Improving the Immune Health of the Muga Silkworm: In A Natural Way- The Probiotic Way

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Muga silk fabric has been an indispensable part of Assamese culture from time immemorial and is considered as the guardian of Assamese ethnic weaver's pride. Muga silk has witnessed the affection of 600-year sovereign Ahom kingdom. Due to its unique golden yellow luster, durability and toughness (toughest among all commercial silks), Muga silk has gained popularity throughout the world. This variety of silk moth is endemic to the Brahmaputra valley of Assam and the adjoining hilly area of Northeast India and was assigned geographical indication (GI) tag in 2007.

Muga silkworm (*Antheraeaassamensis*) broods 5-6 times a year. Itfeeds on a range of host plants. Among the food plants, Som and Solao (as called in Assamese; *Perseabombycina*Kost. and *Litseamonopetala*Roxb. as per scientific naming) are the primary host plants. When these are unavailable, muga silkworm can also feed onsecondary food plants – Dighloti (*Litseasalicifolia*Roxb.) and Mejankori (*Litseacubaba*Lour.).The avenue is highly employment oriented and requires low capital-input. One of the striking features ofMuga silkworm is its outdoor mode of rearing unlike other silk moth varieties (namely, Mulberry andEri). This is also the reason for it being highly disease prone. Shiftsin the agro-climatic conditions and pollution easily affect muga cultivation. As an intrinsic feature, mugasilk worm is less resistant to infection (linked to its genetic make-up and difference in physiology). Even after observing the standard package and practices, muga silk moths easily get diseased in the field.

Much of the yield loss is caused bybacterial and viral infection (more specifically called 'Flacherie' and 'Viriosis', respectively). The severity of these diseases is such that, in a group of

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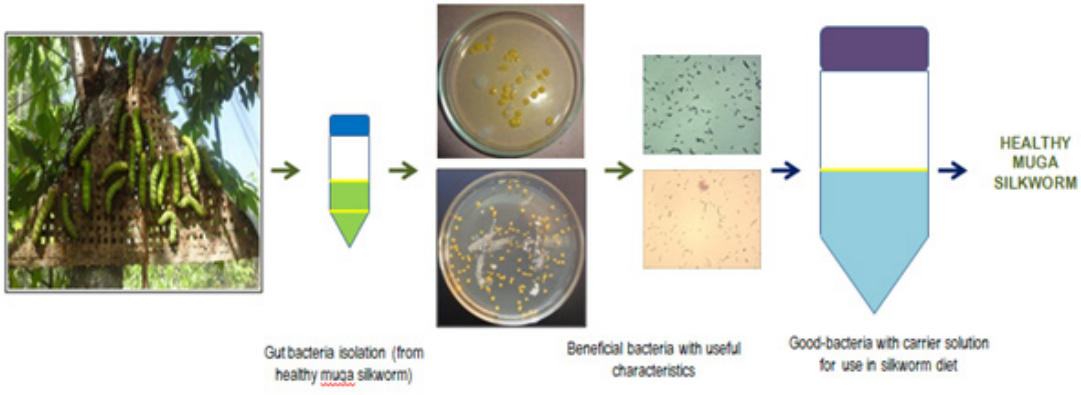
100 moths, under the typical condition, 70 moths get infected by Flacherie (called the 'percentage disease prevalence'– a measure of 'how-bad' is the disease). There are also other comparatively less severe forms of Muga silk disease, namely, 'Grasserie', 'Muscardine'. Each of these diseases is not caused by a specific microorganism, but by a combination of them. With gradual changes in agricultural practices (use of pesticides, felling of forest areas), shifting of agro-climatic conditions, increase in ambient mean temperature, there has been increasing cases of crop failures. Such a situation is very discouraging for the farmers with limited means.

It has long been suggested that healthy and clean leaf diet is a sustainable way to protect the silk moths. However, in out-door rearing sericulture practices, such condition cannot be maintained. From the studies into silkworm gut, it has been observed that the intestinal linings of silkworm support a diverse group of micro-flora. These bacteria perform a range of activities, namely, food digestion, assistance to pheromone production, the supply of essential nutrients, prevention of pathogen colonization and detoxification of harmful chemicals. The necessity of healthy gut-flora (the good bacteria) has already been established in mammals.Thus we hypothesized that maintaining a healthy gut might help increase silk productivity.

With this in mind, I started my research on studying the population of bacteria in healthy silkworms. The idea was to assess bacterial population present in the gut of healthy Mugasilkworms. After studying the activity of the beneficial bacteria, they were to mixwith suitable carriersolutions to be sprayed onto host plants. These bacteria, when eaten by the worms while feeding on the host-plant, would harbourin the gut of silk moths, thus will protect them from bad-bacteria.

Healthy silkworms were collected from different areas of Muga growing regions (also neighbouring states of Assam). The idea was to get a wider view of the bacteria harbouringin the gut of healthy Mugasilkworm. Upon vigorous screening, we observed that bacterial population belonging to a particular species (*Bacillus* species) were common in all the healthy silkworm gut. We then studied each of the bacteria in detail to havemore insight into their contribution towards the well-being of the healthy silk moth. It was found that the bacteria produced several enzymes that are useful for digesting host plant-leaf the worms feed upon (enzymes – Cellulase, Lipase Pectinase). The good-bacteria that we isolated also prevented some bad-bacteria (pathogens of Mugasilkworm) from growing (called antibiosis). This property was due to secretion of some chemicals (antibiotics) that kill the disease-causing bacteria. Thus, we alsounderstood that some bacteria present in the gut of healthy silk moth help in digesting different components of food (carbohydrate, lipid, etc.) while some prevent harmful bacteria from getting access to the gut-linings.

The next goal of our study was to make use of these good-bacteriato enhanceMuga silk production. For this, the preliminary requirement was to make sure the beneficial bacteria did not inhibit one another (antibiosis). Only after ascertaining compatibility among the good-bacteria, they were incorporated in the formulation. We made liquid formulations of these bacteria with certain additives and sprayed onto the host plants periodically. The idea was to observe different vital parameters (Larvae weight, cocoon weight, cell weight, Silk ratio percentage and effective rate of rearing) of the silkworms fed on normal leaf diet and those reared on leaf sprayed with good-



Graphical abstract of improving muga silk productivity using good-bacteria

bacteria formulation (pro-biotic formulation). Our study signifies that there was an enhancement in the vital parameters in silkworms reared on probiotic containing diet.

The concept of probioticincorporation in the diet of silkworm has long been studied; yet, these have not been recommended for standard package and practices for the farmers. For Muga silkworm, application of microbial consortia for enhancing productivity has not yet been reported. We have worked out some of the possible combinations of good-bacterial consortia that can help Muga silkworm to maintain a healthy gut lining. This will help silkworm survive the quantum of pathogenic attacks in the field. Our work for enhancing Mugaproductivity (using combination of bacteria, superior carrier agent that enhance the formulation shelf-life) will encourage more farmers to adopt sericulture and help sericulturists of the region to meet the global demand and reach the world community.