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Effects of using olive tree (*Olea europaea* L.) derivatives as feed additives on growth efficiency, immunological response, and oxidative status in finfish: A Review

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تأثير استخدام مشتقات الزيتون (*Olea europaea L.*) كمضافات علفية على النمو والاستجابة المناعية والحالة التأكسدية للأسماك الزعنفية: مراجعة

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Abstract:
The aquaculture sector has witnessed remarkable growth all over the world, but this sector faces the problem of scarcity and high prices of feed ingredients, especially fishmeal and fish oil, which are known for their importance in fish production and improving their health. This problem has prompted aquaculture nutrition specialists to search for available and less-cost feed alternatives and evaluate the possibility of using them in aquaculture nutrition. These alternative feeds that have been used to feed aquatic organisms include many types, including by-products resulting from the olive tree (*Olea europaea* L.), during the production of olives and olive oil, which include wastewater from olive presses, olive leaves, and olive pomace. Several studies have investigated the possibility of including these by-products from the olive tree in fish feed, depending on the type of by-products used and the species of fish produced. In this research, the pros and cons of using by-products of olive and olive oil production in feeding aquatic organisms were reviewed as a contribution to supporting and developing the field of aquaculture.

Keywords: Olive Derivatives, Fish, Growth, Aquaculture, Alternative Feeds.

الملخص
شهد قطاع الاستزراع المائي نموا ملحوظا في جميع أنحاء العالم، إلا أن هذا القطاع يواجه مشكلة ندرة وارتفاع أسعار مكونات الأعلاف وبشكل خاص مسحوق السمك، وزيت السمك، المعروفان بأهميتهما في إنتاج الأسماك وتحسين صحتها. دفعت هذه المشكلة المختصين في تغذية الأحياء المائية إلى البحث عن البدائل العلفية المتاحة والأقل تكلفة وتقييم مدى إمكانية استخدامها في تغذية الأحياء المائية. تشمل هذه الاعلاف البديلة التي تم استخدامها في تغذية الاحياء المائية العديد من الانواع، والتي من بينها المشتقات الثانوية الناتجة عن شجرة الزيتون (*Olea europaea* L.)، عند انتاج الزيتون وزيت الزيتون والتي تشمل مياه الصرف الناتجة عن معاصر الزيتون وأوراق الزيتون وثفل الزيتون. بحثت العديد من الدراسات في إمكانية إدراج هذه المنتجات الثانوية الناتجة عن شجرة الزيتون في أعلاف الأسماك، وذلك حسب نوع المنتجات الثانوية المستخدمة وأنواع الأسماك المنتجة. تم في هذا البحث مراجعة إيجابيات وسلبيات استخدام المنتجات الثانوية لإنتاج الزيتون وزيت الزيتون في تغذية الأحياء المائية وذلك مساهمة في دعم وتطوير مجال تربية الكائنات المائية.

الكلمات المفتاحية: مشتقات الزيتون، الاسماك، النمو، تربية الاحياء المائية، الاعلاف البديلة.

1-Introduction

Aquaculture (marine and freshwater) has the biggest potential to help marine and inland capture fisheries fulfill the world's need for aquatic food and is still one of the food-producing industries with the fastest rate of growth [1].The global expansion of the use of intensive systems in aquaculture [2] has led to a significant increase in global aquaculture productivity, but this in turn has led to an increase in fish stress, especially in the presence of other factors that contribute to the increase in stress rates such as handling, transportation and harvesting of fish. As a result, this may cause a variety of disorders, such as impaired metabolism, subpar meat, increased susceptibility to infections [3] and in the worst situations, death [4]due to these limitations fish farmers face a difficulty in converting the benefits of increased productivity that associated with intensive production techniques into economic returns. Therefore, the continuity of scientific research will lead to achieving greater possibilities in aquaculture.

With the use of intensive fish farming, breeders used chemical drugs in order to protect the health status of fish and reach the highest economic gains. The use of these drugs in aquaculture appears to be purely commercial and unsustainable because they lead to a number of other problems, including immunosuppressant, environmental pollution, fish pathogen drug resistance, and the buildup of chemical residues that may be dangerous to human health [5][6].As a result, several countries throughout the world, including the United States, the European Union and Asia, have strong demand for aquatic products that are devoid of chemicals and pharmaceuticals. Today, it is more important than ever to switch out antibiotics and other synthetic chemicals with natural dietary supplements or ingredients that can improve fish health, growth, and feed utilization, ultimately ensuring the safety and high quality of the products produced through aquaculture[7][8].

A growing body of research over the past two decades has reached the consensus that plants and their derivatives (extracts, oils, powders, waste, bioactive compounds, etc.) are considered a suitable alternative to the use of antibiotics and various chemical drugs in aquaculture. As useful biologically active metabolites with benefits including immune growth promotion, antioxidant enhancement, antidepressant, digestive enhancement, appetite stimulation modulation [9] [3]and hepatoprotective effects [10], plant derivatives stand out as potential substitutes for synthetic drugs in aquaculture. Another factor is that compared to synthetic medications, plant derivatives are more readily accessible, less expensive, and typically more biodegradable in nature[11].

Numerous evaluations on the possible application of plant derivatives in aquaculture have recently been published [12] [13] [14]. Although olive derivatives of various types may be valuable natural alternatives that contribute to the development of this sector and reduce production costs, there appears to be a scarcity of experimental research related to the use of olive derivatives in aquaculture. Therefore, the aim of this review is to evaluate the most important information about the optimal use of these derivatives in aquaculture and the extent of their usefulness in aquaculture as growth stimulants, appetite stimulants, antioxidants, and immune stimulants.

2-Administration of Olive (*Olea europaea* L.) derivatives in aquaculture

In general, there are three ways to administer plant materials in aquaculture: orally, intravenously, and immersion. According to [15], the administration's purpose, the size and species of fish, the products involved, and the farming system all influence the choice between these strategies. Additionally, the delivery of herbal oils and extracts may be successful via injection and immersion techniques [16];however, the use of these strategies may not be available in all areas of aquaculture, as it requires highly qualified and specialized labor. Today, oral administration is frequently utilized in aquaculture, particularly to increase fish development and health characteristics (Tables1and 2). Clearly, further research is still necessary to homogenize plant product administration techniques for various goals (such as fish growth, disease resistance and meat quality).

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3-Effects of Olive derivatives as food additives on finfish growth

The results of several studies showed that growth parameters and feed utilization, as well as survival rate, were enhanced in different types of fish when using several olive tree products such as leaf extract and olive oil, in addition to the biologically active olive oil compounds.

Several references showed that the crude extracts of the olive plant, compared to other feed additives, achieved a significant increase in weight gain (WG), specific growth rate(SGR), feed consumption(FC), and feed conversion rate (FCR) in common carp(*Cyprinus carpio*) [17] [18] and Nile tilapia (*Oreochromis niloticus*) [19].Likewise, growth efficiency measures and feed consumption indicators were improved in diets fed to Persian sturgeon (*Acipenser persicus*) supplemented with olive oil [20], sea bream (*Sparus aurata*) fed with olive oil bioactive compounds [21], and in rainbow trout (*Oncorhynchus mykiss*) fed a diet enriched with olive (*Olea europea* L.) waste [22](Table 1).

Fish that fed olive products showed an improvement in growth performance and feed utilization indicators because these products contain a variety of immunomodulatory substances, including complex vitamins, minerals, antioxidants, polysaccharides, alkaloids fatty acids, and flavonoids that induced the secretion of digestive enzymes, leading to appetite-stimulating, which in turn improved food consumption, digestion and absorption of nutrients, which promoted the general health status of fish and ultimately produce better growth and survival rates.Olive products can also induce the transcription rate, which leads to increased RNA, and total amino acid and ultimately increases protein synthesis. Earlier research showed that olive products could improve bile synthesis in fish, possibly activate the pancreas, and increase the secretion of digestive enzymes [23] [18].

On the other hand, research has recorded that the effect of olive plant products on fish growth depends on the dose given to the fish, as growth increases to a certain level (optimum addition level) of adding the nutritional supplement, and after exceeding this limit, a decrease in growth occurs. For instance, the increasing level of olive waste in Nile tilapia diets significantly reduced the growth performance and efficiency of feed utilization in fish, and an inclusion level of 25% olive waste in the fish diet was found most suitable to support maximum [24], also [22] suggested that the ideal ratio for adding olive waste to rainbow trout (*Oncorhynchus mykiss*) feed, which may support growth, is 2.5 g kg^{-1} of feed(Table 1). High dietary fiber content may not be the only cause of the poor development performance of fish, so when fish consume increasing amounts of olive waste, dietary limiting amino acids, toxic substances, high dosages, anti-nutritional elements (such as saponin and tannin), and allergic reactions, are all factors that may also contribute to their poor development performance [25][26]. These are the key explanations for why some herbal extracts affect fish development and feed utilization indices negatively or not at all. Therefore, it is important in aquaculture to investigate efficient ways to purify olive waste that do not alter the final required composition of the olive waste.

Table 1. Effects of dietary Olive derivatives supplementation on fish growth.

Type of olive derivative	Fish species, number and weight	Dose* and duration	Notable results**	References
Olive pomace	Tilapia (*Tilapia zillii*), 120, with about 3.95±0.02 g	10%, 20% and 30%for50days	↔ Growth	[27]
Olive (*Olea europea*) leaf extract	Common carp (*Cyprinus carpio*) 240) with weight of 25 ± 3.2 g	2.5%for30days	↔ Growth	[28]
Olive (*Olea europea*) leaf extract	Common carp (*Cyprinuscarpio*) 180 common carp (32.26 ± 1.01 g)	200 mg/kg, 400 mg/kg for 75 days	↑ Growth	[18]

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Olive leaf (*Olea europea* l.) Extract	Rainbow trout (*Oncorhynchus mykiss)* 375 rainbow trout (51.22 ± 3.04g)	0.0%, 0.1%, 0.25%, 0.50% and 1.0%for60days	↔ Growth	[23]
Olive mill waste	Nile tilapia (*Oreochromis niloticus*) 90 fishes with average body weight, 34±0.05g	30%for 12 weeks	↔ Growth	[29]
Olive waste	Nile tilapia (*Oreochromis niloticus*) with average body weight, 4.04 ± 0.31 g	25, 50, 75 and 100%for70days	↓Growth	[24]
Olive waste	Nile tilapia *(Oreochromis niloticus*) 120 weight of 14 g/fish	30%for 2 weeks	↓Growth	[30]
Olive leaves extract	Nile tilapia (*Oreochromis niloticus*) 400 fish	1%, 1.5% and 2%	↑Growth	[19]
Olive leaves extract	Tilapia galilae*(Sarotherodon galilaeus*), with an initial body weight 33 ± 1.0g	1, 2, and 3%for100days	↑Growth	[31]
Olive oil	Persian sturgeon (*Acipenser persicus*) 315 weight of 108±0.02 g	1%, 3%, and 5%FOR60DAYS	↑ Growth	[20]
Olive leaf aqueous-alcoholic extract	Common carp (*Cyprinus carpio*) fingerlings. A total of 135 fingerlings weight of 15 ± 3.4 g	1 and 5 g/kgfor8weeks	↔ Growth	[32]
Olive (*Olea europaea*) leaf extract	Common carp (*Cyprinus carpio*) fingerlings. A total of 120 fingerlings weight of 15 g	0.1% , 0.5% and 1%For 8 weeks	↔ Growth	[33]
Olive (*Olea europea* l.) Waste	Rainbow trout (*Oncorhynchus mykiss*) 120 (2.5 ±0.1 g).	0, 0.5, 2.5 and 5 g kg^{-1} diet	↑ Growth	[22]
Olive leaf extract	Common carp (*Cyprinuscarpio)* 300 fish (15.90 ± 0.93 g)	0.1, 0.25, 0.50 and 1% for 60 days	↑ Growth	[17]
Olive oil bioactive compounds	Sea bream *(Sparusaurata*) 5.4 ± 1.2 g	0.08, 0.17, 0.42 and 0.73% for 90 days	↑ Growth	[21]

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Olive mill vegetation water	Rainbow trout (*Onchorynchus mykiss*) 200 fish (mean body weight: 44.2 g)	1 and 5% for 94 days	↔Growth	[34]
Olive (*Olea europaea*) leaf extract	Common carp (*Cyprinus carpio*) 180 common carp (32.26 ± 1.01 g)	200 mg/, 400 mg/kg for 75 days	↑ Growth	[18]
Olive leaves ether extract	Nile Tilapia (*Oreochromis niloticus*) 180 fish19.7 ±0.94 g	0.1 and 0.4% for 12 weeks	↑Growth	[35]

* Doses given in the table are those supplemented to the fish groups where the notable results were observed. Not every dose was given since otherwise, the presentation of the varying results would be complicated.
** Results of some studies, in which some of the doses displayed different results, were given based on the general conclusions of that particular study.
Symbols: ↑ indicates increase, ↓ indicates decrease, ↔ indicates no change

4-Hematological indices of using Olive derivatives as Immunostimulatorses

Blood is considered the most frequently examined tissue to determine the physiological or physical condition of vertebrates. Health problems, including the ability to carry oxygen, are directly assessed by using primary hematological indicators of red blood cells (RBC), hemoglobin (Hb) concentration, the percentage of blood volume made up of red cells and hematocrit (Hct).These indices can be used to create secondary indices, such as mean corpuscular volume (MCV) =(Hctx10/ RBC), mean corpuscular hemoglobin (MCH) =(Hbx10/RBC), and mean corpuscular hemoglobin concentration (MCHC) =(Hb x 100/Hct), that are used to categorize anemia disorders. In order to account for an animal's innate immune status, particularly under stressful circumstances, other hematological indicators, such as white blood cells (WBC) [7]. Additionally, it has been demonstrated that the neutrophils to lymphocytes ratio is a good tool for determining the stress level in vertebrates [11].

Many blood indicators were studied to infer the health and immune status resulting from the use of olive derivatives in aquaculture (Table 2). Numerous research results have shown that the use of olive derivatives in aquaculture has led to an improvement in some of the aforementioned blood parameters. In rainbow trout (*Oncorhynchus mykiss)* culture for instance, the olive (*Olea europea*) leaf extract diet was reported to have significantly increased blood biochemical parameters after *Yersinia ruckeri* challenge [23].Similarly, the administration of common carp (*Cyprinus carpio*) [33], Persian sturgeon (*Acipenser persicus*) [20] and Nile tilapia(*Oreochromis niloticus*) [19] reportedly improved some hematological parameters after adding the olive leaf (*Olea europea* L.) extract to the fish feed.

The observed increase in hematological indices indicates that olive leaf extracts have the capacity to stimulate erythropoiesis, enhancing the capacity of oxygen transport and fortifying defense mechanisms against physiological stress. This may have been caused by their high nutritional value, particularly their polysaccharides, essential vitamins (such as riboflavin, thiamine, and folic acid), and non-essential amino acids, which are crucial for the production of hemoglobin [36][37].

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Table 2. Effects of dietary Olive derivatives supplementation on hematological indices in fish.

Type of olive derivative	Fish species	Dose and duration	Notable results*	References
Olive (*Olea europea*) leaf extract	Nile tilapia (*Oreochromis niloticus*)	1%, 1.5% and 2% for 2 mounts	↑ WBC, RBC, Hb, PCV	[19]
Olive (*Olea europea*) leaf extract	Common carp (*Cyprinus carpio)*	0, 1, 5 and 10 g/kg for 60 days	↔ Hb, MCH, leukocyte ↑RBC, ↓MCV ↔WBC	[33]
Olive (*Olea europea*) leaf extract	Common carp (*Cyprinus carpio*)	2.5% for 30 days	↓RBC Hct, Hg	[28]
Olive (*Olea europea*) leaf extract	Common carp (*Cyprinus carpio*)	200 mg/kg, 400 mg/kg for 75 days	↑WBCs	[18]
Olive oil	Persian sturgeon (*Acipenserpersicus*)	1%, 3%, and 5% for 60 days	↑Blood parameters	[20]
Olive (*Olea europea*) leaf extract	Common carp (*Cyprinus carpio*) fingerlings.	1 and 5 g/kg for 8 weeks	↑ Blood parameters	[32]
Olive (*Olea europea*) leaf extract	common carp *(Cyprinus carpio*)	0.1%, 0.25%, 0.50% and 1.0% for 60 days	↑Hct	[17]
Olive mill vegetation water	Rainbow trout (*Onchorynchus mykiss*)	1 and 5% for 94 days	↑Blood chemistry	[34]
Olive leaf extract (*Olea europaea*L)	Common carp (*Cyprinus carpio*)	200 mg/, 400 mg/kg for 75 days	↑WBCs,	[18]

*Notes:Hct=Hematocrits;Hb=Hemoglobin;WBC=Whiteblood cells;MCV=Meancorpuscularvolume;RBC=Redbloodcells;MCH=Meancorpuscularhemoglobin;MCHC=me ancorpuscularhemoglobinconcentrate;(↑) =significantlyincreased;(↓)=significantlydecreased,(↔)=notaffected.

5-Immunological and biochemical indices of using olive derivatives in fish

Many immunological and biochemical indicators were studied to determine the effect of using olive derivatives on the immune and health status of aquatic organisms (Table 3). Blood serum contains a variety of substances that can be utilized to assess the health state of fish in addition to hematological characteristics. For instance, the serum total protein (a byproduct of WBC) and globulin (a source of immunoglobulins or antibodies) levels in the blood are indicators of the immune system's activation. While the presence of lysozyme, antimicrobial peptides, phagocytes, and complement factors in the blood indicates that pathogens are being prevented from entering the body by pathogen cell wall destruction (by lysozyme and antimicrobial peptides), phagocytosis (by phagocytes), and neutralization (by complement factors) [3].Additionally, according to [38], aspartate aminotransferase (AST) and alanine aminotransferase (ALT) play a major role in determining hepatoprotective activity, while certain glucose and cortisol levels in the blood can indicate stress.

The uses of a number of olive derivatives are quite effective at enhancing a variety of biochemical parameters in fish farming. Accordingly, olive oil [20], and olive leaf extract [23]; [17] were reported to have enhanced innate immune biochemical parameters, and even resistance against *Edwardsi ellatarda* and *Yersinia ruckeri* in common carp and rainbow trout, respectively. Similar improvements in innate immune biochemical metrics were seen in sea bream (*Sparus aurata*) after dietary administration of olive oil bioactive components [21].

Table 3. Effects of dietary Olive derivatives supplementation on Immunological and biochemical parameters of fish**.**

Type of olive derivative	Fish species	Dose and duration	Infection or stress	Notable results*	References
Olive (*Olea europea*) leaf extract	Nile tilapia (*Oreochromis niloticus*)	1%, 1.5% and 2% for 2 mounts	-	↑ Pp. ↓ Chol and trig	[19]
Olive (*Olea europea*) leaf extract	Common carp (*Cyprinus carpio*)	0, 1, 5 and 10 g/kg for 60 days	Ammonia exposure	↓Lzy.Act, Co.andBA	[39]
Olive (*Olea europea*) leaf extract	Common carp (*Cyprinus carpio*)	2.5% for 30 days	Exposed to the pesticide Danitol®	↑ALT, AST, and ALP	[28]
Olive (*Olea europea*) leaf extract	Common carp (*Cyprinus carpio*)	200 mg/kg, 400 mg/kg for 75 days	-	↑ Lzy NBT , Tp,	[18]
Olive (*Olea europea*) leaf extract	Rainbow trout (*Oncorhynchus mykiss*)	0.0%, 0.1%, 0.25%, 0.50% and 1.0% for 60 days	*Yersinia ruckeri* infection	↑ Serum biochemical parameters, survival rate and TNFα,	[23]

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				IL1-β,8 gene expressions	
Olive mill waste	Nile tilapia (*Oreochromis niloticus*)	30% for 12 weeks	-	↓Glu, Tp, and Cort ↔AST and ALT	[29]
Olive Waste	Nile tilapia (*Oreochromis niloticus*)	30% for 2 weeks	-	↑Glu, ↔Tp, ↑chol, ↑Trig ↑ALT, ↓AST, ↑ALP	[30]
Olive leaves extract	Nile tilapia (*Oreochromis niloticus*	1%, 1.5% and 2%	-	↑Immunity	[19]
Olive leaves extract	Tilapia galilae (*Sarotherodon galilaeus*),	1, 2, and 3% for 100 days	-	↑Pp, AI, and GI. ↓ Glu, Chol, and trig	[31]
Olive oil	Persian sturgeon (*Acipenser persicus*)	1%, 3%, and 5% for 60 days		↑Immunity	[20]
Olive leaf extract	Common carp (*Cyprinus carpio*) fingerlings.	1 and 5 g/kg for 8 weeks	-	↑ Immune parameters	[32]
Olive leaf extract	Common carp *(Cyprinus carpio*)	0.1%, 0.25%, 0.50% and 1.0% for 60 days	*Edwardsi ellatarda*	↑Immune response gene levels IL-1β and TNF-α ↑survival	[17]
Olive (*Olea europea* L.) waste	Rainbow trout (*Oncorhynchus mykiss*	0, 0.5, 2.5 and 5 g kg^{-1} diet	-	↑ Skin mucus.Ig ↔IL-1β and IL10 ↑IL8	[22]
Olive leaf powder	Red sea bream (*Pagrus major*)	8% 40 days	-	↑Collagen content ↑myofibril protein content of the fish muscles	[40]

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Olive oil bioactive compounds	Sea bream (*Sparus aurata*)	0.08, 0.17, 0.42 and 0.73% for 90 day	-	↑Immunity	[21]
Olive leaf extract (*Olea europaea* Leecino)	Common carp (*Cyprinus carpio*)	200 mg/, 400 mg/kg for 75 days	-	↑ Lzy.Act ↑ NBT	[18]
Olive leaves ether extract	Nile Tilapia (*Oreochromis niloticus*) g	0.1 and 0.4% for 12 weeks	-	↑Immunological Parameters	[35]

*Notes:Lzy.=Lysozymeactivity;MPO=Myeloperoxidase;Glu.=Glucose;Cort.=Cortisol;NBT=Nitrobluetetrazolium;AST=Aspartateaminotransferase;ALT=Alanineaminotransferase;Pp=plasmaprotein;↓Chol=cholesterol;trig=triglycerides;Tp=totalprotein;Co=complement;BA=bactericidalactivities;Al=albumin;Gl=globulin;(↑)=Significantlyincreased;(↓)=significantlydecreased,(↔)=notaffected.

6-Olive derivatives as antioxidant agents in fish

Several olive derivatives have been investigated for their effects as antioxidant agents in fish (Table 4).A number of natural antioxidant enzymes are used to detect cell damage caused by reactive oxygen species (ROS), including myeloperoxidase (MDA), catalase (CAT), superoxide dismutase (SOD), and glutathione peroxide (GSH-Px).

Olive (*Olea europea*) leaf extracts were reported to have enhanced rainbow trout (*Oncorhynchus mykiss*) antioxidant enzymes, superoxide dismutase, glutathione peroxidase and glutathione S transferase [34]. Also increasing plasma malondialdehyde was observed by [33] in common carp (*Cyprinus carpio*) after being fed a diet supplemented with olive (*Olea europea*) leaf extract after post-ammonia exposure. It is generally understood that the improvement of antioxidant and hepatoprotective activity in fish by plant derivatives is frequently connected with specific photochemical [41]. Plant derivatives contain photochemical that are known to support the inhibition or suppression of the oxidation process, including phenol/polyphenols (gallic acid, tannins, and ellagic acid), enzymes (SOD, CAT, GSH-Px), vitamins (C, E, and carotenoids), and flavonoids (flavones, isoflavones, flavone, anthocyanins, and catechins). This ability to inhibit or suppress the oxidation process is by increasing the quantity and activity of the body's natural antioxidant enzymes like liver CAT, SOD, and glucose-6-phosphate dehydrogenase or by increasing the bioavailability of vitamin E and C (important antioxidant agents) [42].

Furthermore, It is very difficult toemphasize the antioxidative and hepatoprotective benefits of herbal extracts; so further study is necessary to maximize these benefits in aquaculture, including quantification of the plant derivatives' advantageous phytochemicals (such as flavonoids and phenols) and their correlation to various immune biochemical indices. As these phytochemicals are known to be toxic at larger concentrations, it is also necessary to determine the extent of any potential adverse effects on fish species, the environment, and consumers [43] [9].

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Table 4. Effects of dietary Olive derivatives supplementation on antioxidant status in fish.

Type of olive derivative	Fish species	Dose and duration	Notable results	References
Olive leaf extract	Common carp (*Cyprinus carpio)*	0, 1, 5 and 10 g/kg for 60 days	↑Plasma malonaldehyde after ammonia exposure	[33]
Olive (*Olea europea* L.) waste	Rainbow trout (*Oncorhynchus mykiss*)	0, 0.5, 2.5 and 5 g kg^{-1} diet	↑Superoxide dismutase ↑Glutathione peroxidas ↑Glutathione S transferase	[34]
Olive oil bioactive compounds	Sea bream (*Sparus aurata*)	0.08, 0.17, 0.42 and 0.73% for 90 days	↔ Lipid peroxidation levels, catalase, Glutathione reductase and Glutathione S-transferase activities	[21]

7-Conclusion

In conclusion, this research demonstrates that olive derivatives are widely used in aquaculture and have the potential to increase aquaculture growth and improve a number of physiological and immunological properties. In addition to contributing to reducing production costs. However, there is a need for more research to confirm the optimal use of olive derivatives in the field of aquaculture by learning more about their growth-promoting effects, their immune-stimulating effects, their toxic effects, methods of extracting them, and determining their addition rates in feed to achieve the best results.

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