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PROTEIN ENHANCEMENT OF FISH FEED VIA SERI WASTE

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INTRODUCTION

Aquaculture is predicted to grow while capture fisheries remain stable, it will become increasingly more difficult to meet the demand for low value/trash fish. The ever-increasing cost of fish meal and other ingredients for fish feed has led to the search for other alternatives for protein sources by the industry. Insects form part of the natural fish diet and they represent a good source of protein. Over the last decade, studies on the replacement of fishmeal with insect meal have emerged with promising results. Silkworm pupae, a waste of the silk reeling industry, is a suitable candidate as a Fish Meal replacement because of its high nutritional value.

HISTORY OF SERICULTURE

Sericulture, or silk production, from the moth, *Bombyx mori*(L.), has a long and colourful history unknown to most people. According to Chinese records, the discovery of silk production from *B. mori* occurred about 2,700 B.C. Chinese legend states that the great prince, Hoang-ti, directed his wife, Si-ling-chi, to examine the silkworm and test the practicability of using the thread. Thereafter, Si-ling-chi discovered not only the means of raising silkworms, but also the manner of reeling the silk, and of employing it to make garments. Si-ling-chi was later deified for her work and honoured with the name Sien-Thsan, or "The Goddess of Silk Worms" (Huesser 1927).

STATUS OF INDIAN SILK PRODUCTION

In India, due to favourable climatic conditions, mulberry is cultivated mainly in five states, viz., Karnataka, Andhra Pradesh, Tamil Nadu, West Bengal and Jammu & Kashmir.

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These five states collectively account for 97% of the total area under mulberry cultivation and 95% of raw silk production in the country. The present global scenario clearly indicates enormous opportunities for the Indian Silk Industry. In 2016-17 the mulberry Silk Production Statistics estimated the world silk production to be 192,692 metric tonnes. China's contribution to world silk production is 80% (158,400 metric tonnes), and the share of Indian silk production is 30,348 metric tons (13%). China and India together account for 93% of world silk production. According to the Annual Report of the Central Silk Board (CSB) for the year 2016-2017 the silk scenario of India Domestic demand 36,000 metric tonnes, Own production 30,348 metric tonnes, Gap in production 6000 metric tonnes, Raw silk imports 3795 metric tonnes, Silk fabric imports 3000 metric tonnes, Silk exports (worth Rs.) 2093.42 cr, Sericulture villages 52,360, Sericulture families 9, 47, 631, Employment (lakh persons) 85.10. The market share of Indian silk exports in the global silk trade is 4% to 5%.

GLOBAL DEMAND FOR FISHMEAL

Global fishmeal production averaged about 6.5 million metric tonnes (mmt), respectively, over the past 20 years. Aquaculture used a higher percentage of fishmeal production in 2006 than will be the case in average years. Overall, however, the percentage of annual global production of fishmeal being utilized in aquafeeds has increased steadily over the past 20 years from approximately 15% to 65% respectively (Tacon&Metian 2008). In 2006,27% of the fishmeal used in the aquafeed sector went into feeds for marine shrimp. Feeds for marine fish utilized18% and salmon feeds15% of the fishmeal used in aquafeeds. Overall, 45% of the fishmeal used as aquafeeds in 2006. It has used for carnivorous fish species such as salmon, trout, sea bass, sea bream, yellowtail and other species. Surprisingly, 21% was used in feeds for fry and fingerling carp, tilapia, catfish and other omnivorous species. Global fishmeal production is unlikely to increase beyond current levels, although with increasing recovery and utilization of seafood processing waste, global production could increase by 15-20%. Nevertheless, the continued growth of aquaculture production is fundamentally unsustainable if fishmeal remains the primary protein source used in the aquafeed industry.

SILK WORM PUPAE

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In the silk industry, silkworm pupae (SWP) are discarded after reeling of silk thread, which contains a high percentage of protein that can be used experimentally as an animal feeds for chicken, pigs, rabbits and cattle and also for freshwater fish (Das and Sutradhar, 1971). Silkworm pupae of Antheraea mylitta, Drury, a waste product of the silk industry, is not only rich in protein (Bhuiyan, et al.,1998) but also is also an important source of Nitrogen, Calcium, Phosphorus, Crude Fibre, Lysine, Methionine, etc. (Habib and Hasan, 1995). The pupae remaining after reeling of silk fibre, becomes a waste product of this industry and can serve as a feedstuff. This spent SWP are highly degradable often discarded in the open environment or used as a fertilizer. The utilization of this waste Silkworm pupae (SWP) for feed or for the production of valuable biological substances such as chitin, protein, oil and fatty acids (α-linolenic acid) can be an eco-friendly method to mitigate the environmental impact of silk production.

NUTRITIONAL PROFILE OF SILKWORM PUPAE

Dried silkworm pupae's nutritional value is comparable with that of fishmeal and comes at a much lower price. Its crude protein content ranges from 52 to 72% while for the de-oiled meal it can be up to 65 to 80%. SWP protein is rich in essential amino acids such as valine, methionine and phenylalanine. The contents of essential amino acids in SWP protein were on par with the FAO/WHO/UNU suggested nutritional requirements for fish (2007). The lysine (6-7% in 100 g CP) and methionine plus cystiene levels of approximately 4% are particularly high in silkworm pupae.

SILK WORM PUPAE AS AN ALTERNATIVE SOURCE FOR FISHMEAL

Silkworm pupae *(B. mori)* has been an important fish feed ingredient in the Indo-Pacific region. Increased raw pupa incorporation for a long period leads to off-odour and unpleasant taste. The dead SWP and moths could also be used as fish feed. Studies with deoiled SWP meal revealed, it has a higher protein content than the non-deoiled SWP meal and suitable as a dietary protein source for fish. Silkworm pupae influence of diet on body composition, digestibility of nutrients and the influence of the diet on the organoleptic quality showed that SWP meal is equivalent to fish meal in all respects. pupa which costs much less than the fishmeal and available in large quantities could be profitably utilized in the

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formulation of low-cost, nutritionally balanced diets for carps. The use of SWP as a dietary protein source for catla fingerling and reported that a diet prepared with 100% inclusion of SWP exhibited a better growth performance and it could completely replace fish meal as a protein source. A diet prepared with 50% inclusion of SWP in a diet with fish meal, showed improved growth rate and feed utilization by rohu (*Labeo rohita*) fingerlings. Fermented silkworm pupae (SWP) silage incorporated feed, resulted in appreciable body weight gain, feed conversion ratio (FCR) and specific growth rate (SGR) and proved superior to untreated fresh SWP pastes and fishmeal in the diets of carp species (IMC). Cost-effective silkworm pupae diet could be used as a better alternative to completely replace shrimp meals in the diet of rainbow trout fingerlings (*Oncorhynchus mykiss)* without compromising survival and growth. Thus, it could be used for trout rearing with SWP, replacing fish meal up to 5-15%, without affecting the growth performance. catfish can be successfully reared with SWP, replacing fish meal up to 75-100%, without affecting the growth performance. In the case of, marine fishes can be successfully cultured with SWP, replacing fish meal up to 10%, without affecting the growth performance.