Automobile exhaust pollution: an imperceptible threat to sericulture in Kashmir, India

Sericulture is an art as well as science of rearing of silkworms to produce fibre that has fascinated man over millennia. Although there are various species of silkworm that have been commercialized, *Bombyx mori* L. is the most commonly used and intensively studied[1]. Sericulture in Kashmir has a glorious past, which is evident from the contexts of various religious and historical manuscripts like *Rajatarangini* of Kalhana, *Ramayana* and *Mahabharata*. Sericulture in Kashmir has played a pivotal role in the economy as it provides a source of livelihood to a sizeable section of the society. Owing to the highly conducive climatic conditions, Jammu and Kashmir is famous for the production of bivoltine silk of optimum quality[2].

The growth and development of silkworm larvae is affected by a number of biotic and abiotic factors, including quality and quantity of the leaf, silkworm race and environmental conditions[3]. One of the problems has been the new emerging ravages accrued by air pollution[4] which is associated with the primary (i.e. direct) and secondary (i.e. indirect) effects on the insect population especially when the insects involved are phytophagous like the silkworm larvae. Airborne pollutants are directly or indirectly responsible for the toxicological effects and decline in the population of such insects[5].

Sericulture in Kashmir is being sustained by mulberry trees available along the roadside and walking tracks in an erratic form. These roads witness huge traffic movement which releases various pollutants in the form of gaseous as well as particulate matter. The pollutants spewed into the surroundings from the automobiles have an obvious effect on the mulberry plantations growing along the roadsides[6]. The scenario has also taken a dramatic turn due to faulty developmental practices like laying of roads in those areas which were primarily known for farming of mulberry plantations for the rearing of silkworm larvae. The mulberry leaves from these areas, contaminated from pollutants released from the automobiles, have registered a decline in various physico-biochemical parameters, reducing the quality of mulberry leaf used for the rearing of the silkworm larvae (Figure 1). The feeding of these polluted mulberry leaves, comprising the sole food for *B. mori* L, has a drastic effect on the growth and development of silkworm larvae. Farmers fetching these polluted mulberry leaves for rearing of silkworm larvae collect these leaves in stressful conditions, besides making larvae susceptible to pathogen invasion.

Sericulture in Kashmir, despite having a historical significance in the valley, is now witnessing a decline due to shortage of mulberry leaves, decline in the number of silk-rearing farmers, government monopoly, political turmoil in the state, lack of advanced infrastructure, diseases in silkworm, etc. In this scenario, the obscure threat from automobile pollution is turning out to be another constraint for this industry.

The pollutants released severely alleviate the quality of the mulberry leaf and make it unfit for silkworm rearing. During their growth and development, silkworm larvae come under the direct influence of environmental pollutants via mulberry leaves, which have a major effect on the physiology of the larvae[7]. The silkworm larvae undergo intricate biochemical reactions when they come in contact with air pollutants or polluted mulberry leaves, which eventually results in the poisoning of these larvae[8]. The rearing of silkworm larvae on polluted mulberry leaves not only increases the larval mortality to a significant level, but also affects the performance of these larvae measured in the form of larval, cocoon and silk parameters. The larval growth, larval weight, cocoon weight, shell weight, shell ratio, silk filament length and reliability register a significant decline when the larvae are provided with polluted mulberry leaves. Such leaves also significantly decrease food consumption; conversion efficiency of silkworm larvae provides evidence for the reduced quality of mulberry leaves[9]. Silkworm larvae are affected by a number of diseases, including protozoal, bacterial, fungal and viral diseases[10]. These constitute a major impediment in the development of sericulture in the valley[11]. Providing the larvae with polluted mulberry leaves further aggravates disease occurrence by enhancing their vulnerability to various microbial infections.

Figure 1. Effect of automobile pollution on the quality of fresh mulberry leaves of Goshoerami variety taken simultaneously from two different plantations. (Left) Leaf from a plantation near the roadside. (Right) Leaf from a plantation far away from the road).

Jammu and Kashmir produces best quality bivoltine mulberry silk in the whole country due to its better strength and shine. But there are some factors responsible for the decline of the sericulture industry in Kashmir valley, which include large-scale capital investment, threat from diseases and general apathy among the farmers towards this industry. As against 1800–2000 farmers who were associated with this industry three decades ago, only 350–400 farmers are presently carrying out silkworm rearing in each district. Kashmir was the chief supplier to the state's silk industry. Out of the total cocoon production of 10.36 lakh kg/year in 1988, Kashmir produced 6.65 lakh kg and Jammu contributed only 3.71 lakh kg. Reports revealed that cocoon production in the valley had decreased from 15 lakh kg in 1960 to 8.32 lakh kg in 2009. Also, 20–25% of the total production is being consumed in the state and the rest is sent to other parts of India. Currently 40% of silk production comes from the Kashmir valley, while 60% comes from the Jammu region, depicting the decline in cocoon production from the Kashmir valley[12].

To refurbish the glory of sericulture in the valley, some resurrective measures need to be taken to address these problems. The strategy should include: (i) Prevention of rearing of the silkworm

larvae on polluted mulberry leaves. (ii) Plantation of mulberry plants in fields away from the roadside, where the risk of automobile pollution is less. (iii) Looking for silkworm races which are least affected by feeding them with polluted mulberry leaves. (iv) Making the farmers aware about the ill-effects of rearing silkworm larvae on polluted mulberry leaves. (v) Strengthening the industry at the gross root level by encouraging unemployed youth to take it up as a profession. (vi) Upgradation of the existing infrastructure to national and international levels to make it more promising. (vii) Introduction of better techniques to control the occurrence of microbial diseases which are posing a risk to the survival of this vital industry in the valley.

The effect of automobile pollution on the rearing of silkworm larvae is well documented. Future studies should encompass the toxicological effects of heavy metals on silkworm pathology with specific reference to the immunological degradation caused by these toxic elements when they enter the body of the silkworm via the mulberry leaves. The immunological disruption caused by these xenobiotic compounds can further aggravate the susceptibility of silkworm larvae towards various microbial infections. Various promising steps need to be taken to address the debacle of this vital industry in the Kashmir valley. A systematic approach is the need of the hour to bestow the industry with its lost grandeur. Prompt actions need to be taken to boost the potential of this industry to play a major role in the economy of the state.

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Siderophores of haloalkaliphilic archaea from Lonar lake, Maharashtra, India

Under iron-limiting conditions, most prokaryotes, certain fungi and some monocotyledonous plants are known to produce low molecular weight (often <1000 Da), high-affinity chelating agents that solubilize, by sequestering ferric ion from the environment and transporting it into the cells[1,2] through specific receptors[3,4]. These molecules are known as siderophores and are typically found in iron-deficient cultures[5]. The name siderophore derives from the Greek for 'iron carrier'. Siderophore production by bacteria is considered an important component of bacterial machinery for iron sufficiency and is likely to be more important for survival and growth in a competitive soil environment usually deficient in soluble iron[6,7]. Siderophores are produced as free ligands in cell cultures or in the natural environment, where they preferably bind to Fe^{3+}. However, they also exhibit affinity to other metals.

Historical development of siderophore studies so far has shown that some bacteria and fungi can produce more than one type of siderophore[4,8]. It has likewise been shown that a broad range of structural variations exist within different siderophore classes[3,7]. In 1979, Armstrong and van Baalen[9] isolated the first hydroxamate type of siderophore from the culture of *Agmenellum quadruplicatum* PR6 (*Synechococcus* PCC7002). Over the past decade, several marine siderophores from cultured organisms have been structurally characterized.

As very little is known about assimilation of iron in archaea, the present study was undertaken to catalyse siderophore production by six haloalkaliphilic archaea isolated from Lonar Lake, a saline–alkaline meteorite impact crater lake in Buldhana district, Maharashtra, India (lat. 19°58′; long. 76°36′). All the six organisms are extreme haloalkaliphiles with a minimum salt (NaCl) requirement of 20% and optimum pH 8.0–9.0.

Screening for siderophores was done with the CAS (chrome azural S) test, performed by incorporating the dye in solid Tindal medium on which the cultures were spot inoculated and incubated at 40°C for 4 h. The transformation of blue to yellow colour[10,11] around the growth of organisms threw up four isolates, *Natrinema* sp. SSBJUP-1, *Natrialba wudunaoensis* SSBJUP-2, *Natrialba chahannaoensis* SSBJUP-3 and *Natronobacterium innermongoliae* SSBJUP-4 as producing siderophores.

It must be noted here that glassware used in all the studies was decontaminated of all traces of iron by soaking