Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 7, July 2021: 3122- 3131

Role of Plant Essential Oils in Conventional Fish Production

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Abstract
Essential oils are natural, volatile, complex compounds having a characteristic strong odour and are synthesized by aromatic plants as secondary metabolite. They are in liquid form, colorless, soluble in fats and organic solvents with a low density than water. These oils are synthesized by all parts of the plant that includes roots, stems, branches, bark, wood, leaves, buds, flowers, fruits, and seeds. The oils are deposited in secretory cells, ducts, cavities, epidermal cells or glandular trichomes like the active ingredient present in essential oils initiating from plant metabolites, their chemical content differ depending on the plant part, the degree of growth and development, the time of day or time of year and the environment where such plants are found.
Keywords: Essential oils, fish pathogens, fish growth

Introduction

The accumulation of chemical residues, however, can lead to difficulties such as the selection of resistant organisms, as well as hostility toward the surroundings and human beings. As a result, the use of farmed fish as food that has been treated could pose health risks. Non Biological insecticides used in management of fish diseases are often banned in several countries because of this reason (Ling et al., 2015). Conventional anthelmintic treatments may also be expensive. Infections by the parasites that occur at the individual level, but their influence extends to the entire population where the result is expressed at the community level.

Owing to the huge number of biological active components existing in medicinal plants, these problems have prompted researchers to quest for the application of medicinal plants as a substitute for curing diseases caused pathogens in farmed fish. Recent years have witnessed a surge in the usage of medicinal and aromatic plants owing to the biological active substances to manage diseases that affect the production and output of fishes in aquaculture. Plant based treatment may be an inexpensive and more effective substitute to chemical based treatment in fish farming (Sharifi-Rad et al., 2017).

Around the world, researchers have studied the diversity of essential oil and their application to fish farming. Similar work are of boundless importance and curiosity that offers a clear elucidation of plant species that synthesize essential oils that can be used for treating infections caused by parasites in fish farming.

Essential Oils

Fishery populations are continually being selected to improve economic efficiency. Parasitosis is unquestionably one of the factors that affect fish production externally and internally. Fish farming practices such as high stocking densities and handling techniques are among the factors at play. Due to the increasing prevalence of fish farming, parasitic diseases have become more prevalent, posing a threat to the industry's

sustainability. The diseases reduce the commercial value of fish by causing mortality, slow growth, and reduced feed conversion rates (Soler-Jiménez et al., 2017).
When parasites are in high abundance, they can spread and establish, which can have negative health effects on farmed fish. A thorough understanding of parasites' potential to harm farm-raised fish was therefore required, along with a thorough understanding of eventuality measures and control strategies for infections caused by parasites. The application of chemical substances is traditional in the treatment of diseases in the fish farming industry (e.g. acetic acid, benzoate, copper sulfate, diflubenzuron, emamectin, fenbendazole, formalin, ivermectin, levamisole, parathion, potassium permanganate, praziquantel, sodium chloride etc.) (Hashimoto et al., 2016; Soares et al., 2017).
Essential oils are very composite naturally occurring combinations that contain arrays of components in varying concentrations. Typically, essential oils are with characteristic two or three main ingredients in comparatively more concentrations (20-70%) in contrast with other components present in least amounts (Bakkali et al., 2008). Generally, the main constituents ascertain the biochemical properties of the essential oils. However, due to the diversity of molecules, the bioactivity of these products can be result of the synergism or additive effects of the constituent molecules. The molecules that make up the essential oils comprise of two groups of different biological synthetic origin where terpenes and terpenoids forms the prime group. The additional group is aromatic and aliphatic constituents. All these compounds are characterized by low molecular weight (Carson and Hammer, 2011). Due to its large availability and chemical diversity, many essential oils have been described as substitutes and effective as accompaniments of synthetic mixtures in the chemical industry. These are used in the fields of human health, agriculture, and environmental management. (Carson and Riley, 2003). These compounds have countless possibilities to be used in aquaculture. Valuable biologicals already described in several species of aquatic animals for the growth promotion and appetite stimulation, immunomodulation, properties antibacterial, antiparasitic, anesthetic and anti-stress (Chakraborty et al., 2014; Silva et al., 2013; Ozogul et al., 2020).

Application of Essential Oils

Various pharmaceuticals and veterinary products are frequently used in the cultivation of fish to prevent economic losses pertaining to hygienic complications. Antimicrobials, pesticides and other drugs are used as prophylactics, in therapeutic or as growth promoters in fish, regularly administered as supplements in food or through wash and injections (Rico et al., 2013). However, the fishery industry is aimed to diminish the use of these products owing to hazards posed to humans, residues in food and resistance to chemical in microbial pathogen. The use drugs is increasingly restricted as they have numerous additional and injurious effect on the environment and health affecting the animal and human (Bulfon et al., 2015). In view of the potential harm of chemical drug treatments in aquaculture and, in some cases, its limited effectiveness, health management should emphasze on less detrimental, protective and long-lasting approaches (Reverter et al., 2014). Consequently, attempts were being made in order to explore herbal medicines, such as for example the essential oils and the purified component as probable substitutes to the conventional drugs. Fish growth, haematological profiles, immune responses, and disease treatment were all given special consideration. (Bulfon et al., 2015; Ozogul et al., 2020).

Plant species

Ocimum americanum, popularly known as white basil or basil, has it origin to Africa and Asia widely distributed in tropical and subtropical regions, often used as a plant for healing ailments (Paton et al., 1999). Antifungal and antibacterial activities have been described for the essential oil of this plant (Cimanga et al., 2002; Thaweboon and Thaweboon, 2009), as well as activity insect repellent (Seyoum et al., 2002).

Ocimum gratissimum, known popularly as clove basil, it is a broadly used plant. used in traditional medicine and as a spice in cooking. The essential oil has activity anthelmintic, antifungal and antibacterial (Prabhu et al., 2009). Anesthetic activity in fish was reported for the essential oil of both species of Ocimum studied (Silva et al., 2012; 2015).

Hesperozygis ringens general and commonly known as flea scarf is a plant with woody habit. endemic in southern Brazil possessing antiparasitic and insecticide properties (Ribeiro et al., 2010). Anesthetic and sedative activity in fish was also described regarding essential oil extracted from this plant (Silva et al., 2013; Toni et al., 2014, 2015).

Cymbopogon flexuosus popularly known as lemongrass, is a tropical grass grown mainly for the extraction of its essential oil (Akhila, 2009), employed in the medical and cosmetic industries. Your essential oil has biological properties important such as anti-cancer and antimicrobial activity (Adukwu et al., 2012; sharma et al., 2009).

Bacterial species: *Aeromonas hydrophila*

The Aeromonas genus is basically abundant in the bacterial environment and may to be isolated from all ecological niches. These include aquatic environments, aquatic animal like fishes, food, livestock, species from invertebrates, birds, insects, ticks, and natural soils. The pathogen is considered as a significant disease inducing pathogen of fishes and various warm blooded species. The pathogen induces a variety of complications including organisms that are immunocompetent and immunocompromised (Janda and Abbott, 2010).

Aeromonas hydrophila is considered a secondary pathogen but under different circumstantial conditions may act as a primary pathogen. The pathogens in hostile environmental conditions causes enhanced death rate in farmed fishes (Nielsen et al., 2001). In fish farming outbreaks caused by *A. hydrophila*, the pathogen is related with deviations in ecological parameters augmented with parasitic infections along with other stress factors (Barcellos et al., 2008). The pathogenesis is dependent on many factors including the discharge of several extracellular factors that influences virulence in bacteria (Yu et al., 2004). Amylases, aerolysins, chitinases, elastases, gelatinases, Hemolysins, lecithinases, lipases, nucleases, and proteases are extracellular component synthesized by Aeromonas that promotes their virulence (Pemberton et al., 1997).

Essential Oils as Antibacterials

Essential oils have potential application as antibacterial and antiparasitic in the culture of aquatic organisms, mainly because of the easy obtainment, relatively low cost, for acting against a wide spectrum of pathogens and for commonly presenting more than a mode of action (Nazzaro et al., 2013). The molecules found in essential oils impacting right on cell wall of the bacteria causing lysis of cells, potentiating the antibacterial activity of another substance and inhibit resistance mechanisms and factors of bacterial virulence (Harris, 2002; Stavri et al., 2007), such as, blocking protein and synthesis of DNA, inhibition of enzyme secreted and interfering with quorum sensing the basis of signaling mechanism in bacteria (Citarasu, 2010). However, the most of the described effects include communications with living membranes like morphological changes and membrane break with cytoplasmic extravasation (Devi et al., 2010; Xu et al., 2008). Essential oils with the bioactive molecules can change the action of efflux pumps, bacterial membrane proteins that facilitate the rapid pushing of the molecule out of the cell long before it reaches concentration desired and exert its effects (Walsh, 2000), thus presenting potential in the advancement in synthesis and discovery of new drugs active against multidrug resistant strains (Stavri et al., 2007, Yap et al., 2014).

Several in vitro studies have shown the possibility of using essential oils from plants against important bacteria in aquaculture. The essential oil of *Cymbopogon nardus* showed probability to be employed against

Aeromonas spp., *Edwardsiella* spp., *Escherichia coli*, *Flavobacterium* spp., *Pseudomonas* spp. *Salmonella* spp., *Streptococcus* spp and *Vibrio* spp, isolated from the internal organs of 10 different species of aquatic animals (Wei and Wee, 2013). Starliper et al. (2015) presented that diverse species of *Aeromonas (A. hydrophila, A. salmonicida, and A. veronii*), as a common fish pathogen, were sensitive to essential oils from *Cinnamomum cassia, Origanum vulgare* and *Cymbopogon citratus in vitro*. Essential oil of *Zataria multiflora* at subinhibitory concentrations suppressed the expression of genes responsible for encoding proteins, fibronectin and hemolysin, factors of known virulence of *Lactococcus garviae* (Soltani et al., 2015). the Essential oils of *Rosmarinus officinalis* and *Z. multiflora* were effective in reducing the gene expression of streptolysin, an important virulence factor of Streptococcus iniae, isolated from trout rainbow, Oncorhynchus mykiss, in addition to decreasing hemolysis caused by the bacteria (Soltani et al., 2014). Thymus vulgaris essential oil significantly reduced the formation of biofilm in *A. hydrophila* (Millezi et al., 2013).

In vivo application of essential oils and active molecules as prophylactic measure or therapeutics to combat bacterial diseases in aquatic organisms can be performed, mainly, in two ways: through wash or by incorporation into the feed (Saccol et al., 2013; Sutili et al., 2015). Clove essential oil (Syzygium aromaticum) added to the diet (3%) promoted the survival of nilotic tilapia (Oreochromis niloticus) experimentally infected with Lactococcus garviae. Fish treated with essential oil showed similar survival to the group treated with the antibiotic oxytetracycline (Rattanachaikunsopon and Phumkhachorn, 2009). A wash treatment daily (1h/5 days) with the key ingredient of clove oil - eugenol (10 mg/L) promoted persistence of catfish experimentally infected with *A. hydrophila* (Sutili et al., 2014). Lippia alba essential oil added to water at concentrations 16 and 40 mg/L encouraged the sustenance of naturally infected catfish with *Aeromonas* sp. (Sutili et al., 2015). In both studies, the survival of fish at the aforementioned concentrations did not differed from the respective controls treated with the gentamicin (10 mg/L). In addition to their potential use as antibacterial, the use of essential oils is a substitute in management of parasites in aquaculture. There are increasing quantity of published studies highlighting the probable application of essential oils and their components in the treatment of diseases parasitic fish, although there are still few studies on the treatment of monogenetic parasites. However, the results are promising, showing that Essential oils are its components are strong alternatives to conventional chemotherapy and pesticides, such as formalin. Unlike what happens with chemicals and synthetic drugs, which generally cause increased parasite resistance, and have a long stay in the environment, it is believed that plant extracts such as Essential oils may cause slow resistance development, greatly decrease emission of waste (biodegradable) and, consequently, being harmless to the environment (Chagas, 2004; Dawood et al., 2020).

Steverding et al. (2005) reported application of the essential oil of *Melaleuca alternifolia* was found to be useful in management of *Gyrodactylus* spp. in fish of species *Gasterosteus aculeatus*. Hashimoto et al. (2016) demonstrated the effectiveness of therapeutic wash using essential oil of *Lippia sidoides* and *Mentha piperita* against different monogenetic parasites in Nile tilapia (*Oreochromis niloticus*) gills. the essential oil of L. alba showed efficacy in vitro against monogeneans of tambaquis (Anacanthorus spathulatus, Notozothecium janauachensis and Mymarothecium boegeri) (SOARES et al., 2016).

Essential Oils as Growth Promoters

In animal nutrition, essential oils are employed as as flavoring and preservatives that functions as antioxidant when added to the diet (Franz et al., 2010). In addition to antimicrobial and immunostimulant properties essential oils may bring about encouraging changes in the morphology of animal intestine, present anti-inflammatory, antioxidant, effect the amount and type of secretions produced by the intestinal mucosa and change the physical and chemical properties of the intestinal environment (Zeng et al., 2015).

A greater variety of amino acids is available for protein synthesis when essential oils are used to stimulate intestinal secretions, allowing the microbiota to modulate and improve digestion and absorption of nutrients. (Freccia et al., 2014). As a result of these changes, an increase in the disease resistance and animal growth.

Several studies have discussed the use of these products as additives in fish feed, since the sum of these biological activities makes herbal medicines one of the main alternatives to antibiotics and/or synthetic drugs used as promoters of growth in animal production (Chakraborty et al., 2014; Citarasu, 2010; Harikrishnan et al., 2011). It is important to note, however, that essential oils' effects on the intestinal bacterial population may be indirect, as opposed to the effects observed when conventional antibiotics are used as growth promoters. (Butaye et al., 2003; Lin et al., 2011; Yang et al., 2015; Dawood et al., 2020).

The addition of L. alba essential oil in the silver catfish diet decreased lipid peroxidation, increased glycogen and lactate reserves and increased tissue antioxidant response (Saccol et al., 2013). Jundiás showed greater growth and weight gain after 60 days of feeding with diets containing *Aloysia triphylla* essential oil (Zeppenfeld et al., 2016). Essential oil extracted from the plant O. heracleoticum (oregano), containing carvacrol and thymol as main compounds, promoted the growth of channel catfish after 8 weeks. observed greater weight gain, in addition to better protein efficiency ratio, condition factor and rate of feed conversion (Zheng et al., 2009). This effect, according to the authors, could be attributed to oregano essential oil's antimicrobial properties. Giannenas et al. (2012) demonstrated that the addition of isolated compounds Carvacrol and thymol in the diet modified the intestinal microbiota of rainbow trout. counts total anaerobic bacteria were lower in fish fed diets containing both composed. The authors did not observe significant differences in final weight and gain. of fish weight, however, the group fed diets containing thymol presented better feed conversion rate. Mozambican tilapia fed diets containing essential oil extracted from sweet orange peel (Citrus sinensis) had higher final weight, gain of weight and feed conversion rate after 90 days of treatment (Acar et al., 2015). Ferreira et al. (2014) concluded that essential oil of oregano (O. vulgare) promoted the growth and improved carcass composition of Astyanax altiparanae. With the increase of the essential oil levels in the diet, there was a reduction in lipids and an increase in the protein content of the carcass.

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