Bacillus subtilis: A Multi-tasking Biotool for Agronomic Practices

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Abstract: *Bacillus subtilis* is ubiquitous and can tolerate adverse conditions. It can be potent multi-tasking biotool (MTB) in the agricultural practices. It is a potent biocontrol as well as plant growth promoting rhizobacteria (PGPR). In addition to these qualities, it also has antibiosis activity against many gram-positive as well as gram-negative bacteria. Many antibiotics are isolated from subspecies of *B. subtilis*. It can also be used for food processing and found high potent to inhibit growth of termites (anti-termites).

Keywords: *Bacillus subtilis*, MTB, PGPR, Antibiosis, Anti-termite, etc.

Introduction: *Bacillus subtilis* is ubiquitous and can be isolated from myriad environments – terrestrial and aquatic. It can be grow in adverse conditions and are capable of forming highly resistant dormant endospores in response to nutrient deprivation and other environmental stresses (1). It was earlier known as *Vibrio subtilis* in 1835 and renamed *Bacillus subtilis* in 1872. *B. subtilis* cells are rod-shaped, Gram-positive bacteria that are naturally found in soil and vegetation and grow in mesophilic temperature range (1).

Antibiotic production: *B. subtilis* species are known to be producing antibiotics such as bacitracin which was effective against some gram positive bacteria (2). Other antibiotics *viz.*, polymyxin, difficidin, subtilin, and mycobacillin were affective against Gram-negative bacteria. Some commercially important enzymes can also be secreted by this bacteria viz., amylase, protease, chitinase, xylanase, lipase (3).

Plant growth promoting rhizobacteria: *B. subtilis* are root colonizing bacteria and consider being plant growth promoting rhizobacteria by promoting and growth as well as biological control of plant diseases (4). The potential to use PGPR as integrated practices offers an appealing research area for those scientists engaged in growth promotion studies as it reduce dependency on N and P fertilizers. Treatment with PGPR has increased the germination percentage, seedling vigour and biomass (5). Agronomic crops were inoculated with rhizobacteria enhances the nitrogen fixation, the production of auxins, gibberellins, cytokinins, ethylene, the solubilization of phosphorus and oxidation of sulphur, increase in nitrate availability, the extracellular production of antibiotics, lytic enzymes, hydro-cyanic acid, increases in root permeability (6). ACC (1-aminocyclopropane-1-carboxylate) deaminase activity, siderophore production, enhancing biological nitrogen fixation and enhancement in the uptake of essential plant nutrients could be the best possible explanations. It has been widely reported in numerous microbial species of gram negative bacteria (7). Experiments with different wheat varieties showed that seeds bacterized with selected strains of *Bacillus* could successfully establish in the rhizosphere (8). Some bacteria have ability to colonize the phylloplane with higher frequencies as compared to others (9).

Anti-termite activity: The pathogenicity of *Bacillus subtilis* and *Serratia marcescens*, was much operative against termites (10). *B. subtilis* was found in the intestine and guts of several termites and millipedes cause death due to Hydrogen cyanide production (11). Hydrogen cyanide (HCN) is produced by many rhizosphere bacteria and has been demonstrated to play a role in the biological control of the plant diseases (12). HCN-producing bacteria can be introduced into termite moulds, thereby localizing cyanide production and minimizing potential deleterious effects on other soil fauna. Three different species of hydrogen cyanide-producing rhizobacteria for their potential to kill subterranean termite *O. obesus*, which is an important pest of the Indian subcontinent that causes extensive damage to major agricultural crops and forest plantation trees (13). The16S rDNA sequence analysis of HUB-1-47 revealed a high similarity of 99% to those of *B. subtilis*. Based on these analyses, strain HUB-I-47 was named as *B. subtilis* subsp. *virginiana*. They analyzed anti-termitic activities of the fermentation broth from strain HUB-1- 47 by feeding to *Odontotermes formosanus*. GC-MS analysis indicated that α-terpineol was present in fermentation broth that caused 100% mortality after 14 days of incubation (14).

Antibiosis activity: *Bacillus subtilis* subsp. *subtilis* PTS-394 is not affecting the rhizospheric micro biota but adversely effects soil-borne diseases caused by *Fusarium oxysporum* and *Ralstonia solanacearum* which is the main obstacle to continuous cropping of tomato in greenhouse cultivation (15). The protective action of surfactin produced by *B. subtilis* against infection caused by *Pseudomonas syringae* in *Arabidopsis thaliana* and suggested that surfactin was necessary not only for root colonization but also provided protection against the pathogen (16). Inhibitory concentrations of surfactin produced by the organism on rootsis the measure of disease suppression. Antifungal peptides are produced by AU195 strain of *B. subtilis* shows similarity with bacillomycin (group iturin A). The strain AU195 exhibited strong antagonistic activity against *Aspergillus flavus* and a broad range of other plant pathogenic fungi (17). Four *B. subtilis* strains UMAF6614, UMAF6616, UMAF6639, and UMAF8561 produce siturin and fengycin, play important role in the suppression of powdery mildew of cucurbits caused by *Podosphaera fusca*. The culture supernatant could successively inhibit the powdery mildew at levels previously reported for vegetative cells (18, 19). The melon leaves treated with two strains (UMAF6614 and UMAF6639) strongly supported the evidence of in situ production of inhibitory components (surfactin, fengycin, and iturin A or bacillomycin) (19).

As food and antigens: *Bacillus subtilis* has beneficial effects on animals and humans as probiotic organism (20). LS 1-2 strain of *B. subtilis* can be used to enhance intestinal bacterial balance and the gut health of broilers. Also, it can be used as a growth promoter in diets related to broilers. *B. subtilis* strains are also used either as antigen bearers or as antigen cellular manufactories in the generation of bacterial vaccines. The application of *B. subtilis* spores as vaccine vehicles, delivered through mouth, has attracted noticeable attention because of its probiotic effects and the extended self-life. In another study, it was demonstrated that *B. subtilis* (strain NC11) is a potential probiotic, and displays a good role as an inhibitor against infection related to *Salmonella enteritidis* in the intestinal epithelial cells. *B. subtilis* (WD161) is the producer of amylase can also be applied to co-culturing with *Clostridium butylicum* (TISTR 1032). This will increase the production of acetone–butanol–ethanol (ABE) from starch without an anaerobic remedy (21). *B. subtilis* strain, AS-S01a, is a bacterium that produces a high rate of alkaline α-amylase. It may be applied as a good bacterial source in the production of a high rate of alkaline α-amylase under an appropriate situation. This enzyme does not need the Ca^{+2} ions for performing its action as a detergent and it shows consistency in the presence of enzymes, such as, protease, surfactant, oxidant, and metal ion chelating agents (22). *Bacillus subtilis* (natto) Takahashi, as a natto starter, is generally applied for producing a fermented product, which has been a traditional food in Japan for more than 1000 years. It also produces milk-clotting enzymes (23). Fibrinolytic enzymes in the bacteria have a dissolvent role about fibrin clots and are evidently used as thrombolytic agents (24). These enzymes have been detected in various bacteria, the most important among which is the genus *Bacillus*, especially *Bacillus subtilis*, from traditional fermented foods (25). The bacterial numbers, water quality, and growth during early development of white shrimp enhance the effect of the *Bacillus subtilis* in the shrimp (26). Growth by enhancing the action of the digestive enzymes and food attraction in white shrimp was demonstrated by a probiotic bacterium, *Bacillus subtilis* E20. Aerobic fermentation is a common method for producing enzymes in *B. subtilis* strains (e.g. amylase, protease), insecticides, antibiotics, purine nucleotides, polyglutamic acid, D-ribose, polyhydroxybutyrate (PHB), and so on.

Conclusions: *Bacillus subtilis* is potent plant growth promoting rhizobacteria as well as bio-control agent and effective against plant pathogens. It was also found to be effective inhibitor for the termites as producing hydrogen cyanide. It can also produce many antibiotics and exhibit antibiosis activity against many gram positive and negative bacteria. Recent investigation revealed that *B. subtilis* can be used in food processing and can be used as probiotic bacterium. Thus, from aforementioned information it can be sure that *B. subtilis* can be called as multi-tasking biotools (MTB) in the agriculture practices.

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