some link between human pathogens and plant pathogens present within the plant. It will be an interesting comparative study of virulence, adhesive abilities and adaptive capacities of enteric bacterial isolates that infects both human tissue and plant tissue.

Our preliminary research has shown that one of the rhizosphere fungal strains can have a harbour and niche space for pathogens antagonist. Intracellular living bacterium *Erwinia spp*. has been isolated from a phytopathogenic fungus. This endofungal bacterium has showed unexpected useful properties. A germination stimulating activity of *Erwinia spp*. on cotton seeds was determined. Antimicrobial activity of intracellular bacterium *Erwinia spp*. against some pathogens, for example, *Fusarium* genus strains was established. Different phage types were detected inside the isolated bacteria. Some information about this research can read on my website.

Relationship and interactions between a plant-a phytopathogenic fungus-an intracellular bacterium-a phage (phages) may shed new light on the virulence diversity of phytopathogenic fungi population and show one of the novel niches where a potent pathogens antagonist can lurk. Fodor has described pathogen niche, host niche and vector niche within the environmental diagram [19]. Interactions between a host niche-a pathogen niche-an antagonist niche-a phage (phages) niche and vector niche can be more difficult.

The quest novel niches useful endophytic microorganisms with antagonistic activity against pathogens of human infectious diseases and plant pathogens can be an active area for future investigations. Maybe endophytes will be able to help answer on several questions in a link between human pathogens and the plant.

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