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Review Paper

Effects of Single Cell Protein Replacing Fish Meal in Diet

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Abstract
The increasing world population needs increasing amount of nutrients specially that of protein for human consumption. Fish had been remained important and good source of protein. Even poor and rural people can get free source of nutrition from fish locally. Now a day's demand of cheaper and effective fish meal is increasing. The controlled diet has fish meal with graded levels of yeast SCP (10, 20, 30, 40, and 50%) yeast in feed formulation. Present paper therefore tried to review the available literature in which production of SCP is investigated using yeast and other microbes, requiring less agriculture land, with lower production cost and more effective fish meal diet.

***Key words**: Single cell protein, Fish meal, Yeast, Nutrient digestibility*

Introduction

Single cell protein (SCP) refers to the dried cells of microorganisms such as yeasts, bacteria, fungi and microalgae, grow in large-scale culture systems for use as protein sources in human food or animal feed (Zepka*et al*., 2010; Wang *et al*., 2013). Compared to fish meal, most sources of SCP (from bacteria and yeast) have similar lysine (Lys), methionine (Met) and cysteine (CYs) content, and a higher proportion of tryptophan (Trp) and threonine (Thr) (Skrede*et al*., 1998). There are not only proteins, but also contributes free amino acids, lipids, carbohydrates, vitamins and minerals in SCP (Anupma and Ravindra, 2000). Production of SCP using waste materials as substrate provides an economically feasible protein source that is useful in animal feed and products for human consumption as it often meets dietary requirements for protein (Kuhad*et al*., 1997).

Algae, fungi and bacteria are the chief sources of microbial protein that can be utilized as SCP. In general, high production control make SCP more attractive as a protein source compared with conventional plant and animal origins (Paraskevopoulou*et al*., 2003).
The SCP can be a protein source that offers a potential alternative to fish meal, meat and bone meal, soybean meal, and other protein sources in animal nutrition (Hellwing*et al*., 2007). Certain amounts of traditional protein sources can be substituted by SCP without impairment to the performance of pigs (Braude*et al*., 1977; Hanssen and Farstad, 1980). Previous studies showed that up to 40%, 20% (chickens), and 50% (pigs) of dietary N could be replaced by SCP without affecting nitrogen retention, heat production, and energy retention. Prosin and protide are two kinds of SCP, by-products of the production of lysine and nucleotide fermented from cornstarch by *Corynebacterium glutamicum.*A new source of protein, information regarding their nutritional value and effects on pig performance are limited. Therefore the objectives of the effects of prosin and protide replacing 50% or 100% of fish meal in diet with identical nutrient levels on growth performance, nutrient digestibility and intestinal morphology in weaned piglets.

Fisheries and Aquaculture

The increasing demand for seafood has led to a dramatic upswing in the aquaculture sector. In recent years, the production of farmed fish has been almost as great as the amount produced in the capture fishery industry. It is common to include fish meal or fish oil in fish feed and therefore aquaculture itself is a greater consumer of fish products from the capture industry. Fish meal is produced from fish or fish water that is pressed and dried. This waste was initially used in agriculture as fertilizer and later in pig and poultry feed, but it is currently used mainly in aquaculture, as fish feed. In 2010, 73% of the fish meal and 71% of the fish oil produced were used by aquaculture. At the present time, fish are being caught for use as fish oil and fish meal in the feed industry and at each trophic level there is a substantial loss of net protein. With a growing global human population, it is important to formulate a feed that utilizes resource which is unsuitable for human consumption and converts these to proteins suitable for human consumption.

Alternative feedstuffs

As fish meal is not a sustainable protein source, the aquaculture industry is looking for alternatives that are cheaper and more environmentally friendly. Among those alternative sources are plant-based and microbe-based feedstuffs.

- **Plant based feedstuffs:** Much research has been carried out to find alternative feed sources of protein, with plant materials such as oilseeds, legumes and cereal grains often being used (Gatlin *et al*., 2007). Plant feedstuffs such as soybean meal have the advantages of being much cheaper than fish meal and are considered to be a high quality source of protein (FAO, 2014). However, soybean meal has also been shown to be problematic as a feedstuff for Atlantic salmon (*Salmosalar*) due to its high content of anti-nutritive factors that can increase intestinal permeability and induce enteritis (Knudsen *et al*., 2008).

- **Single cell protein:** Single cell protein (SCP) has become a very interesting protein source for inclusion in fish feed (Overland *et al*., 2013; Vidakovic*et al*., 2015; Langeland*et al*., 2016). Single cell protein has many positive traits, as it is fast growing, renewable and could be grown on substrate from industrial waste products. The nutritional value of its constituents, such as proteins, B-vitamins, pigments and β-glucans, has been suggested to be sufficiently high to make it a good replacement for fish protein (Sanderson and Jolly, 1994; Tacon, 1995).

Anupma*et al*. (2000) listed the following characteristics of organisms suitable as single cell proteins:

1. Non-pathogenic to plants, humans and animals
2. Usable as food and feed
3. Have good nutritional values
4. Do not contain toxic compounds
5. Have low production costs.

Bacterial biomass

Bacterial are fast growing, with a life cycle of hours rather than days, and there have therefore been attempts to harvest specific bacteria as a source of protein. For example, *Methylophilus methylotrophus*, an obligate methane-utilising organism, has been used to produce a commercially available product called PRUTEEN (Stringer, 1982). However, this product was never a major commercial success, since the biomass produced contains too high levels of nucleic acids to be used for human consumption and removal of these in a subsequent step would have made the production process more expensive than that of conventional protein However, other studies examining bacterial biomass in animal feed have found some types to be a good alternative protein source (Rumsey *et al*., 1992).

Microalgae

Microalgae, for example Spirulina, are unicellular, filamentous blue-green algae. Like bacteria, they are fast growing organisms that have gained popularity in the health and food industry and increasingly as a protein and vitamin supplement to aquaculture diets (Usharani*et al*., 2012). Spirulina has long been used as a dietary supplement by people living close to alkaline lakes, where it is naturally occurring. Some Spirulina species, like the blue-green alga *Spirulinaplatensis,* have received more attention because they have a high nutritional content. Spirulina can play an important role not only in human and animal nutrition, but also in environmental protection through wastewater recycling.

Yeast

Yeast has been suggested as an alternative protein source for inclusion in aquaculture feeds (Overland *et al*., 2013; Vidakovic*et al*., 2015; Langeland*et al*., 2016).The nutritional value of yeast high, with high crude protein content. Yeast is also rich in B-vitamins, pigments and β-glucans, which increase its potential to replace fish meal in aquaculture feeds (Sanderson and Jolly, 1994; Tacon, 1995). Moreover, yeast has a similar amino acid profile to fish meal. The β-glucans in the yeast cell walls have been suggested to stimulate immunological maturation in fish (Gatesoupe, 2007). Atlantic salmon has been reported to show better resistance to sea lice infection and also improved feed uptake and ability to counteract soybean meal-induced enteritis when β-glucans and mannan oligosaccharides derived from cell walls of SC are added to the feed (Refstie*et al*., 2010).

Conclusion

Above discussion indicates that growth performance and fish feed conservation are important aspects. Most of the research paper showed that yeast protein is generally accepted by wide range of fishes for example Tilapia, Ranbow trout some carps and most of the minor carps. Therefore, most of the fishes fed on SCP diet showed good growth and better acceptability. This suggest utility of SCP research and also furthering the same for increasing production of fishes India and abroad.

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