

A Comprehensive Examination of Thymic Acid's Advantageous Impacts on Fish Nutrient Absorption and Growth

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Abstract

Thymic acid (TA) is an important food additive that is used to boost feed efficiency, expansion, and production by increasing the structure and operations of the digestive tract and raising digestive secretion. Its primary use is in animal diets, mainly as a component of natural feed to lessen toxic chemicals in a variety of animal species. TA essential oil is crucial in improving nutritional absorption, defenses, overall health, and reproductive and productive capacity in cattle. The objective of this research is to summarize and assess the current body of knowledge regarding the benefits of TA on fish development and reception of nutrients. The inclusion of TA into fish diets has shown significant gains in immune system performance, feed utilization, and general health. TA has demonstrated its capacity to improve fish reproductive and productive capabilities, as well as nutritional absorption and immunity, when combined with medicinal plants that are rich in powerful chemicals and naturally occurring antioxidants. The characteristics of TA, its antispasmodic, antibacterial, immunomodulatory, anticancer, and soothing qualities, are discussed in relation to fish nutrition. The review delves further into the physical properties, physiological functions, natural sources, and chemical makeup of TA in fish diet, providing light on its essential roles in nutrient absorption and development. The findings add to an improved comprehension of TA's beneficial effects on fish health and performance through its varied biological processes. This review is an excellent source for understanding the overall influence of TA on fish welfare and production.

Keywords: Fish, Thymic Acid, Production, Feed Efficiency

INTRODUCTION

A naturally occurring substance found in thyme plants, TA has attracted a lot of interest lately due to its possible positive effects on fish development and nutrient absorption. TA is a bioactive chemical with unique qualities that might improve the nutritional profile and general health of fish species (1). The various functions of TA emphasize how well it affects fish's ability to absorb nutrients, including better absorption of vital vitamins, minerals, and amino acids. A natural monoterpene called Thymol can be present in a variety of essential oils and herbal plants. It comprises around one-third of the petroleum extracted from *Trachyspermum copticum* and the oil's phenolic content (2). This herb's antiviral, antihelminthic, antioxidant, stimulant, antifungal, antispasmodic, antiseptic, carminative, expectorant, soothing, and antibacterial benefits were utilized (3). The significance of these adverse effects stems from the fact that oxytetracycline (OTC) is ineffective against pathogens other than bacteria; its antioxidant-slowing and immune-suppressive qualities make fish more prone to recurring illnesses (4). Thus, it's imperative to develop strategies to lessen OTC's harmful effects on fish. These detrimental consequences might reduce fish endurance and increase their susceptibility to stresses and other infections (such as fungi and viruses) (5). Its immune-suppressive and antioxidant-suppressive properties leave fish vulnerable to subsequent infections (6). The use of organic and biological fertilizers is one of the primary activities in organic farming. Arbuscular mycorrhizal fungus (AMF) symbiosis is an alternative method to improve plant drought tolerance and lessen the demand for synthetic fertilizers. The enhanced water status in plants has been linked to the beneficial effects of AMF. It has been observed that during drought stress,

mycorrhiza-inoculated plants exhibit improved physiology (7). The production of organic acids (OA) involves the decomposition of cellulose by a variety of organisms under different metabolic conditions and pathways. OA are organic molecules containing one or more carboxyl groups. With the suggested restrictions on the application of organophosphorus insecticides, it is anticipated that the usage of synthetic pyrethroids (SPs) will increase due to their high insecticidal efficiency and low toxicity to mammals (8). One of the most frequent unfavorable elements limiting agricultural productivity in arid and semiarid areas of the world is the effects of drought. Its effectiveness against different arthropods that harm the health of humans and animals is effective, quick, and long-lasting. It has been strongly recommended for managing infectious disease vectors and controlling different insects on fruits, vegetables, cotton, and field crops in veterinary and agricultural commodities (9). While a number of scavenging and antagonist compounds have been developed to reduce the toxicity caused by pesticides, some of them have been demonstrated to have unfavorable side effects. These days, it's generally accepted that using natural sources might lessen the harmful effects of pesticides. The molecule affects essential parts of fish physiology, such as food intake, immune system regulation, and overall growth parameters; this study will describe its processes (10). The research aims to offer insightful information on the possible uses of TA in aquaculture techniques, ultimately assisting in the creation of effective and sustainable plans. The study (11) suggested the process of micro-encapsulating or nano-encapsulating plant extracts and their metabolites has been shown to enhance the growth performances of broiler chickens. This suggests that the technology might be widely perhaps utilized as an alternative to growth promoters made from penicillin in the distant future to propose its critical position in the Fish industry in the future; this study illuminates the positive as well as the non-negative impacts of some of the significant medicinal plants that are directly given to poultry as well as their metabolites. The author (12) provided the proportion of saturated fatty acids dramatically and dose-dependently improved. Conversely, when the Nile tilapia meal's coriander oil content was raised, the amount of unhealthy fats, particularly omega-3 fatty acids, dropped significantly. The study above suggests that using coriander essential oil might improve growth performance. The study (13) achieved that the biological advantages of fish oil stem from its large concentrations of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are two examples of polyunsaturated fatty acids (PUFA) with n-3 content. Because of the effects they have on immune functions, these fatty acids are known as immunomodulatory fatty acids. It could be severely oxidatively stressed or immunosuppressed due to illness or other treatments. The author (14) suggested the relationships between current events, urbanisation, advancement, the food industry, and modifications to dietary and lifestyle choices, together with the impact these trends have on mental health, become noteworthy. Gaining insight into these connections might pave the way for the creation of novel medicinal, medication, dietary, and above all preventative treatments. The Research (15) provided to completely understand this process, as the up-regulation of cytokines appears to be linked to a decrease in genetic diversity and, in particular, to a reduction of specific lactic acid bacteria like *Leuconostoc*. Under standard temperature settings, using the tested microencapsulate mix can be a helpful tactic to enhance rainbow trout development and feed utilization.

MECHANISMS OF ACTION AND BIOLOGICAL ACTIVITY

Pharmacological plants, like thymus, have biological activities and modes of action that improve feed digestion, increase intestinal motility, improve nutrient absorption, and improve the secretion of digestive enzymes, and have anti-inflammatory, antispasmodic, and antioxidant properties (16). Thymol prevents humans from releasing the enzyme neutrophil elastase, which reduces inflammation owing to its encouraging potential; Thymol investigated as a brand-new, innovative antileishmanial drug. "Biocides" is the name given to a class of naturally occurring antibacterial compounds (17). TA has strong antibacterial qualities and is used in biocides in combination with resistance to conventional medications like penicillin. Other antibiotics produced in biocide bacteria by depression due to the combinatorial impact Thymol has been demonstrated to have powerful antioxidant and antibacterial effects, and it may cause drug-resistant bacteria to become susceptible to treatments (18). Thymol has been shown to have potent antifungal properties, particularly against strains of *Candida albicans* resistant to diflucan. Essential oil thymol has been shown to have anticancer action and to be

an effective antimutagenic treatment. The source of Thymol, which offers several medicinal advantages against bloating, digestion tumors, tiredness, stools, indigestion, lack of appetite, and respiratory distress, may also function as a positive allosteric modulator (19). It also possesses antibacterial, hypolipidemic, antiparasitic, and antioxidant properties. Thymol may have a nephroprotective impact because of its antioxidant, antibacterial, and antiapoptotic qualities.

Qualities both physical and chemical

The isomeric structures of Thymol and carvacrol differ where the methyl group is located in relation to the OH molecule. Cymene naturally occurs as the monoterpene phenol metabolite thymus. Common thyme used to extract Thymol, which is present in thyme oil, as well as other diverse plant species (20). It is a white, crystalline material with potent antibacterial qualities and a delightful, fragrant smell. Different extraction techniques and filtration can be used to get thymol fractions. The robust, characteristic thyme taste in food preparation is also attributed to Thymol (21). Figure (1) shows Thymol's basic structural formula. Thymol is a volatile chemical which is a liquid. The thymol density of the phenol has been deprotonated, and it dissolves well in alkaline aqueous solutions, alcohols, and other organic solvents with a neutral pH. It also dissolves in water to some extent (22). Thymol can absorb the most significant amount of ultra violence (UV) light at 274 nm. Although Thymol is only marginally soluble in water, it highly dissolves at pH neutrality in alcohols and other chemical solvents (23).

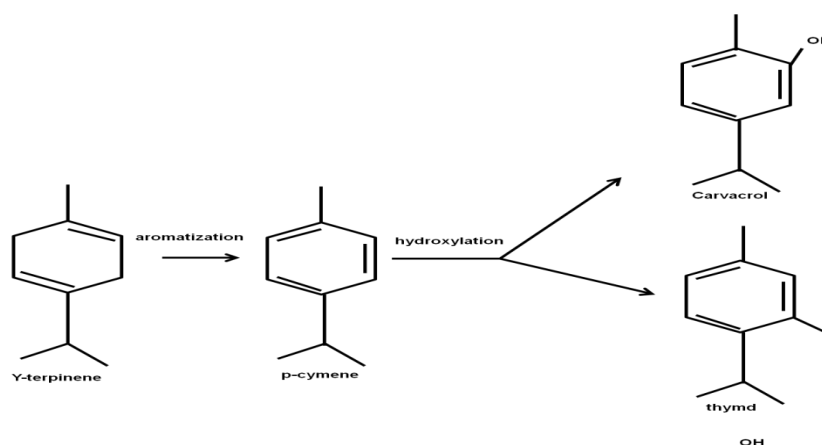


Figure (1). Thymol basic structural formula

(Source: <https://europepmc.org/article/pmc/pmc7571078#figures-and-tables>)

BENEFITS ASSOCIATED WITH THYMOL

Facilitator of growth and productivity

Thymol offers a number of beneficial physical and metabolic effects, as demonstrated by several research studies. According to reports, it may stimulate the secretions involved in digestion, including bile acids, pancreatic enzymes, human salivary amylase, gastric (including a substance cleaved and starch), and rat intestinal epithelium observed a notable rise in the amylase activity of the pancreas, maltase, and trypsin activities in broiler chicks given various combinations of industrial essential oils discovered even though the fishes feed Consumption was reduced by about 10%, they gained more body weight when their food was supplemented with 1,000 mg/kg of thyme essential oil (24). Figure (2) shows an alternation in general acceptance.

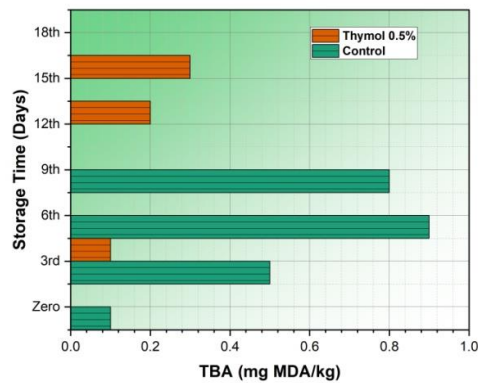


Figure (2). Alterations in general acceptance (Source: Author)

Fishes were supplemented with several additives, such as pepper essential oil, Thymol, sage, and rosemary extracts (25). The impact of these additions on feed digestibility was investigated, and the results showed an improvement in both end efficiency and feed solubility (26-27). Figure (3) shows differences between the medicated fish and untreated fish pH in Thymol. The benefits of thymol essential oil consumption on feed utilization are enzyme stimulation and improved absorption, together with its antimicrobial action, which may enhance the performance of animals.

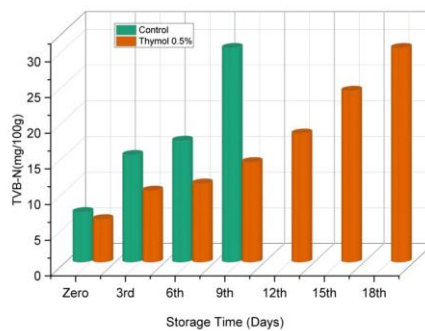


Figure (3): Differences between the medicated and untreated fish's Ph (Source: Author)

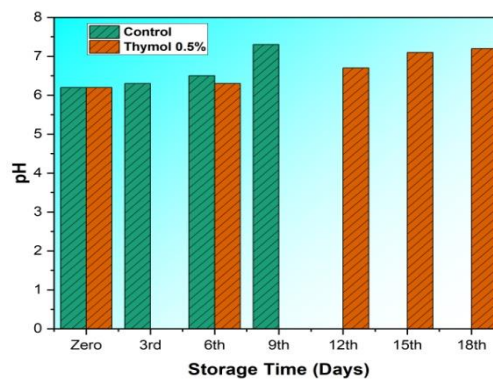


Figure (4). pH variations between the treated and control fish (Source: Author)

Antispasmodic impact

High concentrations of Thymol and camphor demonstrated bronchial relaxing actions, indicating that thymus supplements are significant as an antispasmodic drug on the intestines and trachea's smooth muscle (28). Thymol's biological measures in fish figure (5) and the impact of Thymol on culinary clearance were examined. The antispasmodic qualities of thyme extracts or products are attributed to the combined effects of phenolic molecules and flavonoids, such as flavone luteolin (29).

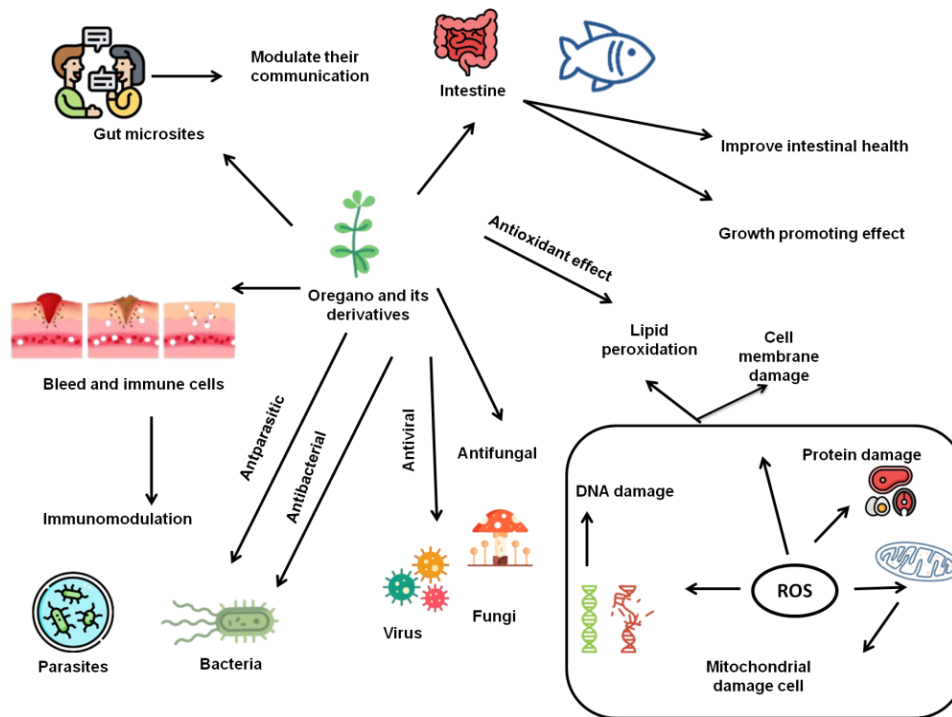


Figure (5). Thymol's biological actions in fish (Source: Author)

Immune modulating actions

Enhancing immunity to ward off frequent illness infections is one of the primary goals of the development of fish and poultry. Immunoglobulin may result from immune-suppressive illness infections vaccination collapse. Using immune stimulators, such as herbal components, might reduce susceptibility to infectious disorders (30). The state of the host immune system largely determines resistance to various illnesses. Using essential oils can improve and enhance their defense system's capacity to combat pathogenic pathogens. The polyphenol portion of aromatic oils of oregano and thymus has immunostimulating properties (31). Hypothesised that Thymol's beneficial, antiseptic, and antioxidant properties may enhance chicks' immunological responses. Table (1) shows the biological effects of thymol oils on fish. With a noteworthy rise in the levels of hematocrit, white blood cells, and red compared to the untreated category, the blood cell and protein levels of broilers fed diets supplemented with oil extract derived from thyme and spice were higher (32).

Table (1). Thymol oil's biological effects on fish (Source: Author)

Thymol\ acid	Addition of 1% thymol	Essential oil of Origanum	Supplementing diets with thymol with carvacrol	Thyme	Encapsulated mixture of carvacrol and thymol

		notes			
Fish type	Shrimp	Rainbow trout	Oncorhynchus mykiss	O. niloticus	O. mykiss
Biological activities	White spot syndrome virus	Non-specific defense and function of lysosomes	The development of tissues containing reduced glutathione (GR) and blood activity of catalase	Nutritional accessibility and the function of digestive enzymes	Growth, body protein content of the fillet

GROWTH METRICS

While the gut microbiota population was increased, feed efficiency, growth curve, and nutrient absorption and digestion were improved in animals given diets supplemented with TEO; conversely, diarrhea was decreased. Adolescent salmon diet can improve several production indices (final Fish characteristics include Weight of the body, monthly growth rate, feed efficiency, and specific growth rate; tissue composition consists of fibres, fatty acids, and whole-body nitrogen). The antibacterial qualities of thyme may aid in improving the efficiency of fish gastrointestinal tracts in metabolizing and absorbing nutrients, potentially lowering disease incidence and mortality (33). It was noted the thymol oil altered the insect's intestinal microbiota, increased enhanced nutritional digestion, increased its antibacterial properties, TEO consumption had positive effects on feed intake, enzyme stimulation, and improved accessibility, which improved fish achievement (34).

Indexes of hemato-biochemistry

The components and blood profile are regarded as crucial markers of the health of the fish tissue. According to reports, they decreased when the rainbow trout diet was supplemented with thymol oil (35). However, alanine transaminase (ALT) levels remain unchanged. A significant impact was noted in most blood biochemical parameters, including albumin, globulin, and total protein, and ALT and AST levels. Furthermore, rainbow trout-fed diets enriched with thyme extracts showed a substantial reduction in liver activity (AST and ALT). In contrast to the control group in fish and other animals, circulating It is common knowledge that cortisol and levels of glucose indicators of stress (36). Thyme extract was able to significantly lower the rise in blood sugar and the stories of cortisol in fish exposed to elevated penicillin as anxiety from their environment (37).

Quality of meat

Flesh discoloration is associated with oxidative processes present in meat products. Pro-oxidants are created during lipidic oxidation and can interact with the hemoglobin to generate hemoglobin using natural additives containing bioactive compounds in animal diets, which have yielded positive results in increasing meat quality. Some research has proven a drop in the loss of color in red meat (38). Evaluated the addition of several natural antioxidants to the diet on investigations pertaining to physical-chemical, microbiological, and sensory aspects of dietary photogenic significantly improved the color qualities during storage, according to research on meat from gilthead sea breams stored 16 days at 4 °C (39). This causes the fillets' color to brighten, enhancing it with thymol oil considerably lower than other methods of ice storage in terms of microbiological expansion, grade rating evaluations, eye shape score, and moisture retaining ability (40). Treatments are suggested that the antibacterial properties of the grilled meat may have increased the inhibitory effect of thymol oil.

CONCLUSION

According to this review, adding TE to feed can improve growth rate, feed efficiency, immunological response, nutrient absorption and digestion, antioxidant indices, and meat quality. TE has antiviral, anticancer, antispasmodic, antibacterial, and anti-inflammatory properties. Reducing lipid peroxidation in fish flesh is another benefit of TE. Research on TE's modes of action, including its biological, pharmacological, nutritional, and health benefits, might be crucial for fish farms. The benefits of dietary thymol supplementation for growth promotion, feed additive, or other purposes. These benefits include improved Consumption of feed, immune system performance, vitamin absorption, and levels of antioxidants. Thymol, a putative antioxidant, has been shown to guard protection against cell damage caused by reducing or stopping the destruction of the mitochondrial membrane. Change liver cells experienced oxidative stress once again, due to the potential and suppression of ROS overproduction. The pharmacological, nutritional, medicinal, and biological action mechanisms of the thymol component should be investigated to understand its potential applications in fish health fully. To develop a fresh strategy for thinking about the use of thymol extracts and essential oils in medicine and related applications, investigations should assess the toxicity and safety of these substances.

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