CREDIT SEMINOR ON
NUTRACEUTICALS IN AQUA FEED

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**Introduction**

The term Nutraceuticals was derived from ‘Nutrition’ and ‘Pharmaceuticals’ by Stephen Defelice, who is the founder and chairman of foundation for innovative medicine. The actual use of Nutraceuticals is to attain desirable therapeutic outcomes with reduced side effects. About 2000 years ago, Hippocrates emphasized ‘let food be your medicine and medicine be your food’; Nutraceuticals are used as food or part of food which will provide medical or health benefits including prevention or treatment of disease (Riyaz 2014).

**NEED FOR NUTRACEUTICALS**

Though antibiotics have positive effects on the fishes and shrimps, they cannot be recommended in commercial aquaculture and mariculture operations due to their residual effects in the muscle of fishes and prawns. In marine fish hatcheries, the indiscriminate use of antibiotics in prophylactic treatment has led to the development of the resistant strains and the need to switch over to other antibiotics (Brown, 1989).

At the global level, people have understood the bad effect of antibiotics and they are now shifting over to natural products (Brown, 1989). From the traditional and ancient wisdom, herbalism has been developed into a modern approach for the disease prevention and general well-being of aquaculture organisms through their safety, efficacy and simplest way of application. This is the low cost therapeutic options for the fast growing aquaculture industry. Natural plant products have been reported to promote various activities like anti-stress, growth promotion, appetite stimulation, tonic and immunostimulation and to have antimicrobial properties in finfish and shrimp larviculture due to the presence of active compounds such as alkaloids, flavanoids, pigments, phenolics, terpenoids, steroids and essential oils (Citarasu et al. 1998).

**NUTRACEUTICALS IN AQUACULTURE**

Antibiotics and several other chemical drugs have been tested in aquaculture operations for various remedies. Even though they give positive effects, they cannot be recommended due to their residual and other side effects. The alternative nutraceuticals/herbal medicinal products used in the aquaculture operations have the characteristics of growth promoting ability and improve the immune system. They increase
feed consumption, induce maturation, and have antimicrobial capability and also antistress characteristics that will be immense use in the culture of shrimps and other fin fishes without any environmental and hazardous problems. In aquaculture, application of nutraceuticals includes addition of feed additives in feed such as antioxidants, vitamins, minerals and carotenoids etc (Brower, 1998)

CLASSIFICATION OF NUTRACEUTICALS

Nutraceuticals or functional foods can be classified on the basis of their natural sources, pharmacological conditions, mechanism of action, or as per chemical constitution of the products.

- On the basis of natural source, it can be classified as the products obtained from plants, animals, minerals, or microbial sources.
- Nutraceuticals as per the chemical groupings.
  - The food sources used as a nutraceuticals are natural in nature and can be categorically divided in different categories such dietary fiber, probiotics, prebiotics, polyunsaturated fatty acids (PUFA), antioxidant vitamins, polyphenols and spices (Kalia, 2005).

HERBAL EXTRACT

Azadirachta indica (neem) shows therapeutics role in health management due to rich source of various types of ingredients. The most important active constituent is azadirachtin and the others are nimbolinin, nimbin, nimbidin, nimbidol, sodium nimbinate, gedunin, salannin, and quercetin (A. Ali 1993). Quercetin and β sitosterol, polyphenolic flavonoids, were purified from neem fresh leaves and were known to have antibacterial and antifungal properties and seeds hold valuable constituents including gedunin and azadirachtin (T. R. Govindachari 1998).Herbal products, stressol-I- and stressol-II-enriched Artemia nauplii fed with Penaeus indicus post larvae (PL 10–20) increased the growth and efficiencies significantly and reduced the osmotic stress (Chitra 1995).

Tefroli contains ingredients such as Tephrosia purpurea, Eclipta alba, Phyllanthus niruri, Andrographis paniculata, Ocimum sanctum and Terminalia chebula enriched with Artemia, and fed to Penaeus monodon postlarvae (PL 20–50) improved the survival, growth and moulting efficiencies. Also, Trasina, a commercial herbal product, enriched Artemia, fed to P. monodon post larvae improved the growth and stress efficiencies significantly (Rani
Methanolic extracts of five different herbal medicinal plants, *Cynodon dactylon*, *Aegle marmelos*, *Tinospora cordifolia*, *Picrorhiza kurooa* and *E. alba*, were selected and prepared as a diet for WSSV-infected shrimp. The different concentrations, i.e. 100, 200, 400, and 800 mg kg\(^{-1}\) diets were positively influenced and, significantly, had better survival (74%) and reduction in the viral load (Citarasu et al. 2006).

Papaya leaf meal contains an enzyme, papain, which increases protein digestion, food conversion ratio, specific growth rate and weight gain in the 16% unsoaked papaya meal diet which was fed to *P. monodon* postlarvae (Penaflorida1995). The best example is the herb *Picrorhiza kurooa* used as an antistress compound for shrimps (Citarasu et al. 1998). Also, *O. sanctum* positively influenced the immunostimulatory effects in * Oreochromis mossambicus* against *Aeromonas hydrophila* infection. Dietary intake of *O. sanctum* also enhanced the antibody response and disease resistance against *A. hydrophila* (Logambal et al. 2000). Adigu’zel et al. (2005) successfully controlled the pathogens, *Aspergillus flavus* and *Fusarium oxysporum*, by the ethanol, methanol and hexane extracts from *O. basilicum* through in vitro Indian almond leaves, *T. catappa*, extract can reduce the fungal infection in tilapia eggs (Chitmanat et al. 2005). The herbal immuno modulator containing *Ocimum basilicum* extracts act as a very helpful in boosting the immune system in *Clarias batrachus* (Gayatrinahak 2014). Whole or parts of medicinal plants can be used for extracting medicinal Compounds. Whole plant *Cynodon dactylon* was used to prevent the White spot syndrome virus (WSSV) infection in black tiger prawns (Balasubramanian et al., 2008).

**PEPTIDES**

Antimicrobial peptides are key components of the innate immune system of most multicellular organisms. They have antimicrobial activities but with no resistance potential and they show potential to act as alternatives to antibiotics (Hancock & Chapple, 1999). Among them, apidaecins (apidaecin type peptides) refer to a series of small proline-rich 18 to 20-residue peptides produced by the insects. Apidaecins are active against a wide range of gram-negative bacteria, through a bacteriostatic rather than a lytic process, but it shows no activity against gram-positive bacteria (Casteels et al., 1994).

**AMINO ACIDS**

Some of the amino acids augment the immunity by blocking the cortisol level as prolonged exposure to cortisol causes immune-supression in fish. Tejpal et al. (2009) found
that dietary supplementation of L-tryptophan at a minimum level of 1.36% reduced the stress caused due to high stocking density and improved the growth performance in *Cirhinus mrigala* fingerlings as well. Though 2.72% dietary tryptophan also reduced the stress but 1.36% level appears to be cost effective. This result may be useful for the farmer for reducing stress caused due to over stocking density.

**CAROTENOIDs**

Crustacean processing discards (shrimp, krill and crabs) are also potential carotenoid sources. Crustaceans discards constitute an attractive ingredient for industrialization, since around 70% of the raw weights of the catch are processing discards (Wilkie, 1972; Simpson and Haard, 1985) with high carotenoid content and its use reduces the environmental problem caused by the large amounts of wastes (Torrissen and Naevdal, 1984; Shahidi and Synowiecki, 1991; Shahidi, 1995). The freshwater micro algae, *Haematococcus pluvialis* has been commercially exploited for aquaculture primarily due to its rapid growth and high astaxanthin content (Sommer *et al.*, 1991, 1992; Choubert and Heinrich, 1993). The microalgae *Chlorella vulgaris* has become a potent pigment source, which imparts yellow/blue hues. The biomass of this algae had already been proved to be useful in the diets of rainbow trout yielding both muscle and skin pigmentation effects (Gouveia *et al.*, 1996, 1997) In fish, carotenoids have similar functions as those found in other animal species: they are vitamin A precursors (Schiedt *et al.*, 1985) markedly affect reproduction performance (Craik, 1985); are potent antioxidants (Bjerkeng and Johnsen, 1995); enhance immune system (Nakano *et al.*, 1995; Amar *et al.*, 2003); and affect liver structure (Segner *et al.*, 1989; Page *et al.*, 2005).

**VARIOUS NUTRACEUTICAL USED IN AQUA FEED**

**Vitamin**

**Pyridoxine (vitamin B6)**

- Pyridoxine (vitamin B6) is essential for absorption and metabolism of amino acids and is also involved in development of red blood cells (David *et al.*, 2004). Dietary pyridoxine supplementation at 100mg /kg diet reduces the endosulfan-induced stress and triggers the immune response in *Labeo rohita* fingerlings. Akthar *et al.* (2010)
Mineral

Phytic acid (PA) is found in most of the ingredients commonly used in fish feed like barley, rice, sorghum, wheat, maize, gram, groundnut, rapeseed, soyabean, cottonseed and sesame (Halver, 1989; De Silva and Anderson, 1995). Phytic acid isolated from plants belongs to the group of organic phosphates and is a mixture of calcium-magnesium salt of inositol hexaphosphoric acid, also known as phytin. Salts of phytic acid are also called phytate. It is an abundant plant constituent comprising 1 to 5% by weight of the legumes, cereals, oil seeds, pollens and nuts (Vohra and Satyanarayan, 2003). The degradation of phytate (myo-inositol hexakis phosphate, InsP6) is of nutritional importance because the mineral binding strength of phytate decreases and the solubility increases when phosphate groups are removed from the inositol ring resulting in an increased bioavailability of essential dietary minerals (Lonnerdal et al., 1989).

Phytate of plants are also unavailable to fish like other monogastric animals that lack intestinal phytase (Pointillart et al., 1987). Thus, primary source of phosphorus found in fish ponds is of dietary origin. The addition of microbial phytase to the diet has been reported to improve the utilization of phytate phosphorus in rainbow trout Oncorhyncus mykiss (Cain and Garling, 1995; Rodehutscord and Pfeffer, 1995). Jackson et al. (1996) supplemented practical diets of channel catfish (Ictalurus punctatus) with different levels of microbial phytase and reported that bone ash, bone phosphorus, weight gain and feed consumption were higher and feed conversion ratio lower for fish fed diets supplemented with phytase as compared to control group. They also showed that the concentration of faecal phosphorus decreased linearly as phytase supplementation level increased, clearly demonstrating the efficacy of phytase in improving bioavailability of phytate phosphorus in channel catfish.

Prebiotics

As defined by Gibson and Roberfroid (1995), “a prebiotic is a nondigestible food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, and thus improves host health.”

Mannanoligisaccharides (MOS) MOS are glucomannoprotein-complexes derived from the cell wall of yeast (S. cerevisiae) (Sohn et al., 2000). Grisdale-Helland et al. (2008) evaluated the effect of MOS supplementation on on-growing Atlantic salmon. Dietary MOS
was supplemented at 1% to salmon for a period of 16 weeks. The results showed that apparent energy digestibility of the MOS supplemented diet was increased compared with the control treatment. Analysis of body composition revealed that gross energy content was increased with the addition of MOS but crude protein was reduced. Furthermore, whole blood neutrophil oxidative radical production and serum lysozyme activity were reduced in fish fed the MOS supplemented diet.

In the rainbow trout study by Staykov et al. (2007), growth performance and immune parameters of fish reared either in freshwater net cages or fresh water raceways were investigated. Compared to the control fish, 0.2% dietary MOS supplementation increased final body weight, reduced FCR and mortalities in both net cage and raceway reared trout.

**Probiotics**

The word probiotic is constructed from the Latin word pro (for) and the Greek word bios (life) (Zivkovic, 1999). The use of probiotics in humans is a success. The conventional definition of probiotics is “live microorganisms when added to food help to reconstruct a balanced indigenous microflora in the GIT of host” (Fuller et al 1992). Food and Agriculture Organization (FAO/WHO) stated that probiotics are live microorganisms, which, when consumed in adequate amounts, confer a health benefit for the host. (FAO/WHO 2001).

**The beneficial effects of probiotics**

- Improvement of feed utilization,
- Modulation of intestinal microflora,
- Enhancement of immune responses,
- Antagonism to pathogens (Balcazar et al., 2006, Irianto and Austin, 2002)

The use of probiotics as farm animal feed supplements dates back to the 1970s. They were originally incorporated into feed to increase the animal’s growth and improve its health by increasing its resistance to disease. The results obtained in many countries have indicated that some of the bacteria used in probiotics (Lactobacilli) are capable of stimulating the immune system (Fuller, 1992). In aquaculture, however, Vibrio spp., Bacillus spp., lactic acid bacteria, and microalgae are mainly utilized as probiotics for growth and survival enhancement and reduction of pathogen. (S. Rengpipat 1998). Lara-Flores et al. (2003) used two probiotic bacteria and the yeast, Saccharomyces cerevisiae as growth promoters in Nile tilapia (Oreochromis niloticus) fry. The results of this study indicated that the fry subjected to diets
with a probiotic supplement exhibited greater growth than those fed with the control diet. In addition, they suggested that the yeast is an appropriate growth-stimulating additive in tilapia cultivation.

**CONCLUSION**

There are several advantages of using nutraceuticals for improving growth and immune functions fish and shell fishes as the compounds are naturally occurring and are not giving residual effects. Nutraceuticals having bright scope of using as an immunomodulatory substances in intensive fish culture practices to minimise the loss of production due to pathogenic microbial and parasitic infections. These could replace expensive imported prophylactic therapeutic drugs and their undesirable side effects.
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