Probing the potential of myctophid silage in aqua-feed formulation

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Myctophids are the most abundant and diverse mesopelagic fishes in the Southern Ocean (Saunders et al., 2019). It contributes to about 65% biomass among mesopelagics with an estimated global biomass of 550-660 million tonnes. Though myctophid fishes are one of the most abundant marine organisms, they are least studied and underutilized group. Moreover, reports states that they are usually considered as by-catch from the shrimp trawlers and discarded back to the sea (Hidalgo and Browman, 2019). Considering the large standing stocks of myctophids in some parts of the world ocean and its fishery potential, a strategy should be devised to exploit the biomass rather than dumping as by-catch. It has been reported that myctophids have considerably good amount of protein ranging from 11–23% and lipid content of 0.5–26% (Zhang et al., 2023). However, inspite of its nutrient richness, they are often being neglected. Only a small portion of lanternfishes is being utilized in the form of sun-dried fish products, fishmeal, fish oil, fish silage etc. (Shaviklo and Rafipour, 2013). The myctophids can be a source of protein and lipid if processed and extracted appropriately.

Proteins are often reported as one of the high-priced ingredients in aquafeed formulations adding to nearly 70% of the total operational cost. Hence, to make the global aquaculture industry more economical and sustainable, one important aspect is to use cost-effective feed ingredients. Fish meal remains as one of the important protein sources in aquafeed formulations taking into account its unique essential aminoacid composition, micronutrient content and high protein digestibility. However, the high price along with the irregularity in supply have fostered researchers to screen affordable replacements for fish meal, whether wholly or partially. (Howlader et al., 2023). Considering the high protein content in myctophids, its potential as an aquafeed protein source needs be explored.

Fish silage has recently emerged as an affordable alternative for fish meal. It is defined as a liquid product obtained from the whole fish or parts of it, by resorting to different production methods such as chemical, biological and enzymatic silage. Silage prepared by any of the above methods are reported to be proteins, enzymes, organic acids, amino acids,

and even biologically active secondary metabolites qualifying it as a sustainable, low cost feed ingredient. In this regard, the present study was designed with an objective to utilize the myctophid biomass as an aqua feed ingredient, specifically as a protein source by resorting to silaging. Around 86 - 90% of total lipid in myctophids are contributed by wax esters (Noguchi et al., 2004).

Two myctophid species, viz, *Neoscopilus microchir* and *Diaphus watasei* were selected for the present study (fig 1a,1b). They were mixed in a ratio of 1:1 and accordingly, a mince was formulated. Nutrient profiling of the mince thus developed indicated that it had fairly good amounts of protein, lipid and ash with values of 77.14, 6.13 and 8.91 % ash respectively on dry weight basis. Myctophid silage was prepared by adding commercial grade formic acid at different concentrations of 2.5% (T1), 3% (T2) and 3.5% (T3) (fig 2a, 2b). The pH was checked regularly which was maintained below 4 and after five days it was found to be stable. The silage thus prepared was evaluated for biochemical changes for 10 days with sampling on every alternative day. Changes in degree of hydrolysis and protein was studied. It was observed that on the 7th day of silaging, an intense putrid smell was recorded for the T1 treatment indicated its spoilage. However, such adverse changes were not observed for T2 and T3 treatments. Further, the lowest degree of hydrolysis was recorded for T1 and the values were almost similar for T2 and T3 with values of 53.57 and 51.23% respectively. The degree of hydrolysis is important indicator in determining the functional properties of hydrolyzed proteins. Several factors can affect the degree of hydrolysis such as time of silaging, method of silaging, the nature of raw material employed etc. However, in this case all these parameters have remained constant with only difference in the concentration of formic acid. It was clear from the data that employing a lower concentration of 2.5% formic acid has resulted in a lower degree of hydrolysis which is not preferred. The degree of hydrolysis was found to increase upto 53.57% when 3% formic acid was employed. Interestingly, it was observed that a further increase in formic acid concentration to 3.5% resulted in slightly lowering the degree of hydrolysis to 51.23% indicating 3% concentration was more ideal.

Fig. 1. (a) Neoscopilus microchir

Fig. 2. (a) Silage mixed with formic acid

Fig. 1 (b). Diaphus watasei

Fig. 2 (b). Myctophid Silage

From the point of degree of hydrolysis, T2 treatment can be considered as better. Furthermore, by employing a weak organic acid such as formic acid at concentration of 3%, myctophid silages with better assimilation could be achieved. This study points out the significance of converting myctophid into valuable aquafeed ingredient, specifically as a protein source. However, further scientific evaluation in terms of growth performance has to be carried out for validating the above findings and efficacy of the developed feed with myctophid silage has to be evaluated by studying its growth and physio-metabolic changes in a fish model study.

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