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A Review of Use of Probiotic as Growth Enhancer to Mulberry Silkworm

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ABSTRACT: Probiotics are live bacteria and yeasts that are good for you, especially your digestive system. We usually think of these as germs that cause diseases. But your body is full of bacteria, both good and bad. Probiotics are often called "good" or "helpful" bacteria because they help keep your gut healthy. Many types of bacteria are classified as probiotics. They all have different benefits, but most come from two groups. Ask your doctor about which might best help you. *Lactobacillus* & *Staphylococcus*- This may be the most common probiotic. It's the one you'll find in yogurt and other fermented foods. Different strains can help with diarrhea and may help people who can't digest lactose, the sugar in milk. *Bifidobacterium*- You can find it in some dairy products. It may help ease the symptoms of irritable bowel syndrome (IBS) and some other conditions. *Saccharomyces boulardii* is a yeast found in probiotics. It appears to help fight diarrhea and other digestive problems. Probiotics promote growth. They enhance growth due to nutritional supplementation. In the present review, we have used probiotic as growth enhancer to mulberry silkworm.

KEYWORDS: probiotic, mulberry silkworm, growth enhancer, health, bacteria, supplement, nutrition

INTRODUCTION

The domestic silk moth (*Bombyx mori*) is an insect from the [moth family Bombycidae](#). It is the closest relative of [Bombyx mandarina](#), the wild silk moth.



Bombyx mori

The silkworm is the [larva](#) or [caterpillar](#) of a silk moth. It is an economically important insect, being a primary producer of [silk](#). A silkworm's preferred food are [white mulberry](#) leaves, though they may eat other mulberry species and even the [osage orange](#). Domestic silk moths are entirely dependent on humans for reproduction, as a result of millennia of selective breeding. Wild silk moths (other species of *Bombyx*) are not as commercially viable in the production of silk. [Sericulture](#), the practice of breeding silkworms for the production of raw silk, has been under way for at least 5,000 years in China,^[1] whence it spread to [India](#), [Korea](#), [Nepal](#), [Japan](#), and the [West](#). The domestic silk moth was domesticated from the wild silk moth [Bombyx mandarina](#), which has a range from northern India to northern [China](#), Korea, Japan, and the far eastern regions of [Russia](#). The domestic silk moth derives from Chinese rather than Japanese or Korean stock.^{[2][3]}

Silk moths were unlikely to have been domestically bred before the [Neolithic](#) Age. Before then, the tools to manufacture quantities of silk thread had not been developed. The domesticated *B. mori* and the wild *B. mandarina* can still breed and sometimes produce hybrids.^{[4]:342}

Domestic silk moths are very different from most members in the genus *Bombyx*; not only have they lost the ability to fly, but their [color pigments](#) have also been lost.^[5]

Mulberry silkworms can be categorized into three different but connected groups or types. The major groups of silkworms fall under the univoltine ("uni-"=one, "voltine"=brood frequency) and bivoltine categories. The univoltine type is generally linked with the geographical area within greater Europe. The eggs of this type hibernate during winter due to the cold climate, and cross-fertilize only by spring, generating silk only once annually. The second type is called bivoltine and is normally found in [China](#), [Japan](#), and [Korea](#). The breeding process of this type takes place twice annually, a feat made possible by the slightly warmer climates and the resulting two life cycles. The polyvoltine type of mulberry silkworm can only be found in the tropics. The eggs are laid by female moths and hatch within nine to 12 days, so the resulting type can have up to eight separate life cycles throughout the year.^[6] Eggs take about 14 days to hatch into larvae, which eat continuously. They have a preference for [white mulberry](#), having an attraction to the mulberry odorant [cis-jasmone](#). They are not [monophagous](#), since they can eat other species of *Morus*, as well as some other [Moraceae](#), mostly [Osage orange](#). They are covered with tiny black hairs. When the color of their heads turns darker, it indicates they are about to [molt](#). After molting, the [larval](#) phase of the silkworms emerge white, naked, and with little horns on their backs.

After they have molted four times, their bodies become slightly yellow, and the skin becomes tighter. The larvae then prepare to enter the [pupal](#) phase of their lifecycle, and enclose themselves in a cocoon made up of raw silk produced by the [salivary glands](#). The final molt from larva to pupa takes place within the cocoon, which provides a vital layer of protection during the vulnerable, almost motionless pupal state. Many other [Lepidoptera](#) produce cocoons, but only a few—the [Bombycidae](#), in particular the genus *Bombyx*, and the [Saturniidae](#), in particular the genus *Antheraea*—have been exploited for fabric production.^{6,7}

If the animal is allowed to survive after spinning its cocoon and through the pupal phase of its lifecycle, it releases [proteolytic enzymes](#) to make a hole in the cocoon so it can emerge as an adult moth. These enzymes are destructive to the silk and can cause the silk fibers to break down from over a mile in length to segments of random length, which seriously reduces the value of the silk [threads](#), although these damaged silk cocoons are still used as "stuffing" available in China and elsewhere for [doonas](#), jackets, etc. To prevent this, silkworm cocoons are boiled. The heat kills the silkworms and the water makes the cocoons easier to unravel. Often, the silkworm itself is eaten.⁸

As the process of harvesting the silk from the cocoon kills the larva, sericulture has been criticized by animal welfare and rights activists. [Mahatma Gandhi](#) was critical of silk production based on the [Ahimsa](#) philosophy "not to hurt any living thing". This led to Gandhi's promotion of cotton spinning machines, an example of which can be seen at the Gandhi Institute,^[7] and an extension of this principle has led to the modern production practice known as [Ahimsa silk](#), which is [wild silk](#) (from wild and semiwild silk moths) made from the cocoons of moths that are allowed to emerge before the silk is harvested.⁹

The moth – the adult phase of the lifecycle – is not capable of functional flight, in contrast to the wild *B. mandarina* and other *Bombyx* species, whose males fly to meet females and for evasion from predators. Some may emerge with the ability to lift off and stay airborne, but sustained flight cannot be achieved. This is because their bodies are too big and heavy for their small wings. Silk moths have a wingspan of 3–5 cm (1.2–2.0 in) and a white, hairy body. Females are about two to three times bulkier than males (for they are carrying many eggs), but are similarly colored. Adult [Bombycidae](#) have reduced mouthparts and do not feed. The cocoon is made of a thread of raw silk from 300 to about 900 m (1,000 to 3,000 ft) long. The fibers are very fine and lustrous, about 10 μm (0.0004 in) in diameter. About 2,000 to 3,000 cocoons are required to make 1 pound of silk (0.4 kg). At least 70 million pounds (32 million kg) of raw silk are produced each year, requiring nearly 10 billion cocoons.^[8]

Different concentrations of probiotic supplements of half litre solution was prepared and taken in separate containers every alternate day treatment wise. The harvested mulberry leaves were dipped in probiotic solutions separately treatment and concentration wise and then fed to silkworms once daily (morning feed) treatment and concentration wise from fourth instar first day onwards till they reached spinning stage. Spinning larvae were separately mounted on netrikas for cocoon construction treatment and replication wise. Observations were made on larval weight a day before

spinning, fifth instar and total larval duration; effective rate of rearing and fresh weight of silk glands on the day of 50 per cent spinning. The increase in larval period was directly related to concentrations of probiotics used and attributed to the assumption that, the worm's nutritive requirement might have been fulfilled within lesser duration because of feed supplementation of probiotics.¹⁰ The interaction of feed additives along with concentration indicated significantly highest silk gland weight of silkworm. The variation in the response of probiotics and their concentration might be attributed to supplementation of nutrients which in turn might have played role on the metabolic process in silkworm. The protein is effective only up to an optimal level beyond which the larval growth is impeded considerably and accordingly at higher concentration of probiotics the response.¹¹

II.DISCUSSION

There were lower incidence of diseases in the treated silkworms and this might be due to influence of feed additives containing protein, amino acids, carbohydrates and minerals which act as building blocks of tissues making them robust and thus imparted healthiness to larvae. Further, due to better growth and development on account of nutritious feed received during silkworm rearing.¹² Nutrition plays an important role in improving the growth and development of the mulberry silkworm like other organisms. It is stated that silk production is dependent on the larval nutrition and nutritive value of mulberry leaves, which plays a very effective role in producing good quality cocoons. Probiotics are the live microbial food supplements beneficially affecting host by improving the microbial balance and enhanced the rapid cellular growth and development. There are no commercial probiotics formulations specifically designed for sericulture though they are available in for human, aquaculture and veterinary medicinal use. Scientists observed improvement in larval body weight, cocoon weight, shell weight and pupation percentage of silkworm larvae when fed on mulberry leaves treated with *Lactobacillus plantarum*.¹³



Silkworm Cocoons

In the present study, the effect of probiotics viz. *Lactobacillus*, *Bifidobacterium* and *Saccharomyces* on mulberry silkworm through leaf fortification have been investigated. It is well known that probiotics contain nutrient supplements such as proteins, carbohydrates, amino acids, vitamins, sterols, hormones, antibiotics etc. and are known to influence the growth and development as well as health of humans, poultry, fish and cattle. Attempts have been made by several authors to know the effect of probiotics under different concentrations in isolation on silkworms and in the present study the effect of different probiotics on mulberry silkworms under different concentrations has been studied for effective rate of rearing, cocoon weight and economics.¹⁴ The present study may be due to less incidence of diseases in the treated silkworms and this might be due to influence of feed additives (probiotics) containing protein, amino acids, carbohydrates and minerals which act as building blocks of tissues making them robust and thus imparted healthiness to larvae. Further, due to better growth and development on account of nutritious feed received during silkworm rearing.¹⁵ The cocoon weight depends on the rearing conditions, quality and quantity of the mulberry leaves supplied during rearing. The cocoon weight is important commercial character indicate the approximate quantity of raw silk output. The increased cocoon was attributed to daily feeding of mulberry leaves supplemented with probiotics to fourth instar and fifth instar silkworms. Also, the feed supplement ingredients involved in the synthesis of silk proteins and nucleic acids such as RNA and DNA in the silk gland cells there by improves the silk content in the cocoon shell.¹⁶

III.RESULTS

Feeding silkworms with leaf supplemented with a proteinaceous source (probiotic) can enhance the cocoon and shell weights. In India, considerable seasonal fluctuations occur in the nutritional value and composition of mulberry leaves

depending on factors such as weather, agricultural practices, pest and diseases which have an immense impact on the growth and development of silkworm which in turn results in crop loss.¹⁷



Rearing and farming of mulberry silkworm

Supplementation of mulberry leaves by using different nutrients as probiotics and feeding to the silkworms are useful modern techniques to increase economic value of cocoons. Nutritional studies on silkworms are an essential requisite for its proper commercial exploitation and are sole factors which augment quality and quantity of silk. In recent years, attempts have been made in sericulture with nutrients such as protein, vitamins, carbohydrates, amino acids, vitamins, hormones and antibiotic etc. for better performance of good quality of cocoons. Probiotic are the live microbial food supplements that benefits host by improving the microbial balance and enhancing the rapid cellular growth and development. Certain probiotic bacteria inhibit the growth of microbes. *Streptomyces noursei* are probiotic microbes which have been proved for their antibacterial activity and used as good ecofriendly management of silkworm diseases. Effect of supplementary feed such as 'Serifeed' improved the growth and development of *Bombyx mori* L. It has been reported that probiotic might produce vitamins and detoxify the compounds in the diets or breakdown the digestible compounds, which may lead to the nutritional improvement and stimulate appetite.¹⁸

Silkworms fed with bacterial fortified mulberry leaves were effective in improving the intestinal microbial balance thereby increasing the cocoon characters. Silkworms exhibited considerable differences when fed with bacterial fortification with Probiotics. The highest cocoon weight (2.014 g); pupal weight (1.605 g); shell weight (0.409 g) and shell ratio (20.30 %) was recorded in probiotics than control. Nutritional contributions and the symbiotic benefits offered by insect gut-dwelling bacteria which can substantially modify and promote the health and silk production capacity of *B. mori*.¹⁹ The digestive system is home to many types of bacteria. They help to keep intestines healthy and assist digesting food. They are also believed to help the immune system. In probiotic therapy, live microbial feed supplements are improving the intestinal microbial balance of host. In the present investigation, the growth and cocoon parameters of silkworm significantly increased in all the treated groups compared to control. The significant increase were recorded in larval weight (4.12 g), cocoon weight (1.97 g), pupal weight (1.60 g), shell weight (0.37 g), shell ratio (18.78 %), silk productivity (4.81 cg/day), filament length (1170.84 m), filament weight (0.31 g) and denier (2.38) was registered in probiotics at 108 cfu/ml at bacterial cell concentration. The reduced mortality (3.64 %) was recorded which could be due to the suppression of disease causing pathogens by the antimicrobial property of supplemented bacteria.²⁰

IV.CONCLUSIONS

Nutrition is the single most factors that influence the growth and development of *B. mori*. Fortification of mulberry leaves with complementary compounds were increased the larval growth and post cocoon characteristics. The present investigation revealed probiotic supplementation significantly promoted the larval growth which in turn was reflected on qualitative and quantitative improvement in cocoon characters. Based on the above observations, it could be

concluded that the novel probiotic strains *Lactobacillus*, *Staphylococcus*, *Saccharomyces* etc. could serve as a potential probiotic candidate for silkworm growth and development.²⁰

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