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Beneficial microorganisms in mulberry cultivation

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Abstract
Mulberry is one of the most widely cultivated staple food crop for silkworms. The mulberry leaves were shown to harbour substantial populations of bacteria, streptomycetes, yeasts, and moulds and these microorganisms confer lot many benefits to mulberry. Beneficial microorganisms can be applied as biofertilizers to plant and also as probiotics they reduce chemical fertilizer intake in turn pollution and heavy fertilizer cost on farmers.

Keywords: Mulberry, azotobacter, arbuscular mycorrhizal fungal (AMF)

Introduction
Mulberry is one of the most widely cultivated economical crops around the world because it is staple food for silkworms and lot many other usages of it. The growth, development of larva and subsequent cocoon production are greatly influenced by nutritional quality of mulberry leaves.

According to Charles (2004) [6] lower animals do not have well developed humoral immunity and immune-stimulation could be achieved easily through probiotics. As well as, Amala *et al*. (2011) [7] insist on up-gradation of the immunity of silkworms by probiotics rather than giving control measures for a disease. It was discovered that the mulberry leaves contain significant populations of bacteria, streptomycetes, yeasts, and moulds. According to Vasantharajan *et al*. (1968) [4] among all Azotobacter and Beijerinckia were observed to contribute to nearly 5 to 10 per cent of the bacterial population. The growing plant was observed to benefit more from the root inoculation than the foliar treatment. It has been demonstrated that the mulberry leaf leachates contain both carbohydrates and amino acids. Plant will provide carbon source to azotobacter and in turn azotobacter will provide nitrogen source to plant as it is free living Nitrogen fixer. Like this Plant and azotobacter gain mutual benefit. According to Shi *et al*. (2016) [2].

A number of arbuscular mycorrhizal fungal (AMF) species, within nine AMF genera - *Acaulospora*, *Ambispora*, *Archaeospora*, *Claroideoglomus*, *Diversisporav*, *Glomus*, *Gigarspora*, *Redeckera* and *Paraglomus*, can colonize mulberry roots to form beneficial arbuscular mycorrhizae. AMF has the capacity to increase the leaf growth and biomass production, the quality and nutraceutical potential of mulberry leaves and fruits, for silkworm growth and reduction chemical fertilizer input. An AM symbiosis also effectively confers mulberry plants greater tolerance to drought, salt, heavy metals and root disease stresses though improved water and nutrient uptake, intensive root systems, enhanced photosynthetic capacity, osmotic adjustment, activity of antioxidant enzymes, total sugars, proteins, amino acids, and phenols. These many benefits are advented by AMF to mulberry plant.

According to Taha *et al*. (2017) [3] probiotics are viable, non-pathogenic microorganisms which when administered in adequate amounts, confer a health benefit on the host. Mulberry leaves supplemented with *Saccharomyces cerevisiaen* (yeast) and *Bifidobacterium bifidum* (bacteria) probiotics were used to feed two silkworm hybrids. The impact of microorganisms administration was studied on larval, pupal and cocoon and shell weights. As well as, ERR, cocooning, pupation and cocoon shell percentages. Silk filament length, breaks and silk % were recorded. Digestive enzymes (Protease, Invertase and Amylase) were estimated colorimetricaly. The results revealed that, *B. bifidum* and *S. cerevisiae* improved all tested parameters comparing with control. The effect of probiotics may be dependent on the tested *Bombyx mori* hybrid. Renditta that stands for the quantity of cocoons required for producing a kilogram of raw silk was significantly improved in all supplemented groups either for *B. bifidum* or *S. cerevisiae*. Addition of yeast (*Saccharomyces cerevisiae*) and bacteria (*Bifidobacterium bifidum*) as probiotics on mulberry leaf for silkworm rearing.

There is a pronounced increase in the activity of protease, amylase and invertase in probiotic treated worms than control. Beevi *et al*. (2018) [1] reported significant beneficial effect was recorded on mulberry leaf yield, growth and yield parameters of bivoltine silkworm double hybrid reared on two mulberry varieties *viz*., Victory-1 and MR-2 due to inoculation with microbial consortium containing nitrogen fixing bacteria *Azotobacter* and *Azospirillum*, phosphate solubilizing & mobilizing microorganism besides EMs even after curtailing nitrogenous and phosphatic chemical fertilizers to the extent of 25-75% of recommended dose. There was a profound increase in the activity of the amylase and invertase in the digestive juice of the probiotic treated with *Saccharomyces cerevisiae* worms than the control as reported by Esaivani *et al*. (2014) [5] which support the present findings. So we can conclude as application of microbial biofertilizers has plenty of advantages and it curbe the disadvantages of chemical fertilizers.

Conclusion
Promising perspectives for future mycorrhizal studies in mulberry should at least focus on a comprehensive understanding of AMF diversity and community composition, and molecular mechanisms of a specific AMF species that can contribute benefits to tolerate abiotic and biotic stresses by mycorrhizal mulberry plants.

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