Journal of Bioremediation & Biodegradation
ISSN: 2155-6199

Chauhan, J Bioremed Biodeg 2015, 6:2
DOI: 10.4172/2155-6199.1000e164

Editorial Open Access

Sinorhizobium meliloti Bacteria Contributing to Rehabilitate the Toxic Environment

Ashish Chauhan*

National Institute of Pharmaceutical Education and Research, Mohali, Punjab, India

Abstract

Nitrogen fixing microorganisms play a vital role in the rejuvenating the environment. A *Sinorhizobium meliloti* bacterium is one such microbe and has immense potential to rehabilitate the toxic environment that lies unexplored. The review highlights some of its uses in agriculture and environment.

Introduction

Production of nitrogenous fertilizers has stagnated in recent years because of high costs and pollution. Estimated 90% of applied fertilizers never reach roots and contaminate groundwater. Hence, the importance of nitrogen fixing organisms has emerged as key issue. The nitrogen fixation by organisms occurs by a symbiotic relationship, association or free living organisms (Figures 1-3) that plays an important role in maintaining the nitrogen cycle in the environment. The biological fixation in brief that could be depicted as follows:

Nitrogenase

N_2 + 8 flavodoxin$^-$ + 8H$^+$ + $MgATP_2$- + 18 H_2O → $2NH_4^+$ + $2OH^-$ + 8 flavodoxin + 16 $MgADP^-$ + $16H_2PO_4^-$ + H_2

It is a rare, extremely energy consuming conversion because of stability of triply bonded N_2. The fixed Nitrogen which can be directly assimilated into Nitrogen containing bio-molecules. Some of the host plant and bacterial symbiont are shown in the Table 1.

The nitrogen can be fixed by non-symbiotic nitrogen fixation by Cyano bacteria *Anabaena nostoc*. It can be fixed by terrestrial and rhizosphere associated microorganisms like *Azospirillum, Azotobacter, Acetobacter, Klebsiella* and *Clostridium* [1,2].

Sinorhizobium meliloti and its uses to the environment

Kingdom: Bacteria Phylum: Proteobacteria Class: Alpha Proteobacteria Order: Rhizobiales Family: Rhizobiaceae Genus: Sinorhizobium Species: *S.meliloti*

Sinorhizobium meliloti is a soil bacterium of Rhizobiales group of the Alpha proteobacteria sub-division. *S. meliloti* forms nitrogen-fixing

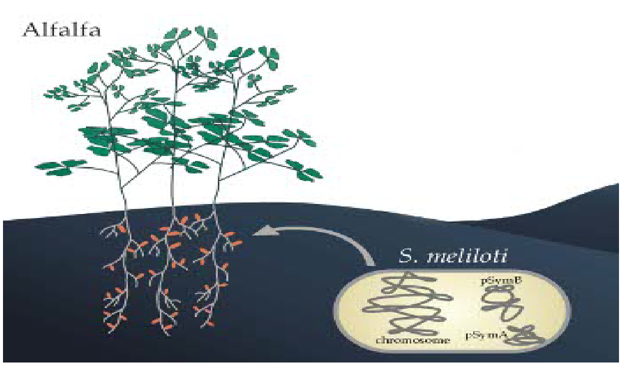

Figure 1: The symbiotic relationship between the plant and bacteria.

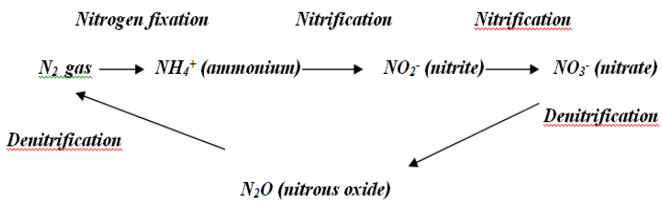

Figure 2: The Nitrogen cycle depicting its transformations in the nature.

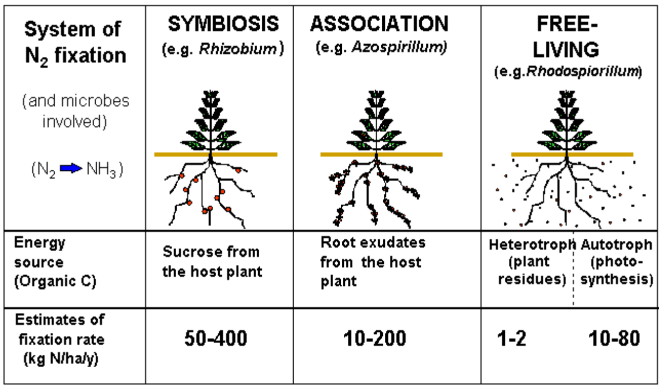

Figure 3: The various types of nitrogen fixation.

nodules on the roots of leguminous plants of the genera Medicago, Melilotus and Trigonella and it is the best studied model system for the rhizobium legume symbiosis. *S. meliloti* is distributed all over the world and is present in many soil types, both in association with legumes and in free-living form. The occurrence of this species reveals a wide metabolic capability that allows its adaptation to very different environmental

***Corresponding author:** Ashish Chauhan, National Institute of Pharmaceutical Education and Research, Mohali, Punjab, India, Tel: +91-9464616773; E-mail: aashishchauhan26@gmail.com

Received February 15, 2015; **Accepted** February 24, 2015; **Published** February 27, 2015

Citation: Chauhan A (2015) *Sinorhizobium meliloti* Bacteria Contributing to Rehabilitate the Toxic Environment. J Bioremed Biodeg 6: e164. doi:10.4172/2155-6199.1000e164

Host plant	Bacterial symbiont
Alfalfa	*Rhizobium meliloti*
Clover	*Rhizobium trifolii*
Soybean	*Bradyrhizobium japonicum*
Beans	*Rhizobium phaseoli*
Pea	*Rhizobium leguminosarum*
Sesbania	*Azorhizobium caulinodans*

Table 1: Some of the host plant and their bacterial symbiont that fixes the nitrogen.

and nutritional conditions. *S. meliloti* has been the subject of extensive genetic, biochemical and metabolic research. The sequencing of the strain Rm1021 genome provided a solid foundation for a number of molecular studies of the genetic basis of plant-bacterium interactions and of the response of *S. meliloti* to environmental stimuli. Strains of *S. meliloti*, as for other rhizobial species, are known to show different nodulation capabilities and phenotypic characteristics, such as salt and stress tolerance and exo-polysaccharide production. Despite the large number of genetic and molecular biology studies of the sequenced Rm1021 strain and its natural populations, little is known about the overall extent of metabolic diversity of Rm1021 and environmental strains. Consequently, clear evidence on possible functional and metabolic roles of the observed genomic polymorphism is still lacking. In past years, more attention has been focused on that part of bacterial genetic variation which is directly related to the phenotype.

Sinorhizobium meliloti cells serve a significant role in the survival of many plant species and they also largely contribute to the environment. The atmosphere is composed of approximately 85% nitrogen and it is an essential element to most living organisms and their metabolic activities. But, nitrogen exists in the atmosphere as dinitrogen (N_2) that is unusable by most plants and animals. *S. meliloti* cells in the environment form symbiotic relationships with leguminous plants and convert N_2 into organic nitrogen. *S. meliloti* also serves as denitrifying agent that reduces nitrate and nitrite into free N_2 in the environment (Figure 2). *S. meliloti* is unique and one of the first organisms to have a cluster of all four nitrogen oxide reductases (nap, nir, nor, nos) on the same chromosome. Denitrification can have hazardous effects such as a loss of biologically useful nitrogen, a buildup of N_2O as a byproduct which contributes to acidic rain and a depletion of the ozone layer. However, denitrification conducted by *S. meliloti* cells can have positive effects as well if it is harnessed properly. For example, the N_2O produced by denitrification can serve as a green-house gas that traps heat. The microbial denitrification can contribute significantly to the purification of waste water. Nitrogen-rich fertilizers have contributed to the pollution of ground water. This water is potentially hazardous to pregnant women and infants and thus scientists are considering using microbial denitrification in water treatment facilities to remove excess NO_3. A bacterium isolated from soil (designated 9702-M4) synthesizes an extracellular polymer that facilitates the transport of such hydrophobic pollutants as polynuclear aromatic hydrocarbons, as well as the toxic metals lead and cadmium in soil [3-9]. This property of the organism if expedited can play a crucial role to purify the toxic soil and inhibit the health hazards.

Conclusions

S. meliloti has huge potential to reduce the toxicity from the environment so; there is need of enhancing the survival of nodule forming bacterium by improving competitiveness of inoculant strains there is need to extend host range of crops that can benefit from biological nitrogen fixation. We should engineer microbes with high nitrogen fixing capacity for a healthy environment.

References

1. Ba S, Willems A, de Lajudie P, Roche P, Jeder H, et al. (2002) Symbiotic and taxonomic diversity of rhizobia isolated from Acacia tortilis subsp. raddiana in Africa. Syst Appl Microbiol 25: 130-145.
2. Rogel MA, Ormeño-Orrillo E, Martinez Romero E (2011) Symbiovars in rhizobia reflect bacterial adaptation to legumes. Syst Appl Microbiol 34: 96-104.
3. Schneiker-Bekel S, Wibberg D, Bekel T, Blom J, Linke B, et al. (2011) The complete genome sequence of the dominant Sinorhizobium meliloti field isolate SM11 extends the S. meliloti pan-genome. J Biotechnol 155: 20-33.
4. Sharma RS, Mishra V, Mohmmed A, Babu CR (2008) Phage specificity and lipopolysaccarides of stem- and root-nodulating bacteria (Azorhizobium caulinodans, Sinorhizobium spp., and Rhizobium spp.) of Sesbania spp. Arch Microbiol 189: 411-418.
5. Kowalski M (2004) The effect of rhizobiophages on Sinorhizobium meliloti-Medicago sativa symbiosis. Biology and Fertility of Soils, 39: 292-294.
6. Mnasri B, Mrabet M, Laguerre G, Aouani ME, Mhamdi R (2007) Salt-tolerant rhizobia isolated from a Tunisian oasis that are highly effective for symbiotic N2-fixation with Phaseolus vulgaris constitute a novel biovar (bv. mediterranense) of Sinorhizobium meliloti. Arch Microbiol 187: 79-85.
7. Villegas Mdel C, Rome S, Mauré L, Domergue O, Gardan L, et al. (2006) Nitrogen-fixing sinorhizobia with Medicago laciniata constitute a novel biovar (bv. medicaginis) of S. meliloti. Syst Appl Microbiol 29: 526-538.
8. Gubry-Rangin C, Béna G, Cleyet-Marel JC, Brunel B (2013) Definition and evolution of a new symbiovar, sv. rigiduloides, among Ensifer meliloti efficiently nodulating Medicago species. Syst Appl Microbiol 36: 490-496.
9. Janecka J, Jenkins MB, Brackett NS, Lion LW, Ghiorse WC (2002) Characterization of a Sinorhizobium isolate and its extracellular polymer implicated in pollutant transport in soil. Appl Environ Microbiol 68: 423-426.