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Use of Herbal Food Additives in Fisheries

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Abstract

The use of vegetable products to prolong the shelf life of fish in addition to as a functional feed additive in aquaculture is expected to increase significantly in the near future. In parallel with the increasing world population, the inability to increase fisheries has made it inevitable to meet the aquaculture needs from aquaculture and this has led to the continuous increase of aquaculture and to reach a great market potential. Synthetic feed additives and antibiotics used unconsciously have become a major problem with the increase in aquaculture and in many countries restrictions on antibiotic use have been imposed. As a result of these restrictions, interest in functional feed additives has increased. It has been shown in many studies that it may be appropriate to use herbal products as an alternative to antibiotics and synthetic substances used as growth enhancers in aquaculture. Natural products, such as medicinal plants, can be widely used as feed additives to improve the efficiency of feed use and increase animal production performance. This study aims to promote the use of medicinal plants as an alternative to chemical products in the aquaculture sector.

Keywords: Aquaculture, medicinal plants, feed additives

Review article

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INTRODUCTION

The aquaculture sector is among the fastest growing sectors in many world countries. This growth in the sector stems from aquaculture rather than hunting. The amount of fisheries hunting remains the same or decreases from year to year. However, there is a continuous increase in aquaculture. When the aquaculture areas are examined in detail, it is seen that the largest production areas that contribute positively to the growth of the sector are marine areas or reservoir.

One of the most important elements in aquaculture has been the principle of obtaining the highest yield from the unit area and unit feed since the aquaculture areas began to shrink and feed costs increased. In addition, the quality of the obtained seafood as well as the preservation of freshness is very important.

The use of many chemicals and antibiotics is quite common in fish farming with the fight against diseases. The use of antibiotics is highly criticized for causing the development of antibiotic-resistant bacterial strains, suppression of the immune system of fish, environmental pollution and the accumulation of chemical residues in fish tissues that may harm public health. For these reasons, the interest of the aquaculture industry in plant resources is increasing day by day (Dikel, 2015).

In recent years, the use of feed additives in fish feeds to increase production has become widespread. The additives added to feeds increase the digestibility of the feed while reducing the effects of anti-nutritional factors. In addition, it plays a role in fish gaining resistance to diseases. It is desirable that probiotics to be used as feed additives should be non-pathogenic, should not produce toxic substances, should maintain their viability during storage and have high interaction with nutrients in the structure of the feed (Yıldırım et al., 2013).

Herbal additives in aquaculture are used for many purposes to increase the growth parameters of fish, to develop resistance to diseases, to improve meat quality, to increase fatty acid profile and to prolong shelf life.

When analyzing plant bioactivity according to the purpose of use in fish farming, studies with plant sources, 36% for antibacterial activity, 17% antiparasitic activity, 16% immunostimulatory activity, 14% antiviral activity, 13% growth promoter and only 4% were used for antifungal activity (Reverter et al., 2017).

In a study on this subject, it has been reported that the herbal additives used in aquaculture can be used for purposes such as Antibiotic, phytotherapy, immunostimulant effect, growth enhancer, tranquilizer in aquaculture, anesthetic agent, improving meat quality, gaining taste and odor and prolonging shelf life (Dikel, 2019). In this study, the purpose and manner of the use of herbal products, which have recently gained importance in terms of aquaculture, are summarized.

Antibiotic Use of Plant Resources in Aquaculture

Antibiotics produced from natural sources or synthetically produced can be defined as substances capable of inhibiting or killing the growth of microorganisms (Romero et al., 2012). In aquaculture, antibiotics at the therapeutic level are often administered orally to fish, often for a short time to groups of fish that share ponds, tanks or cages (Defoirdt et al., 2011).

All medicines used legally in aquaculture must be approved by the governmental authority for veterinary medicine (e.g the US Food and Drug Administration). For example, in the United

States, the following antimicrobials are authorized for use in aquatic culture: oxytetracycline, florfenicol, and sulfadimetoxine / ormetoprim. These regulatory agencies may establish rules for the use of antibiotics, including permissible delivery routes, dosage forms, withdrawal times, tolerances, and dose rates and limitations, the use of species. The most common way to deliver antibiotics to fish is by mixing the antibiotic with a specially formulated feed (Dawood et al., 2018). Recently, with the effect of some restrictive and limiting factors, the aquaculture sector has been focusing on herbal solutions that serve the same purposes instead of medicaments (medicines and chemicals with therapeutic protective and growth-enhancing effects) they have to use in production (Dikel, 2015). The use of medicinal plants in aquaculture has attracted worldwide attention and has become an active scientific research topic (Galina et al., 2009; Chakraborty and Hancz, 2011; Harikrishnan et al., 2011a). Bulfon et al. (2013) examined the use of phytomedicins on fish species in 105 scientific publications published in the literature from 1998 to 2011. In particular, 83% of these surveys were conducted between 2006 and 2011, while 15% were conducted between 2001 and 2005. Relatively few studies were conducted before 2001.

An important alternative to antibiotics is the use of functional feed additives to improve growth performance and increase immune resistance in fish. A variety of feed additives with direct and indirect modes of action may replace the effects of in-feed antibiotics used to promote growth in aquatic animals. Recently, a great number of research has been conducted on the development of alternatives to antibiotics to preserve the health and performance of aquatic animals. The most widely investigated alternatives include probiotics, prebiotics, synbiotics, acidifiers, plant extracts, nucleotides and immunostimulants such as β-glucan and lactoferrin (LF). (Dawood et al., 2018).

Most of the studies with herbal products is done in countries such as China, India, Thailand and Korea. In these countries, many plants such as garlic (*Allium sativum*), garlic grass (*Allium tuberosum*), green tea (*Camellia sinensis*), cinnamon (*Cinnamomum verum* or *C. zeylanicum*), turmeric (*Curcuma longa*), lupine (*Lupinus perennis*), mango (*Mangifera indica*), mint (*Mentha piperita*), nutmeg (*Myristica fragrans*), basil (*Ocimum basilicum* and *O. sanctum*), coral pavilion (*Origanum vulgare*), radiant (*Rheum officinale*), rosemary (*Rosmarinus officinalis*) and ginger (*Zingiber officinale*) are generally used (Dikel, 2015).

Many scientific documents indicate that garlic is used effectively in the fight against bacterial pathogens from freshwater fish, *Pseudomonas fluorescens*, *Myxococcus piscicola*, *Vibrio anguillarum*, *Edwardsiella tarda*, *Aeromonas punctata f intestinalis*, and *Yersinia ruckeri* (Lee and Gao, 2012). Rosemary plant has been found to resist Streptococcus iniae and Streptococcus agalactiae bacteria in Tilapia (*Oreochromis sp*) (Zilberg et al., 2010).

Use of Plant Resources as Growth Enhancers

Medicinal plants have been shown to have growth-promoting effects. Substances used as plant supplements essentially improve digestive enzymes and thus increase the survival and growth rates of aquatic animals (Dikel, 2019). Büyükdeveci et al. (2018) in their study of garlic found that feeds increased the density of bacterial colonies that increase the activity of proteinase enzyme in the intestinal microbiota of trout, therefore, these fish grow better. Another study showed that three plants (*Eclipta alba*, *Alteranthera sessilis* and *Cissus quadrangularis*) showed an appetizing effect and increased the activity of digestive enzymes (protease, amylase and lipase) of freshwater shrimps (Radhakrishnan et al., 2014).

There are many scientific studies showing that plant supports are used as growth enhancers in aquaculture. Garlic-enriched diets have been reported to improve the growth

parameters of Nile tilapy and increase survival (Aly and Mohamed, 2010; Shalaby et al., 2006; Aly et al., 2008; Özgüven and Dikel, 2018).

Diets containing *Oregano vulgare* essential oil have been reported to improve the growth performance and survival rates of catfish (Zheng et al., 2009). In another study, the growth parameters improved as a result of oral administration of Achyranthes aspera to *Labeo rohita* (Rao et al. 2006). Xie et al. (2008) reported that the growth performance of *C. carpio* feeding on diets enriched with *Rheum officinale* increased. Uzunağaç and Dikel (2010) reported that spirulina increased the survival rate in the study of wintering Nile tilapia puppies with spirulina supplemented feed in greenhouse conditions in winter.

Similarly, when 1% fenugreek was added to the feed of *Oreochomis niloticus* fish, an increase in growth performance and a decrease in feed evaluation rate were found (Mostafa et al., 2009). In another study on the effect of black cumin oil (*Nigella sativa*) on the growth performance, body composition and fatty acid profile of rainbow trout (*Oncorhynchus mykiss*), it was reported that black cumin oil positively affected the growth of trout while reducing feed evaluation rate (Öz et al., 2018).

In another study, the use of 100 mg/kg supplemented meadow triangle in *Oreochromis aereus* fish feeds has been reported to improve the growth performance and feed evaluation rate (Turan, 2006).

Use of Herbal Additives to Improve Meat Quality and Prolong Shelf Life in Aquaculture

The use of antibiotics can cause the death of beneficial microorganisms as well as harmful microorganisms in the digestive system (Sarıca, 1999). Therefore, the additives used today to increase production and fight against diseases are being replaced by organic products or chemicals that do not leave residues in fish. Many substances such as seaweed, probiotics, bacterial compounds, enzymes and plant extracts have been used in the studies as an alternative to chemical use in the aquaculture sector (Bagni et al., 2005; Bonaldo et al., 2007).

Benkeblia (2003) investigated the antimicrobial effect of different onion species (green, yellow and red) and garlic essential oil extracts on two bacterial species (Staphylococcus aureus, Salmomella enteritidis) and three fungus species (*Aspergillus niger, Penicillium cyclopium Fusarium oxysporum).* The strongest antibacterial effect was observed in garlic and the lowest effect was observed in green onion. All of the garlic extracts showed inhibitory activity at any concentration used. Among the onion species, red onion was the strongest inhibitor.

It is obligatory to keep the aquaculture cold after harvest until it is put on the market. The microbiological activities must be stopped or slowed down whether they are stored as a whole or a product. Otherwise, the product is at risk of rapid deterioration and staling. For this purpose, there are many studies on the storage and processing of seafood. In some of these studies, herbal additives are supplemented to fish feed (Öz et al., 2017; Öz, 2016; Öz, 2017; Öz, 2018a; Öz, 2018b) and some of them are supplemented to fish meat after harvesting (Topuz et al., 2014; Aircraft, 2019; Yerlikaya, 2015; Ucak et al., 2018).

In a case study on this subject (Öz, 2018), fish harvested after 90 days feeding period by supplementing garlic (*Allium sativum*) to rainbow trout feeds were stored in deep freezer at −18 ° C and periodically changes in chemical, microbiological and sensory parameters were examined. In this research, garlic supplemented fish feed has improved sensory, chemical and microbiological levels of the rainbow trout. The effects of black cumin oil (*Nigella sativa*) on the shelf life of rainbow trout (*Oncorhynchus mykiss*) were investigated. Similarly, positive results were found in this study (Öz et al., 2017).

CONCLUSION

The aquaculture sector in our country is growing rapidly and its share in the total aquaculture production has increased above 50%. In order to make this growth sustainable and increase the yield and quality and thus the income, feed additives should be used. Herbal feed additives used in animal breeding are alternative to antibiotics and many synthetic feed additives because they are both natural and do not threaten animal and human health. With these herbal feed additives, more researches should be done to increase the productivity of the fish in different seasons, different length groups, different aquaculture environments and in different seasons, and appropriate feed rations should be established for the fish according to the positive results.

REFERENCES

Aly S. A. & Mohamed M. F. 2010. Echinacea purpurea and Allium sativum as immunostimulants in fish culture using Nile tilapia (*Oreochromis niloticus*). *Journal of Animal Physiology and Animal Nutrition*, 94(5), e31-e39.

Aly S. M., Atti N. M. A. & Mohamed M. F. 2008. Effect of garlic on the survival, growth, resistance and quality of *Oreochromis niloticus*. In *International Symposium on Tilapia in Aquaculture* (Vol. 2008, pp. 277-296).

Büyükdeveci M. E., Balcázar J. L., Demirkale İ., Dikel S. 2018. Effects of garlic-supplemented diet on growth performance and intestinal microbiota of rainbow trout (*Oncorhynchus mykiss*). *Aquaculture*, 486, 170-174.

Dawood M. A., Koshio S. & Esteban, M. Á. 2018. Beneficial roles of feed additives as immunostimulants in aquaculture: a review. *Reviews in Aquaculture*, 10(4), 950-974.

Defoirdt T, Sorgeloos P, Bossier P. 2011. Alternatives to antibi-otics for the control of bacterial disease in aquaculture.*Cur-rent Opinion in Microbiology*, 14, 251–258.

Dikel S. 2015. The use of garlic (*Allium sativum*) as a growth promoter in aquaculture. *Turkish Journal of Agriculture-FoodScience and Technology*, 3(7), 529–536.

Dikel S. 2019. Su Ürünleri Yetiştiriciliğinde Bitkisel Katki Maddeleri. Veterinerlik ve Su Ürünleri Araştırmaları I. Akademisyen Kitabevi, ISBN: 9786052583111, Sayfa: 81-93.

Mostafa A. A. Z. M., Ahmad M. H., Mousallamy A. & Samir A. 2009. Effect of Using Dried Fenugreek Seeds as Natural Feed Additives on Growth Performance, Feed Utilization, Whole-body Composition and Entropathogenic *Aeromonas hydrophilachallinge* of Monosex Nile Tilapia *O. niloticus* (L) Fingerlings, *Australian Journal of Basic and Applied Sciences*, 3(2), 1234-1245.

Öz M. 2017. Çörek Otu (*Nigella sativa*) Yağının Gökkuşağı Alabalığının (*Oncorhynchus mykiss*) Karaciğer Yağ Asidi Profiline Etkisi. *Etlik Veteriner Mikrobiyoloji Dergisi*, 28(1), 55-59.

Öz, M. (2018a). Effects of garlic (*Allium sativum*) supplemented fish diet on sensory, chemical and microbiological properties of rainbow trout during storage at -18 ^{o}C. *LWT*, 92, 155-160.

Öz M. 2018b. Effects of black cumin (*Nigella sativa*) oil on ammonia and biogenic amine production in rainbow trout. *Indian Journal of Animal Research*, 52(2), 265-269.

Öz M., Dikel S. & Durmus M. 2018. Effect of black cumin oil (*Nigella sativa*) on the growth performance, body composition and fatty acid profile of rainbow trout (*Oncorhynchus mykiss*). *Iranian Journal of Fisheries Sciences*, 17(4), 713-724.

Öz M., Dikel S., Durmuş M. & Özoğul Y. 2017. Effects of Black Cumin Oil (*Nigella sativa*) on Sensory, Chemical and Microbiological Properties of Rainbow Trout during 23 Days of Storage at 2±1 C. *Journal of Aquatic Food Product Technology*, 26(6), 665-674.

Öz M., Dikel S., Durmuş M., Özşahinoğlu I. & Mumoğullarinda P. 2016. Çörek otu (Nigella sativa, L) Yağının Gökkuşağı Alabalığı (*Oncorhynchus mykiss*)'nın Depolanması

Esnasında Yağ Asidi Değişimine Etkisi. *Nevşehir Bilim ve Teknoloji Dergisi*, 4(1), 57-68.

Özgüven A., Dikel S. 2018. Sera Koşullarında Melez Tilapiaların Sarımsak (*Allium sativum*) destekli yemlerle beslenmesinin büyüme performansına ve vücut besin bileşenleri üzerine etkileri. *Journal of Advances in VetBio Science and Techniques,* 3(3), 35-44.

Radhakrishnan S., Saravana Bhavan P., Seenivasan C., Muralisankar T. & Shanthi R. 2015. Effects of native medicinal herbs (*Alternanthera sessilis, E clipta alba* and *C issus quadrangularis*) on growth performance, digestive enzymes and biochemical constituents of the monsoon river prawn *Macrobrachium malcolmsonii*. *Aquaculture nutrition*, *21*(4), 496-506.

Rao Y. Vasudeva B. K., Jyotyrmayee D. P. & Chakrabarti R. 2006. Effect of Achyranthes aspera on the immunity and survival of *Labeo rohita* infected with *Aeromonas hydrophila*. *Fish and Shellfish Immunology*, 20(3), 263-273.

Romero J., Feijoó C. G. & Navarrete P. 2012. Antibiotics in aquaculture–use, abuse and alternatives. *Health and environment in aquaculture*, 159.

Shalaby Shalaby A. M., Khattab Y. A. & Abdel Rahman A. M. 2006. Effects of Garlic (*Allium sativum*) and chloramphenicol on growth performance, physiological parameters and survival of Nile tilapia (*Oreochromis niloticus*). *Journal of Venomous Animals and Toxins including Tropical Diseases*, 12(2), 172-201.

Topuz O. K., Yerlikaya P., Ucak I., Gumus B. & Büyükbenli H. A. 2014. Effects of olive oil and olive oil–pomegranate juice sauces on chemical, oxidative and sensorial quality of marinated anchovy. *Food chemistry*, 154, 63-70.

Turan F. 2006. Improvement of Growth Performance in Tilapia (*Oreochromıs aureus* Linnaeus) By Supplementatıon of Red Clover (*Trifolium pratense*) in Diets, *The Israeli Journal of Aquaculture- Bamidgeh*, 58(1), 34-38.

Uçak I. 2019. Taze karideslerin raf ömrünün uzatilmasinda soğan kabuğu ekstraktının etkisi. *Gıda*, 44(2), 226-237.

Uçak I., Khalily R., Abuibaid A. K. & Ogunkalu O. A. 2018. Maintaining the quality of rainbow trout (*Oncorhynchus mykiss*) fillets by treatment of red onion peel extract during refrigerated storage. *Progress in Nutrition*, 20(4), 672-678.

Uzunağaç C., Dikel S. 2010. Kişlatma Koşullarinda Nil Tilapia Yavrularina Saf Spirulina (*Spirulina Platensis*) ve Alabalik Yeminin 4 Farkli Rejimle Verilmesinin Canli Kalma Oranina Etkilerinin Karşilaştirilmasi. *ÇÜ Fen Bilimleri Enstitüsü Dergisi*, *23*, 1.

Xie J., Liu B., Zhou Q., Su Y., He Y., Pan L., Ge X. & Xu P. 2008. Effects of anthraquinone extract from rhubarb Rheum officinale Bail on the crowding stress response and growth of common carp *Cyprinus carpio* var. Jian. *Aquaculture*, 281(1-4), 5-11.

Yerlikaya P., Ucak I., Gumus B. & Gokoglu N. 2015. Citrus peel extract incorporated ice cubes to protect the quality of common pandora. *Journal of food science and technology*, *52*(12), 8350-8356.

Yildirim Ö., Acar Ü. & Çantas I. B. 2014. Balik yemlerinde kullanilan yem katki maddeleri/Feed Additives in Aquafeeds. *Journal of Fisheries Sciences*, 8(4), 278.

Zheng Z. L., Tan, J. Y. W. & Liu, H. Y. 2009. Evaluation of oregano essential oil *(Origanum heracleoticum* L.) on growth, antioxidant effect and resistance against *Aeromonas hydrophila* in channel catfish (*Ictalurus punctatus*). *Aquaculture*, 292, 214–218.

Zilberg D., Tal A., Froyman N., Abutbul S., Dudai N., Golan-Goldhirsh A. 2010. Dried leaves of Rosmarinus officinalis as a treatment for Streptococcosis in tilapia. *Journal of Fish Diseases*, 33(4), 361-369.