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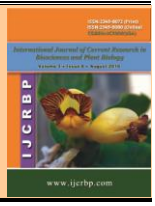

Review Article

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Sodium Taurocholate as Novel Additive: A Right Choice for Ornamental Fish Feed

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Abstract

The rearing of ornamental fishes is a common custom among the many people due to their coloration. Though many ornamental fishes are colorful in nature, when it comes to artificial tanks, they lose their bright coloration than that of wild. Despite many pigments are being a part of the ornamental feed for many years, the capacity of animals to acquire coloration depends on the increase in the digestion, absorption and metabolism of them. Supplementing pigments in the diet doesn't mean fish can be attained coloration and it depends on the presence of some dietary factors. The addition of such factors in the diet would influence the utilization of pigments in the animals. Sodium taurocholate is a novel additive which promotes the utilization of dietary carotenoids to the fish discussed in this article.

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Introduction

Aquaculture is a swiftly growing worldwide industry, involving cultivation of varied fish for edible and decorative purposes. In recent years, the maximum amount of world fish production is supported by culture fisheries as trends in the capture fisheries got declined (FAO, 2016). Feed accounts for 50-60% of the total expenditure in aquaculture and no doubt that success of fish cultivation will greatly depend on the development of proper feeds. Feed is basically prepared with composition of many ingredients contains varied nutrients and bioactive compounds that positively affect the biological status of the animals. Besides, supplementations of specific additives are added in the animal diet to alter the lifestyle of some species. For instance, carotenoids are used in feed of many ornamental fishes as well as salmon, rainbow trout, gold fish, red and gilthead sea bream for pigmentation.

It understood long before that dietary pigment is responsible for the coloration in the ornamental fishes (Clydesdale, 1993; Sylvia et al., 1996). This observation has led researchers to focus study on pigments in coloration. The aim of incorporating pigments in the animal diet is that they reflect in the skins (Schiedt, 1998). There are different types of carotenoids according to the colour they can administer to the animals are represented in the Fig. 1 (García-Chavarría and Lara-Flores, 2013).

The cultivable fishes such as salmon and trout the quality of the fillets is due to feeding their diet with pigments (Satio and Regier, 1971). The research on carotenoids in the animal's or fish is not new; but, finding out the factors that can improve its utilization is new and it is the current area of interest among some researchers who studying the effect of pigments over pigmentation in the animals.

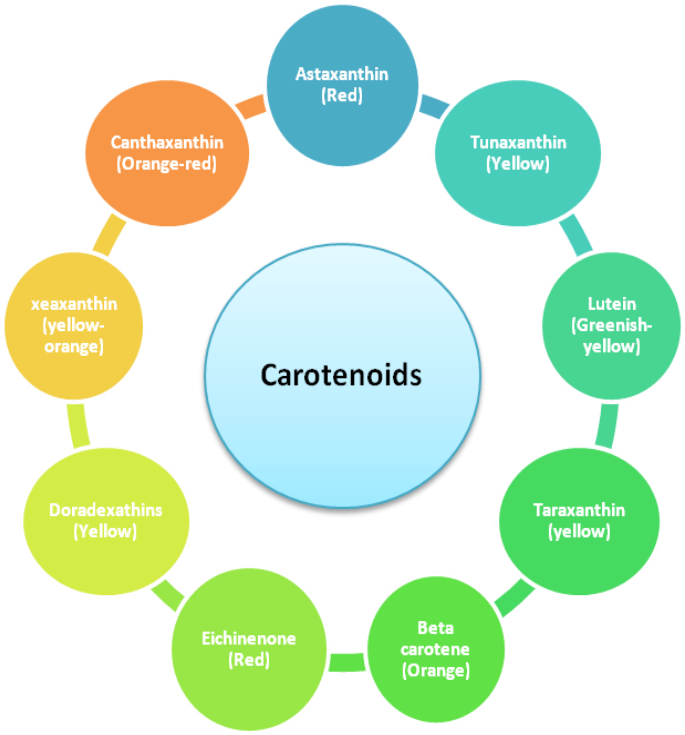

Fig. 1: Various types of carotenoids along with their colour properties (Source: García-Chavarría and Lara-Flores, 2013).

Factors affecting the utilization of carotenoids

It is unfortunate that the fish doesn't have the capacity to synthesize pigments *de novo* and therefore dietary sources are essential (Goodwin, 1986). Besides, the digestibility of pigments is less in fish. Digestion of carotenoids is very low (i.e. only 39 to 49.5%) in salmon when fed (Torrissen et al., 1990). There are several factors that affect the utilization of carotenoids in fish (Leng and Li, 2006). Therefore, the fish coloring is affected by the presence of certain compounds present in the feed, including fat content, vitamin E, vitamin A and some drugs. Through the addition of such substances in the diet, it is possible to promote the pigmentation in animals (Castenmiller and West, 1998). As suggested by Torrissen et al. (1990) adding higher lipid content of 4.1-23.0% in the feed along with carotenoids improve the digestibility of carotenoids. It established that astaxanthin was promoted the pigmentation in *Xiphophorus helleri* by the addition of lipids; but when exceeds 20% have no impact (Han, 2001).

Why to add Na taurocholate in the diet?

According to different author's pigmentation in the animals are not only directly related to the dietary intake of pigments in the diet (Parker, 1996). It depends on the external or other internal factors (Leng and Li, 2006; Torrissen et al., 1990; Han, 2001).

It has been discovered recently that Na taurocholate in the diet promotes the absorption of astaxanthin. A recent study made in the blood parrot shows improved retention of carotenoids in the skins, tails, fins and muscles when Na taurocholate fed along with astaxanthin (Yang et al., 2012).

Exactly how Na taurocholate can improve the pigment retention in fish?

Carotenoids are hydrophobic in nature and have less solubility in the gastrointestinal tract of fish (Van den Berg, 1999). The absorption rate of carotenoids in the animals varies because it is subjective to the environmental and dietary factors. The capacity of carotenoid absorption in the intestine of fish is slow (Erdman, 1988). Carotenoids are derivatives of lipids and therefore, the absorption relies on micelle formation and micellar solubilisation (Choubert et al., 1994). The formation of micelles occurs by the bile salts and free fatty acids derived from the fatty acid during the fatty acid breakdown, so that solubilisation will take place and absorption is possible (Lakshman et al., 1996).

Na taurocholate is a conjugated product of taurocholate with sodium. Taurocholate may not be stable while feed processing and therefore it is conjugated with the stable form of sodium. Taurocholate is a category under bile salt family. Bile salt is an important component required for fat and fat-soluble nutrients as they decrease the surface tension of the liquids present in the gastro-intestinal tract by acting as a detergent between liquids and solid substances, so that absorption can take place (Zhou et al., 2001).

In the absence of bile salts, many fat soluble substances would be undigested and excreted. Bile salts are secreted by the liver, stored in the gallbladder and goes to the small intestine when requires. Fatty materials, including carotenoid pigments cannot be digested in the normal way, just like other water-soluble nutrients (Barbosa et al., 1999). So they need some helpers who can help in the digestion. Some studies evidenced that the addition of Na taurocholate in the diet promotes the absorption of carotenoids; in turn they improve the coloration of ornamental fishes (Lakshman et al., 1996; Chen et al., 2001; Yang et al., 2012).

Studies evidenced that Na taurocholate improves the absorption of carotenoids

The study was conducted to identify the effect of Na taurocholate and free fatty acids on the absorption of β-carotene and lutein. The isolated small intestinal mucous cells were successfully cultured with these two carotenoid sources and witnessed that the addition of Na taurocholate and free fatty acids improves the absorption rate. It optimized from the study that Na taurocholate at the rate of 3mM and 10mM improves the β-carotene and lutein respectively. Similarly, oleic/stearic fatty acids at the rate of 100:0 and 3:1 improve the β-carotene and lutein respectively. More than these amounts tend to decrease the rate of absorption (Chen et al., 2001). The study conducted in the basal diet with 4% astaxanthin plus >400 mg/kg Na taurocholate enhances the degree of astaxanthin absorption and pigmentation in blood parrot than that of astaxanthin or Na taurocholate alone (Yang et al., 2012). It was also observed in ferrets that the addition of 0.5 to 1% of Na taurocholate in the diet promoted the carotenoid absorption threefold higher (Lakshman et al., 1996).

Is Na taurocholate important only to ornamental fish feed?

No doubt that pigments have an equal role in the farming aquatic animals. It was reported by several authors that incorporating the carotenoids in the feed promote the muscle or fillet quality of fishes (García-Romero et al., 2014; Spinelli et al., 1974; Coral et al., 1997). By considering the faded fillet color, the export values of some farming fishes are discouraged. Due to the potential role of the pigments in the flesh coloration, different places work has been established in this area. Recently attempts have been made at ICAR-CIFE, Mumbai, India wet laboratory in the Pangasius catfish with different carotenoid sources for improving the fillet coloration. Despite the positive results obtained in these studies, the requirement of carotenoids must be further optimized by studying with Na taurocholate as a novel source of the additive. This would be the new area, need special research interest.

Advantages of using Na taurocholate as fish feed additive

- It has very good stability.
- It can be stored for a long time (Yang et al., 2012).
- The degree of water absorption and oxidation rate is less as compared to vitamin E and fat.
- It also has antibacterial and immunostimulatory action (Xue et al., 2004).
- The role of Na taurocholate is very specific and therefore may have high sensitivity will act on the promotion of carotenoid utilization.

Recommendations and concluding remarks

Recent research in feed nutrition is more focus on finding out the potential additives that improve the quality of feed. Though their applications claimed to have the beneficial impact in aquaculture, the addition of each additive also raises the costs of feed. To be economically sustainable, the feed has to be prepared with the optimum ingredients and additives without affecting both nutrition and quality. Till now research conducted in response to the pigmentation used higher levels of pigments in the diet. The application of pigments in the fish feeds is costly. Besides, fish have very limited capacity to digest carotenoids. Therefore, carotenoids in the diet need not be wasted. It is a great advantage that the addition of Na taurocholate along with carotenoids in the diet minimizes the wastage of supplemented carotenoids and promotes greater pigmentation to the fish.

Apart from the role in carotenoid utilization and fat digestion, Na taurocholate also has a role in the antibacterial and immunostimulatory action. The supplementation of immunostimulants to the feed got momentum in the recent years. In this connection, it would be feasible if supplementing this additive may replace some expanses of currently used immunostimulants in the fish feed. In this fashion, it has a great potential to reduce the feed costs as well; but require research studies.

The previous studies confirmed the dietary carotenoids increase the absorption and retention of pigments when fed with Na taurocholate. Therefore, it is concluded that considerable studies must be focused on these aspects and optimum inclusion level of Na taurocholate required for the carotenoid based supplemented diet should be carefully studied and recommended to the feed formulators to place Na taurocholate as an important additive in the fish feeds to promote the coloration of aquatic animals.

Conflict of interest statement

Author declares that he has no conflict of interest.

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