Bio Vet Innovator Magazine

Volume 2 (Issue 2) FEBRUARY 2025

Popular Article

Transforming Waste into Feed: The Potential of Silkworm Pupa Meal in Poultry Farming

Dr. Aditi Gupta[1], Dr. Naresh Godara[2], Dr. Sohrab Malik[1], Dr. Anmol Pareek[3]
[1]*PhD Scholar (Livestock Production Management), SKUAST-Jammu*
[2]*MVSc Scholar (Veterinary Physiology), SKUAST-Jammu*
[3]*PhD Scholar (Livestock Production Management), DUVASU, Mathura*
***Corresponding Author:** gupta0111aditi@gmail.com
DOI: https://doi.org/10.5281/zenodo.14969347

Received: February 24, 2025
Published: February 27, 2025
© All rights are reserved by **Aditi Gupta**

Introduction:

The term "poultry" describes the domestic or commercial rearing of birds for their meat and eggs, such as chickens, ducks, turkeys, geese, etc. Both poultry meat and eggs provide a high-quality animal protein content profile with an ideal amino acid profile that is suitable for human ingestion in sufficient amounts. Consequently, it plays a significant part in advancing and developing human health. India is the world's third-largest producer of eggs and the fifth-largest producer of chicken meat. Over the past 30 years, expectations regarding the productivity and efficacy of poultry feed have significantly changed due to the growing demand for products derived from animals. It is expected that this change will continue in the future. By 2050, the world's meat consumption is expected to have increased by 58%.

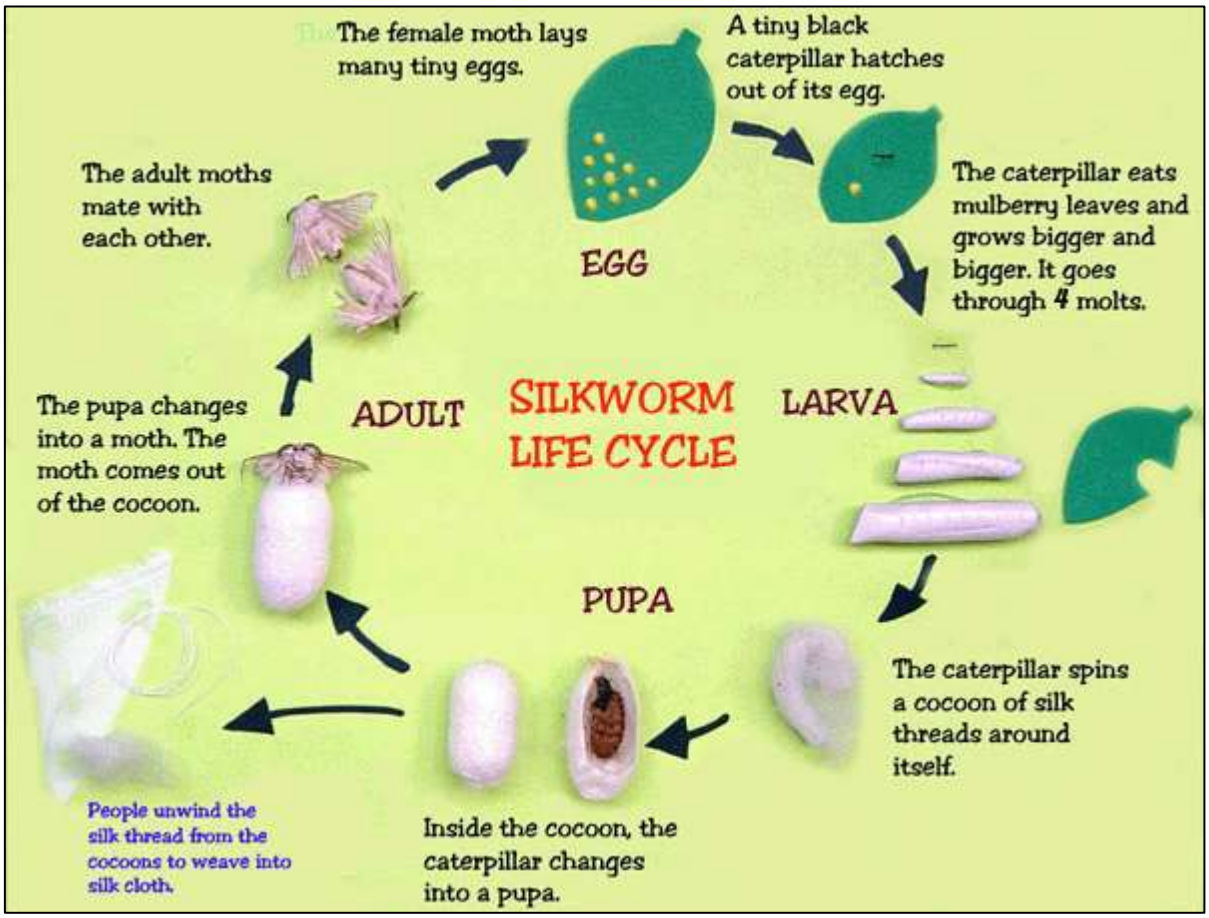
The cost of feed accounts for 60–80% of production costs in the poultry business, and it is continuously increasing. Currently, 15% of the chicken feed cost is animal protein, which is the costliest ingredient. The feed industry now needs more traditional, costly feedstuffs like fishmeal and soybeans due to recent advancements in poultry production and manufacturing processes. Therefore, looking for locally accessible, non-traditional protein sources to substitute for traditional protein components in poultry meals is essential to turning poultry farming into a sustainable sector in the future.

Approximately three-fourths of all life on Earth is made up of insects. Insects are becoming more popular as a possible substitute protein source in chicken feed because of their comparable lipid content (30–40% dry matter basis) and protein content (40–60% dry matter basis) to conventional soybean and fish meal. Waste silkworm pupae are one of the many protein sources that, when properly cared for and reasonably priced, can be a valuable dietary protein for hens. When silkworm pupae pull silk from their cocoons, they are discarded as a waste byproduct of the silk industry. The enormous number of pupae generated and discarded (about 5500 pupae per kilogram of raw silk) seriously endangers the ecosystem, land, and water. For these pupae to be disposed of or used in a productive company, technical interventions are required.

A well-studied component of poultry and animal feed is pupal powder, which is made from the silkworm pupae and also referred to as the silkworm pupae meal. Other common names are silkworm pupae (SWP), silkworm meal, wasted silkworm pupa, deoiled silkworm pupa meal, non-deoiled silkworm pupa meal, etc. As a good source of protein, carbs, fat, fiber, ash, methionine, lysine, calcium, and phosphorus, it has a high nutritional value and may provide an affordable animal feed for the expanding livestock industry.

Growth, Development and Types of Silk Worm:

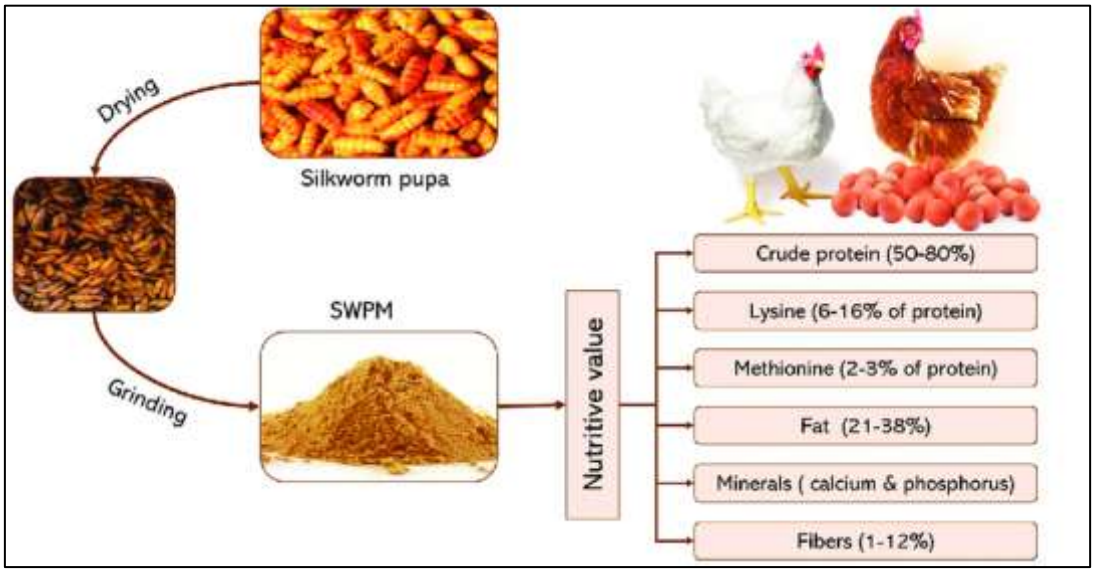
The caterpillars of a species of moth that produces silk are called silkworms. The cocoons of the domestic mulberry silkworm (Bombyx mori), a moth that is a member of the Bombycidae family, provide over 90% of the silk produced worldwide. The silkworm caterpillar's life cycle starts when an adult moth lays eggs, which hatch. The caterpillar then grows steadily on mulberry and shea butter leaves for four to six weeks, reaching its maximum size of roughly 10 cm. After reaching the pupal stage, the silkworm creates a cocoon to protect itself from raw silk. The moths then emerge after the pupae release an enzyme that causes the cocoon to open.



Following are the different types of silkworms from which silkworm pupa meal is obtained:

Species of silk moth	Silk Producing States	Preferred Food (Leaves)	Type of Silk
Bombyx mori	Karnataka, Andhra Pradesh and Tamil Nadu	Mulberry	Mulberry Silk
Antheraea assamensis	Assam, Meghalaya, Nagaland, Arunachal Pradesh and Manipur	Champa	Muga Silk
Antheraea mylitta	West Bengal, Bihar and Jharkhand	Arjun	Tasar Silk
Attacus ricini	Assam, Meghalaya, Nagaland, Arunachal Pradesh and Manipur	Castor	Eri Silk

Nutritive Composition of Silkworm Pupa Meal:



Silkworm Pupa Meal Vs Conventional Protein Source:

Constituents (% DM)	Silkworm pupae meal	Silkworm pupal meal (defatted meal)	Fish meal	Soya meal
Crude protein	60.7	75.6	70.6	51.8
Lipid	25.7	4.70	9.90	2.00
Calcium	0.38	0.40	4.34	0.39
Phosphorus	0.60	0.87	2.79	0.69
Ca:P ratio	0.63	0.46	1.56	0.57

Safety and Limitations:

Because of its sustainability and nutritional composition, silkworm pupa meal is becoming increasingly popular as a substitute protein source in poultry feed. However, its efficacy and safety must be thoroughly assessed.

Nutritional value:

The protein, lipids, vitamins, minerals, and necessary amino acids found in silkworm pupa meal can greatly enhance poultry growth and egg production. The meal includes roughly 40–60% protein, 15–25% fat, 6–8% ash, and about 10–15% carbohydrates. Due to its protein content and amino acid composition, particularly the high amounts of cysteine and methionine, it is a desirable feed element.

Anti- nutritional factors (ANFs):

ANFs can reduce the efficiency of feed and impact the health and performance of the poultry. Various ANFs found in silkworm pupa meal are-

a. ***Chitin-*** Silkworms and other arthropods' exoskeletons include a fibrous material called chitin. Like cellulose, it is indigestible to the majority of animals, including poultry. Even though poultry can withstand trace levels of chitin, its presence can make the meal less digestible. Although chitin is usually well absorbed when the food is adequately processed, excessive levels might cause gut irritation or decreased feed intake.

b. ***Protease inhibitors-*** Protease inhibitors are substances that prevent the breakdown of proteins into amino acids by digestive enzymes like proteases. Protease inhibitors can slow down the digestion of proteins, which

makes it harder for chickens to get the most out of their food. They may restrict performance or growth if they are present in high amounts.

c. ***Lectins-*** Proteins called lectins bind carbohydrates and can obstruct nutritional absorption. Although they are more frequently found in plants, lectins can also be found in some goods derived from insects, such as silkworm pupae. These adhere to the intestinal wall, preventing the absorption of nutrients and possibly causing upset stomach. Nonetheless, lectins in silkworms are normally found in trace amounts and rarely pose serious problems for poultry.

d. ***Phenolic compounds-*** Phenolic substances, including flavonoids, which are generally regarded as antioxidants, may be present in silkworms. Phenolic chemicals, however, can have anti-nutritional effects in large concentrations by binding to minerals and proteins and reducing their availability to the animal. If taken in excess, they may impair the absorption of important nutrients like iron and zinc, which could have an impact on the growth and health of chickens.

e. ***Fatty acids oxidation-*** Pupae of silkworms have a comparatively high fat content, especially unsaturated fatty acids. Inadequate storage or processing of the meal can cause the fats to oxidize and break down, generating free radicals and other substances that can affect birds, resulting in stunted growth, low-quality feathers, and eventually organ damage if ingested in excess.

Excessive Protein and Fat:

While silkworm pupa meal is a high-quality protein source, if fed in excess, it can lead to an imbalance in the hen's diet, particularly in terms of excess protein or fat.

- High protein content may cause: Kidney stress or renal issues due to excess nitrogen excretion.
- Obesity if the fat content is too high, especially if layers are not consuming enough other nutrients to balance their energy needs.

Inclusion Levels:

The majority of research carried out in different parts of the world indicates that, depending on the kind of chicken (broilers, layers, etc.), silkworm pupa meal can be added to poultry diets at levels of 5% to 20% without having a major adverse effect.

Treatment and Processing Methods:

To ensure the safety and effectiveness of silkworm pupa meal in poultry feed, it's essential to apply specific treatment and processing methods that help neutralize or reduce the anti-nutritional factors (ANFs) and prevent contamination.

1. **Heat treatment-** Many anti-nutritional agents, such as lectins, protease inhibitors, and certain phenolic compounds, can be rendered inactive by heat treatment. Additionally, it stops lipids from oxidizing and lowers microbial contamination. High heat (usually between 80 and 120°C for 15 to 30 minutes) can be applied to the silkworm pupa diet. This will increase the meal's safety, improve digestion, and break down dangerous substances. It is among the most widely used and trustworthy techniques for deactivating ANFs and guaranteeing that the food is safe for poultry to eat.
2. **Enzyme treatment-** To improve digestibility and nutrient absorption, certain enzymes can be added to

silkworm pupa meal to aid in the breakdown of anti-nutritional components including fiber and chitin. It is possible to incorporate enzyme preparations, like cellulase or chitinase, into the meal. These enzymes primarily target fibrous materials that are difficult for chickens to digest, such as chitin.

3. **Drying-** Mycotoxin contamination can result from the growth of bacteria, molds, and fungi, which must be stopped by proper drying. Additionally, it aids in lowering moisture content, which stops lipids from oxidizing and going rancid. The meal for silkworm pupae should be dried until the moisture content is between 8 and 10%. Oven drying, solar drying, or the use of specialist drying equipment can all be used for this.
4. **Ethanol treatment-** It is a potential method used to process silkworm pupa meal or other animal-based proteins to improve their safety, digestibility, and nutritional profile by reducing anti-nutritional factors (ANFs), microbial contamination, and other harmful components.

Phenolic chemicals, tannins, and other lipophilic (fat-soluble) pollutants are examples of toxins or anti-nutritional elements that ethanol can aid in eliminating. Its antibacterial qualities can aid in lowering the quantity of dangerous bacteria (including Salmonella and E. coli) and fungi that might contaminate the pupa meal. By lowering the number of allergenic proteins in the meal, ethanol treatment may help make it safer for chickens to ingest. Depending on the intended result, ethanol treatment normally entails soaking or washing the silkworm pupa meal in ethanol at concentrations ranging from 50% to 95%. After a predetermined amount of time—typically a few hours—for the meal to react with the ethanol, the ethanol is either separated or evaporated.

Effect of Silkworm Pupa Meal on Broilers and Layers:

1. **Better Growth and Performance:** A number of studies have demonstrated that adding silkworm pupa meal to broiler diets at the proper inclusion levels—usually between 10 and 15 percent—can improve feed conversion ratio (FCR) and weight gain. High protein and amino acid content provide an outstanding source of nutrients that promote muscular growth and general development.
2. **Improved Feed Efficiency:** Broilers fed diets containing silkworm pupa meal frequently exhibit improved feed conversion, or the more effective conversion of feed into body mass, as a result of the high-quality protein and balanced amino acid profile. Better growth per unit of feed used results from this, which also improves feed efficiency.
3. **Enhanced Immune Function:** The immune system of broilers and layers may be strengthened by the presence of bioactive substances in silkworm pupa meal, such as vital fatty acids and antimicrobial peptides. According to research, SPM can lessen the requirement for antibiotics and other growth enhancers by increasing the resistance to sickness.
4. **Cost-Effectiveness:** In areas where silkworms are produced in significant quantities as a byproduct of sericulture, silkworm pupa meal may be a more affordable option than more conventional protein sources like soybean meal and fish meal. For poultry breeders, using SPM as a substitute protein source can lower feed expenses.
5. **High Digestibility:** The protein in silkworm pupa meal is generally well-digestible by broilers, especially when the meal has been processed to eliminate anti-nutritional elements (e.g., heat-treated, fermented, or enzyme-treated). This makes it more likely that the birds will be able to absorb and use the nutrients.

6. **Increased Egg Production:** Adding silkworm pupa meal to layer diets has been linked to increased egg production, according to several studies. The metabolic activities involved in the creation of albumin and egg yolks are supported by the high protein and amino acid content.
7. **Improved Egg Quality:** Silkworm pupa meal has been associated with improved egg quality, such as increased egg weight and shell strength, in addition to increasing the number of eggs.
8. **Omega-3 Fatty Acids:** Polyunsaturated fatty acids, such as omega-3 fatty acids (like oleic and linoleic acid), are present in silkworm pupa meal. These fatty acids are good for the general health of the hens and can also enhance the nutritional value of the eggs. These fatty acids may improve the colour of the egg yolk and raise the omega-3 content of the eggs, which is a desirable quality in some markets when added to layer diets.

Conclusion:

In place of conventional chicken feed ingredients like fish meal and soybean meal, silkworm pupae meal (SWPM) offers a viable and sustainable substitute. It is a healthy choice for poultry because to its high protein and fat content, and its production is in line with the principles of the circular economy. Adding SWPM to poultry diets has several benefits, such as increased palatability, the potential to increase market demand for chicken meat, and a smaller environmental effect. SWPM lessens feed-food competition and promotes more effective resource usage by using a waste product from the manufacturing of silk.

Future Prospects:

More study is required to fully understand SWPM's potential as a component in chicken feed. Key areas to focus on include-

- ***Process optimization:*** Improving processing techniques to improve SWPM's digestibility, palatability, and shelf life are important areas of focus.
- ***Performance evaluation:*** Performing extensive research to evaluate how SWPM affects animal performance, intestinal health, and meat quality in a range of poultry species and rearing environments.
- ***Regulations to be taken into account:*** resolving any legal issues and creating standards for the efficient and safe application of SWPM in chicken feed.
- ***Customer acceptance:*** Recognizing and resolving any possible issues with customer attitudes and preferences toward ingredients in insect-based feed.

Researchers and industry participants can support the broader acceptance of SWPM as a sustainable and financially feasible poultry nutrition option by tackling these issues.