plant growth-promoting activity, induced systemic resistance activity against scab pathogen in cucumber, and antifungal activity against various phytopathogenic fungi. The phosphate solubilizing activity of 60-2G may be mainly accomplished by production of gluconic acid through a direct extracellular oxidation of glucose by glucose dehydrogenase that required a PQQ cofactor for its activation. A *pqq* gene cluster conferred phosphate-solubilizing activity in *E. coli* DH5α was cloned and sequenced. The 6,783 bp *pqq* sequence had six open reading frames (from A to F) and showed 50 - 95 % homology to *pqq* genes from other bacteria. The *E. coli* strain expressing the *pqq* genes solubilized phosphate from hydroxyapatite after a pH drop to 4.0, which paralleled in time the secretion of gluconic acid. To study the role of PQQ in biocontrol traits of *E. intermedium*, PQQ mutants of 60-2G were constructed by marker exchangee mutagenesis. The PQQ mutants of *E. intermedium* were lost activities of solubilizing phosphate, growth inhibition of phytopathogenic fungi, and plant growth promotion. These findings suggest that PQQ plays an important role, possibly activation of certain enzymes, in several beneficial bacterial traits of *E. intermedium* by as yet an unknown mechanism.

2-18. Enhancing Resistance of Red Pepper to Phytophthora Blight Diseases by Seed Treatment with Plant Growth Promoting Rhizobacteria

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Plant growth promoting rhizobacteria (PGPR) have been shown to suppress phytopthora blight. This suppression has been related to both microbial antagonism and induced resistance. The PGPR isolates were screened by dual culture plate method and most of the isolates were showed varying levels of antagonism. Among the PGPR isolates pyoverdin, pyochelin and salicylic acid producing strains showed the maximum inhibition of mycelial growth of *Phytophthora capsici* and increased plant growth promotion in red pepper. PGPR isolates further analysed for its ability to induce production of defence related enzymes and chemicals. The activities such as Phenyle alanin ammonia lyase (PAL), Peroxidase (PO), Polyphenol oxidase (PPO) and accumulation of phenolics were observed in PGPR pretreated red pepper plants challenged with *Phytophthora capsici*. The present study shows that an addition of direct antagonism and plant growth promotion, induction of defense related enzymes involved to enhance resistance against invasion of *P. capsici* in red pepper.

2-19. Isolation and characterization of an antifungal substance from Burkholderia cepacia, an endophytic bacteria obtained from roots of cucumber.

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In order to develop a new microbial fungicide for the control of vegetable diseases using

endophytic bacteria, a total of 260 bacterial strains were isolated from fresh tissues of 5 plant species. After they were cultured in broth media, their antifungal activities were screened by *in vivo* bioassays against *Botrytis cinerea*(tomato gray mold), *Pythium ultimum*(cucumber damping-off), *Phytophthora infestans*(tomato late blight), *Colletotrichum orbiculare*(cucumber anthracnose), and *Blumeria graminis* f. sp. *hordei*(barley powdery mildew). As the results of screening, 38 bacterial strains showed potent antifungal activities against at least one of 5 plant pathogens. A bacterial strain EB072 displayed potent disease control activities against 3 plant diseases. Among the bacterial strains with a potent antifungal activity against cucumber anthracnose, three bacterial strains, EB054, EB151 and EB215, also displayed a potent *in vitro* antifungal activity against *C. acutatum*, a fungal agent causing pepper anthracnose. A bacterial strain EB215 obtained from roots of cucumber was identified as *Burkholderia cepacia* based on its physiological and biochemical characteristics and 16S rRNA gene sequence. An antifungal substance was isolated from the liquid cultures of *B. cepacia* EB215 strain by ethyl acetate partitioning, repeated silica gel column chromatography, and *in vitro* bioassay. Its structural determination is in progress by various instrumental analyses.

2-20. Enhancement of Biocontrol Activity of *Serratia plymuthica* A21-4 Toward Phytophthora Blight of Pepper by Amendment of Nutritional Condition

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Serratia plymuthica A21-4 strongly inhibits the mycelial growth, zoospore formation, and cystospore germination of *Phytophthor* spp and *Pythium* species. The bacterial isolate produced antifungal substance and chitinase. The bacteria also enhanced to plant growth remarkably in low nutritional condition. The application of cell suspension of A21-4 to pepper seedlings in greenhouse experiments and soil drenching in farmer's field was proved successfully to control the phythophthora blight of pepper. For the effective control, however, relatively high density of cell number(10^9cfu/㎖) is required. Density effect was similar in plant growth promoting activity of A21-4. Though this investigation we improved the problem with changes of culture condition of bacteria and some nutritional amendment.

2-21. Antagonistic activity of *Streptomyces halstedii* and *S. violaceusniger* to pepper anthracnose fungus *Colletotrichum gloeosporioides*

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More than 1200 microorganisms were isolated from soil samples collected from various sources and localities. Among the isolates, 2 actinomyces (TH-04 and BA313) and 1 *Bacillus* sp. (CJ3) were selected as antagonists to pepper anthracnose fungus *Colletotrichum gloeosporioides*. These 3 isolates inhibitied mycelial growth of *C. gloeosporioides* and the inhibition rates were over 70% on PDA. When the isolates were co-cultured with conidia of *C. gloeosporioides* in potato