Mediterranean Aquaculture Journal 2024 11 (2): 1-14

Mediterranean Aquaculture Journal

https://maj.journals.ekb.eg

Print ISSN: 1687-7616 Online ISSN: 1687-7187

Original Article

Impact of dietary essential oils of Coriander (*Corriandrum sativum*) and Basil (*Ocimum basilicum*) on growth, digestive enzymes, antioxidant activity and intestinal histology of fingerling Nile tilapia (*Oreochromis niloticus*)

Yousef T. Mohamed[1], Shymaa M. Shalaby[2], Ashraf Y. El-Dakar[1]*, Mohamed M. Rashad[3], Mohamed F. Abdel-Aziz[1]

[1]Department of Aquaculture and Biotechnology, Faculty of Aquaculture and Marine Fisheries, Arish University, Arish, Egypt
[2]Department of Aquaculture, Faculty of Fisheries, Suze University, Egypt
[3]Depatment of Marine Ecology, Faculty of Aquaculture and Marine Fisheries, Arish University, Egypt

ABSTRACT

Dietary phytobiotics and their derivatives of essential oils (Eos) are crucial to intensive systems due to their high content of bioactive compounds that improve the immunity and health of fish under stressful conditions. A 42-day feeding trial evaluated the effects of coriander and basil oils on the growth performance, digestibility and antioxidant activities of Nile tilapia (*Oreochromis niloticus*) fingerlings. Six experimental groups were designed as: 1) Control: fish fed a basal diet; 2) 5BO: basal diet with 0.5% basil oil; 3) 5CO: basal diet with 0.5% coriander oil; 4) 5BO5CO: diet with 0.5% basil and 0.5% coriander oils; 5) 10CO: basal diet with 1% coriander oil; 6) 5BO10CO: diet with 0.5% basil and 1% coriander oils. A total of 210 fingerlings with an average initial weight of (3.35±0.26) were divided into 12 cages (80 L) with a density of 15 fish/ cage and fed 5% of their biomass twice daily with a basal diet containing 30% crude protein. Results illustrated, that fish fed dietary 0.5 % of coriander oil was the best in growth and physiological indices. However, growth indicators of fish fed with basil oil alone were the least. Besides, hepatic antioxidants showed that the group of 5BO5CO had the highest total antioxidant capacity with the lowest malonaldehyde. Additionally, significant improvements in intestinal tissues, including enhanced villi structure and absorption capabilities. Above all, dietary coriander oil at the treated doses positively affected the performance and physiological status of fish either blended with basil oil or alone.

Key Words: Basil (*Ocimum basilicum*), Coriander (*Corriandrum sativum*), Essential oils, Growth performance, Nile tilapia (*Oreochromis niloticus*)

1. INTRODUCTION

Intensive farming systems are considered the best way to optimally exploit a unit of area and quantities of available water and the most effective strategy to increase fish production. Fish competition and environmental stress related to this intensification may lower the immune system and encourage opportunistic pathogens, which would reduce the survival rate of aquatic animals (Adineh et al., 2021; Yousefi *et al.*, 2021 and Abdel-Aziz *et al.*, 2021). Additionally, these unfavorable circumstances could result in disease outbreaks and significant mortality rates for cultured species (Bondad-Reantaso *et al.*, 2012).

Correspondence: Ashraf Y. El-Dakar Mail: ayegypt99@gmail.com
Department of Aquaculture and biotechnology, Faculty of Aquaculture and Marine Fisheries, Arish University, Egypt
Received: Jan. 29, 2025 Revised: Feb. 10, 2025 Accepted: Feb. 11, 2025

Furthermore, it is well known that tilapia fish raised at a high stocking rate may show reduced growth, antioxidant activity, feed utilization, immunological responses, welfare, and general health status (Negm *et al.*, 2021, Tammam *et al.*, 2020). Usually used to treat or prevent infectious diseases, antibiotics and chemotherapeutics can easily infect people through the food chain. The use of antibiotics in aquaculture has lately been outlawed in several nations (Marron *et al.*, 2013). Therefore, the use of phytobiotics as accelerators of immunological and physiological responses was the main focus of nutritional strategies. Phytobiotics are highly promising for use in aquaculture systems because they have been shown to have several beneficial biological effects on aquatic species, including appetite stimulation and growth promotion.

Phytobiotics may also be environmentally friendly substitutes for antibiotics or other synthetic chemotherapeutics, enhancing defense systems and disease resistance without negative effects (Hoseinifar *et al.*, 2019; Thabet *et al.*, 2023 and Abdel-Aziz *et al.*, 2023).

Essential oils (EOs) are a natural blend of organic substances with a strong fragrance that are synthesized by aromatic plants during secondary metabolism (Carson and Hammer 2011).

Accordingly, incorporating essential oils into the diet has been regarded as a preventive measure as it raises zootechnical parameters (Chung *et al.*, 2021). Essential oils have the potential to replace antibiotics or growth promoters in animal diets due to their positive effects on digestion, gut microbial community, growth performance, and welfare (Zeng *et al.*, 2022).

The potential use of coriander, or *Corriandrum sativum*, as a natural feed additive in aquaculture has garnered a lot of attention in recent years (Abascal and Yarnell, 2012). Coriander has the ability to improve fish health, growth, and overall well-being due to its abundance of essential nutrients, bioactive compounds, and antioxidant properties (Abdou Said *et al.*, 2021).

Coriander also contains a lot of vitamins, including β-cryptoxanthin, vitamin C, and vitamin A/β-carotene, as well as minerals, like calcium, iron, zinc, magnesium, and potassium. Furthermore, coriander has shown antibacterial, antifungal, antiparasitic, and anthelmintic qualities (Chalechale *et al.*, 2019). Coriander essential oils (CO) are frequently used for its therapeutic properties, including antibacterial, antifungal, antioxidant, anti-inflammatory, and antimicrobial (Bignami *et al.*, 2013).

According to the International Organization of Standards (ISO) standard, essential oils for coriander comprise the following: Geraniol (0.5%-3.0%), linalool (65.0%-78.0%), α-pinene (3.0%-7.0%), camphor (4.0%-6.0%), myrcene (0.5%-1.5%), limonene (2.0%-5.0%), γ-terpinene (2.0%-7.0%), and geranyl acetate (1.0%-3.5%). Linalool is the primary component, accounting for up to 70% of certain essential oil samples (Msaada *et al.*, 2007).

The plant *Ocimum basilicum*, on the other hand, is used as an aromatic spice and a source of essential oil, also it can be used both fresh and dried. Due to their antibacterial and fungistatic qualities, their primary ingredients are also utilized as plant medications (El-Dakar *et al.*, 2008 and Dambolena *et al.*, 2010). Biochemistry analysis of basil oil (BO) showed that the major compounds of basil essential oil were β-linalool (46.67%) and estragole (27.43%) (Roldán *et al.*, 2010).

Also, Ismail (2006) showed that the primary terpenes contained include linalool (44.18%), cineole (13.65%), eugenol (8.59%), caryophyllene (3.10%), methyl cinnamate (4.26%), and acubebene (4.97%). Subsequently this study aimed to evaluate interaction between essential oil of Coriander and basil on growth performance, antioxidant activates, and histoligical of liver and intestine of Nile tilapia *Oreochromis niloticus* fingerlings.

2. MATERIALS AND METHODS

2.1. *Concern of Ethical*

Ethical guidelines of animal care were followed, and the experimental procedures was approved by Arish University Committee of Research Ethics (Institutional Review Board, IRB) Egypt.

2.2. *Location of study and experimental protocol*

The study was conducted in Aquaculture Unit in Desert Regions (AUDR), Collage of Aquaculture and Marine Fisheries, Arish University, North Saini, Egypt. This study were performed to include 6 experimental groups:- 1-Control: fish fed a basal diet; 2- 5BO: fish fed the basal diet containing 0.5% basal oil; 3- 5CO: fish fed the basal diet containing 0.5% coriander oil; 4- 5BO5CO: fish fed dietary 0.5% basil oil and 0.5% of coriander oil; 5- 10CO: fish fed the basal diet containing 1% Coriander oil and 6- 5BO10CO: fish fed dietary 0.5% basil oil and 1% of coriander oil.

2.3. *Fish and cultured conditions*

A total stock of 210 fingerlings Nil tilapia were reared at AUDR pond with an average Initial weight of (3.35±0.26g) were randomly selected and divided into 12 Polyethylene cages (80 L) under a greenhouse housed with dimensions of L 100 cm × W 40 cm× H 60 cm at a rate of 15 fish/ cage. Underground water (brackish 5 ppt) was used, and their temperature was kept at range from 25 to 30 ˚C. Air stones were used to regulate cage aeration by 2 HP air blower. A basal diet contained 30% crude protein was used and the tested oils of coriander and basil were added sparely according to the tested doses. Feeding was offered twice daily for six days weekly and water change rate was 20% every two days. Every two weeks, fish were weighted to adjust the feeding rate. Water quality were continually monitored and kept at the optimum limit of dissolved oxygen, mg/L and total ammonia nitrogen, mg/L according to (EPA, 2003). The trial lasted 42 days after start.

2.4. *Biometry of fish*

Total weight gain (TWG, g) = Final body weight (FW)–Initial body weight (IW).

Average daily gain (DG, g) = (Total weight gain (TWG, g)/days.

Survival rate (SR, %) = (Number of fish at the end/Number of fish at the beginning of trial period) × 100.

Feed conversion ratio = Feed intake (g)/fish)/ TWG, (g).

Specific growth rate (SGR, %/day) = (ln FW - ln IW/days) ×100.

2.5. *Sampling collecting*

Immediately after collecting the final biometric data (day 42), samples of three fish from each tank were used for antioxidant analysis and investigating the intestinal histology (n = 12 per treatment). The fish were removed from the tank and then anaesthetized with benzocaine hydrochloride (0.1 g/L). Liver and whole digestive tract samples were aseptically excised from six fish and immediately immersed in liquid nitrogen and stored at - 80°C until analyzing the antioxidant activity and digestive enzymes. Besides, some specimens of intestine samples were fixed in 10% formalin (24 h) and subsequently preserved in 70% alcohol according to standardized necropsy protocol (Meyers, 2009).

2.6. *Hepatic and intestinal analysis*

Glutathione peroxidase (GSH), superoxide dismutase (SOD), malonaldehyde (MDA) and Total antioxidant capacity (TAC), Superoxide dismutase (SOD), Total antioxidant capacity (TAC) were determined spectrophotometrically using Bio-diagnostic reagent kits, Dokki, Giza, Egypt according to (Beutler *et al.*, 1963; Das *et al.*, 2000; Ohkawa *et al.*, 1979 and Koracevic *et al.*, 2001).

Amylase activity was analyzed by the starch-hydrolysis method described by (Bernfeld, 1955). Lipase activity was determined using the method of (Furne *et al.*, 2005).

2.7. Histomorphology of intestine

The samples were dehydrated in an ethanol series, then, they clarified in xylene and embedded in paraffin blocks at 60 ◦C. Subsequently, sections of 5µm thickness were stained with Harris hematoxylin and eosin (H&E) and periodic and reactive Schiff acid then examined under a light microscope to identify any pathological changes (Layton, *et al.*, 2019).

2.8. *Proximate composition of whole body*

A proximate analysis of whole-body fish at the end of the experiment were determined according to methods of (AOAC, 2000).

The moisture was determined by oven drying to constant weight at 105 ◦C for 24 h. The crude protein content of concentrated sulphuric acid-digested ingredients was determined by Kjeldahl analysis (nitrogen×6.25) Crude fat was determined by Soxhlet method using petroleum ether (60–80 ◦C boiling point) for 16/ hours. The ash content of fish samples were determined by igniting a silica crucible in a muffle furnace at 550 ◦C for 4 h.

2.9. *Statistical procedures*

Data were statistically analyzed by using a one-way analysis of variance (ANOVA test) using SPSS Statistical Package Program (SPSS) version 23. Mean of treatments were compared by Duncan multiple range test when the differences were significant. Level of significance in all tests was $P \le 0.05$.

3.RESULTS

3.1. *Growth, feeding utilization, and survival rate*

Results in table 1 showed significant difference ($P \le 0.05$) among the treatments in final weight, weight gain and average daily gain but specific growth rate, FCR and survival rate don't significantly change. However, fish fed 5BO5CO and 5CO had the highest performance and best FCR compared to the other treatments.

Table (1) Body biometric indices of Nile tilapia fed Supplementary diet of basil and coriander oils for 42 days.

Items	Groups						*Sig.*	*PSE**
	Control	5 BO	5CO	5BO5CO	10CO	5BO10CO		
IW, g	3.350	3.350	3.400	3.320	3.325	3.310	0.770	0.015
FW, g	13.05^{b}	12.315^{c}	13.315^{ab}	13.520^{a}	13.00^{b}	12.585^{b}	0.040	0.160
TWG, g	9.70	8.965^{b}	9.915^{ab}	10.200^{a}	9.675^{b}	9.275^{b}	0.046	0.140
ADG, g	0.231^{ab}	0.2135^{b}	0.2361^{ab}	0.2427^{a}	0.2304^{ab}	0.221^{b}	0.050	0.003
SGR, %/days	3.235	3.095	3.245	3.345	3.240	3.175	0.450	0.299
FCR	1.469	1.313	1.334	1.304	1.467	1.377	0.440	0.300
Survival rate%	90.00	100.00	96.00	95.00	90.00	95.00	0.800	1.870

Means with different superscripts letters (a, b, and c,) significantly differ at $P \le 0.05$.

3.2. Antioxidant activities and digestive enzymes

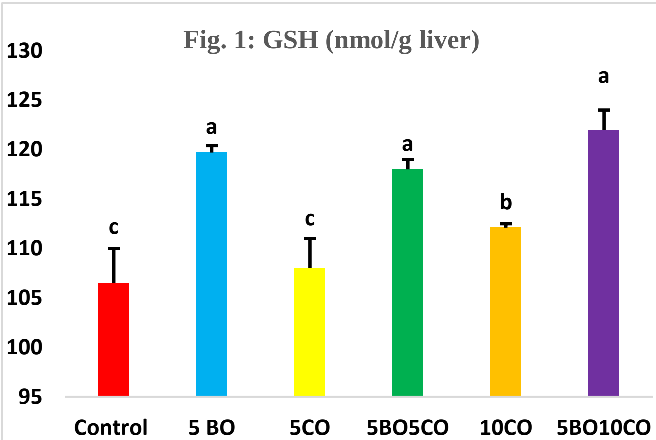
Figures of (1, 2) illustrated significant variations in liver antioxidant activities among the treatments fish of 5BO5CO, 5BO10CO and 5BO had the highest levels of GSH and SOD compared with the other treatments especially control group which was the lowest. The levels of TAC were significantly higher in 5BO5CO and 5CO followed by control in comparison with the other groups (Fig. 3). On the other hand, 5BO5CO had the lowest MDA (Fig. 4). Figures 5 and 6 showed significant differences in concentrations of intestinal amylase and lipase among the groups. Fish fed dietary 5BO5CO or 5CO had the highest levels of these enzymes.

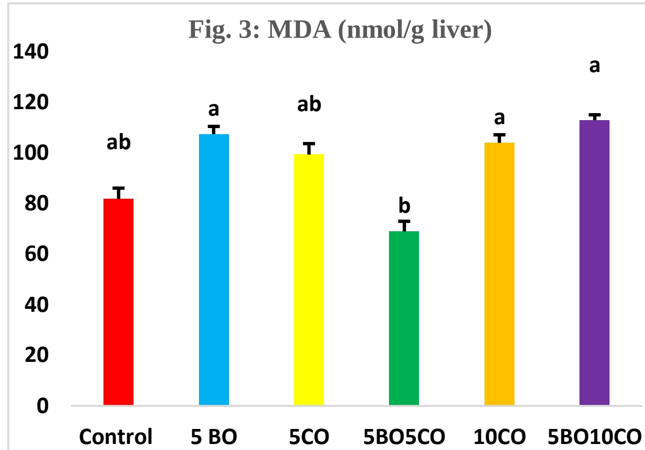
3.3. Intestinal histomorphology

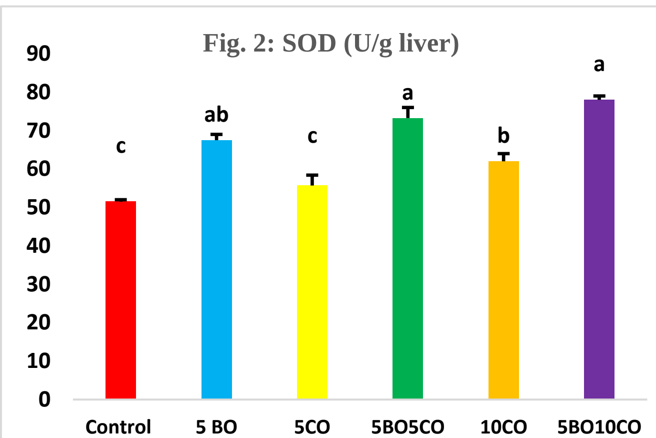
The histological analysis revealed distinct effects of dietary supplements on intestinal structure between the six groups. The control group (C) displayed normal mucosal organization with goblet cells and immune cells in the lamina propria (Figure 7 A & 7A/). Group (5BO), supplemented with basil oil (5 g/kg), exhibited histopathological changes, including villus atrophy and apoptosis in epithelial cells (Figure 7B &7B/). Group (5CO) showed severe intestinal damage, with absent or significantly damaged villi (Figure 7C). In contrast, group (5BO+5CO), supplemented with both basil and coriander oils (5 g/kg each), demonstrated enhanced intestinal structure, elongation of villi, and improved absorption and growth (Figure 7D).

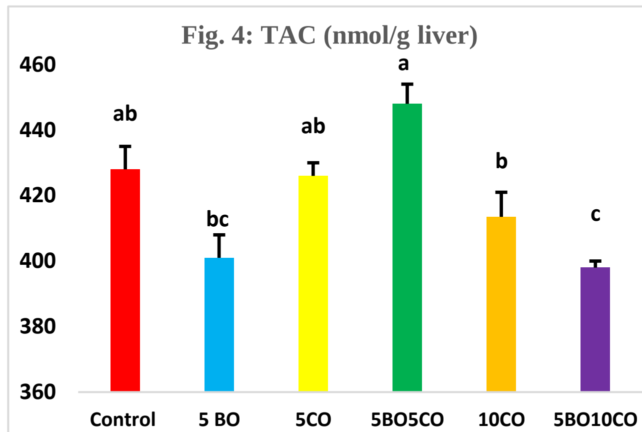
Group (10CO) showed adverse effects, including vacuolized, rounded villi and increased mucosal thickness (Figure 7E).

Finally, group (5BO+10CO) exhibited typical mucosal organization, elongated villi, and improved absorption and growth performance (Figure 7F).

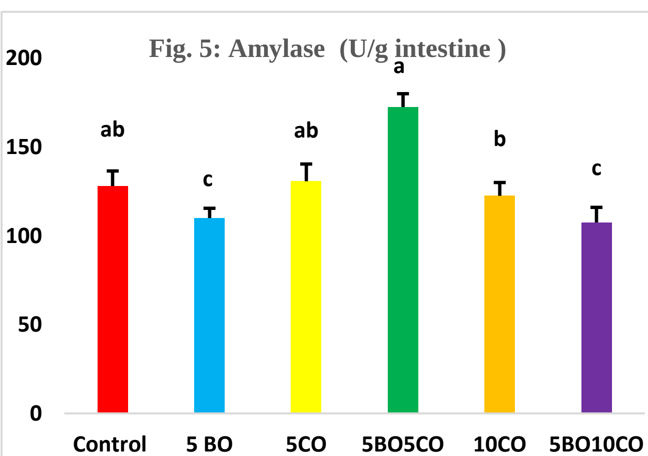


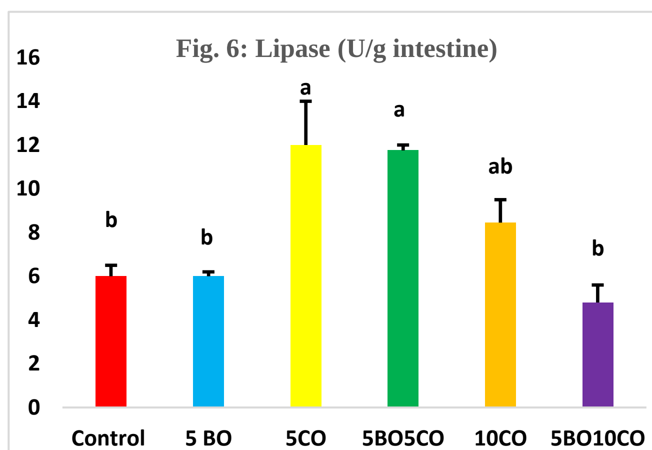






Figures (1, 2, 3 and 4): liver concentration of GSH (*P-value:* 0.009), SOD (*P-value* =0.007), MAD (*P-value*=0.123) and TAC (*P-value*=0.00) in Nile tilapia fed Supplementary diet of basil and coriander oils for 42 days.
Means followed by standard error bars with different superscripts (a, b, and c,) significantly differ at $P \leq 0.05$.





Figures (5 and 6): intestinal concentration of amylase (*P-value:* 0.045), lipase (*P-value* =0.008) in Nile tilapia fed Supplementary diet of basil and coriander oils for 42 days.
Means followed by standard error bars with different superscripts (a, b, and c,) significantly differ at $P \leq 0.05$.

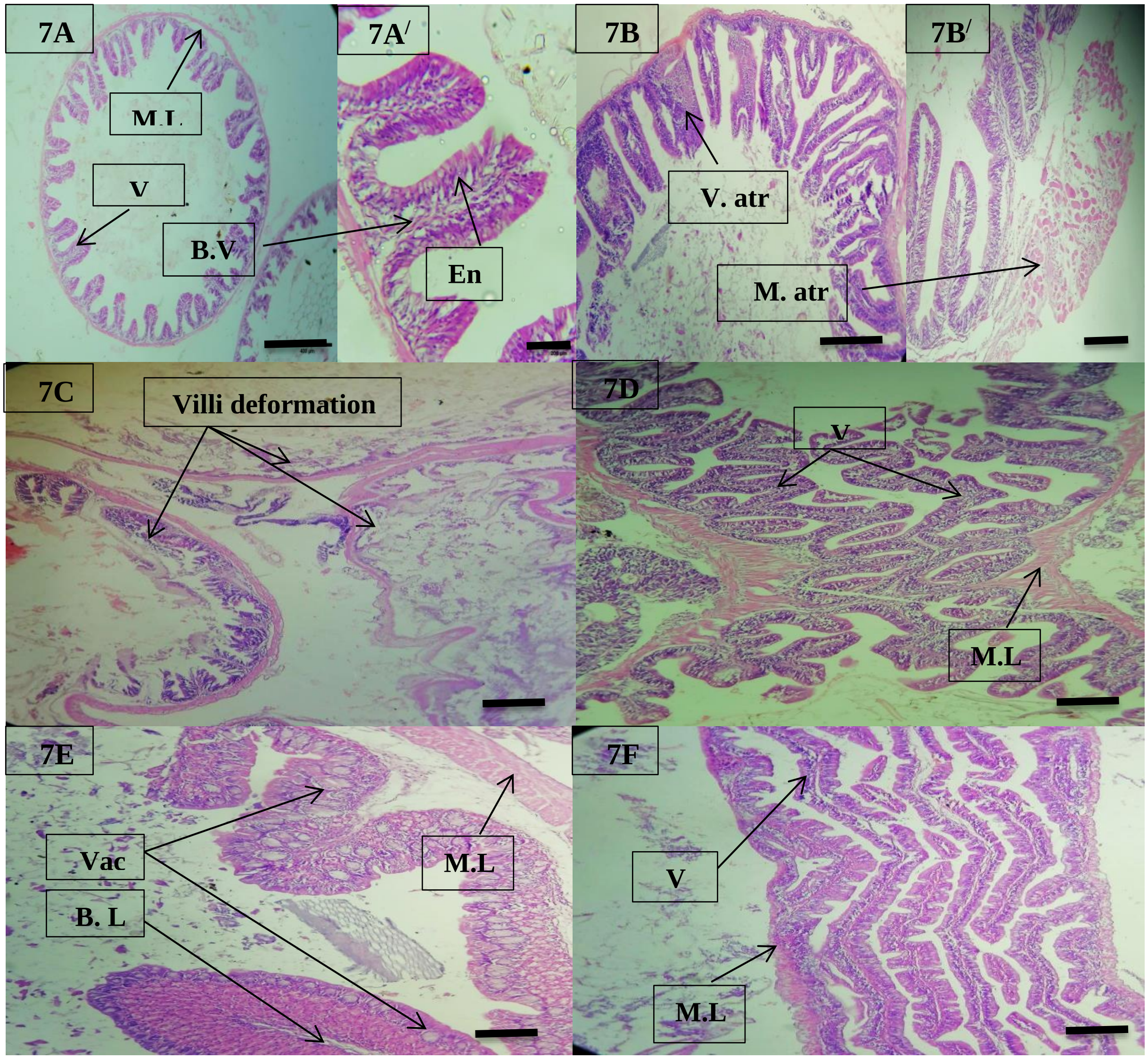


Figure 7: micrograph of histological sections for *Oreochromis niloticus* intestine. (7A &7A/) shows the control group (C) displayed normal mucosal organization with goblet cells and immune cells in the lamina propria. (7B &7B/) shows Group 5BO, exhibited histopathological changes, including villus atrophy and apoptosis in epithelial cells. (7C) shows Group 5CO, severe intestinal damage, with absent or significantly damaged villi. (7D) shows group 5BO+5CO, demonstrated enhanced intestinal structure, elongation of villi, and improved absorption and growth. (7E) shows adverse effects, including vacuolized, rounded villi and increased mucosal thickness in group (10CO). (1F) exhibited typical mucosal organization, elongated villi, and improved absorption and growth performance of group (5BO+10CO).

Abbr: B. V= Blood Vessels, En. C= Entrocytes, M. L= Muscular lamina, M. atr = Muscular atrophy, V= Villi, V. atr = Villi atrophy. Scale bar = (1A/ &1B/ =200 µm) and (1A, 1B, 1C, 1D, 1E & 1F = 400µm).

3.4. *Whole body composition*

Fish body composition at the end of the trial was presented in table 2. Body content from moisture, protein, lipid and ash were significantly differed with the different treatments. Fish fed dietary coriander oil with or without basil oil had the highest content of protein especially 5BO5CO and 10CO which had the lowest lipid content.

Table (2): Body composition of Nile tilapia fed a supplementary diet of basil and coriander oils for 42 days (DM basis).

Items	Groups						*Sig.*	*PSE**
	Control	5 BO	5CO	5BO5CO	10CO	5BO10CO		
Moisture, %	72.120	73.425	71.840	72.220	71.250	71.730	0.106	0.21
Protein, %	69.797^{ab}	68.055^{b}	69.509^{ab}	70.677^{a}	71.434^{a}	68.769^{b}	0.002	0.43
Lipid, %	18.492^{b}	19.744^{a}	19.591^{a}	17.163^{c}	16.970^{c}	19.581^{a}	0.000	0.35
Ash, %	11.710^{b}	12.200^{a}	10.900^{c}	12.160^{a}	11.595^{b}	11.650^{b}	0.003	0.13

Means with different superscripts letters (a, b, and c,) significantly differ at $P \leq 0.05$.

4. DISCUSSION

A number of studies confirmed that phytobiotic and their derivatives are important for aquatic animals as immunostimulatory, growth promoters, and appetite enhancers (Copatti *et al.*, 2022, El-Dakar *et al.*, 2023 and Fadel *et al.*, 2024).

As natural immunostimulants and antioxidants, essential oils (EOs) have gained specific interest. Moreover, volatile oils enhance palatability regulate appetite and increase reproduction of fish (de Oliveira *et al.*, 2020). In addition to promoting the beneficial bacteria that are important in food digestion mediated by the secretion of digestive enzymes, EOs have a strong antibacterial effect on pathogenic bacteria by reducing their activity and destroying their cell walls (Abdelkhalek *et al.*, 2020). They also improve local intestinal immunity (Alagawany *et al.*, 2021).

Interestingly, EOs enhance the permeability of intestinal barriers and increase intestinal nutrient absorption. Also, the gut secretions stimulating effect of EOs allows the microbiota to modulate and improve digestion and absorption of nutrients. This stimulation may provide a greater array of amino acids for protein synthesis and thus increase body protein content (Freccia *et al.* 2014). Therefore, the effects of EOs on the gut bacterial population also may be indirect, in contrast to the effects observed when using conventional antibiotics as growth promoters, where the mechanisms are mainly related to the activity directly on the bacteria (Yang *et al.*,2015). However, the type of herb and its active ingredient content, as well as the component of the plant used (leaves, stems, or seeds), all affect how EOs acting, the dosage as well as the form (oils, powder, and extract). Additionally, a variety of factors, including species, raising settings, nutrition requirement, and feed ingredients in their basal diets, influence how the animals react to using the dietary photobiotic.

Our study showed that dietary basil oil at 5 g/kg did not give positive effects on fish performance on the contrast, several studies confirmed that basil in other forms (extract or powder) had a positive effect on fish performance (El-Dakar *et al.*, 2008; Noorbakhsh *et al.*, 2024).

Also, this study showed that increasing dietary coriander oil intake from 0.5-1% led to decreased fish growth regardless of adding basil oil. This may be due to the use of EOs or interactions of EOs in the animal intestine tract. Also, some bioactive compounds in oils are usually sensitive to acidity and digestive enzymes during passage through the gastric tract (Zhang *et al.*, 2017) depending on the EO compound and its dose, the degradation and absorption may occur in different sites of the digestive tract, suggesting that each molecule may have a specific place to act. Furthermore, The EO compounds could be absorbed in the upper digestive tract and metabolized before reaching their optimum site of action. Thus, they would be ineffective and may be necessary to protect the EOs from gastric absorption (Thapa *et al.* 2015 and Zhang *et al.*, 2017). As with rainbow trout (*Oncorhynchus mykiss*), Navarrete *et al.* (2010) assessed the impact of dietary *Thymus vulgaris* EO on the bacterial makeup of the fish and found that it doesn't affect the microbiota of the gastrointestinal tract.

According to their findings, the amount of *T. vulgaris* oils needed to inhibit the bacterial pathogen was greater than that used in the *in vivo* study, which could account for the host's insufficient benefit. Furthermore, those authors proposed that encapsulating the Eos might be a viable substitute for reaching the fish's intestinal with active EOs. The concentrations of Eos used (lower than the concentrations needed to inhibit bacterial populations) may be partially responsible for the potential lack of *in vivo* effects on the gut bacterial composition of fish; however, this could also be related to the instability of the EOs and their interactions with the host, food ingredients, and environmental factors (Helmy *et al.*, 2023).

On the other side, our results don't agree with (Abdel-Tawwab *et al.,* 2021) they reported that Indian shrimp fed on diets supplemented with BO performed better in terms of growth and feed utilization than the control group, and the optimum growth was observed at levels of 2.5–5.0 g BO/kg diet. The dietary addition of *O. basilicum* essential oil for 45 days improved growth performance and increased hematological variables and intestinal enzyme activity in Nile tilapia (de Freitas Souza *et al.,* 2019). In this study, dietary blend oils of coriander and basil at doses of 5 g/kg of each or dietary coriander oil at 5g/kg alone had the best effect on growth indices.

Coriander supplementation at this dose may improve digestive enzyme activity in fish, leading to better nutrient utilization and absorption. Also, coriander oil had more the availability of their bioactive compounds, such as phenols and flavonoids in coriander, may contribute to improve the feeding utilization in fish. Where, bioactive compounds of essential oils can promote the greater secretion of proteolytic digestive enzymes, causing better use of nutrients and a growth-promoting effect (Morante *et al.*, 2021).

Therefore, in our study, it is possible to correlate the results of weight gain with intestinal amylase and lipase. From an integrative view, the greatest advantage in terms of gut absorption and growth promotion resulted in the fish fed 5BO5CO and 5CO. Increased intestinal lipase activity improves lipid digestibility (de Freitas Souza *et al.*, 2019). Moreover, the most efficient of carbohydrate digestion in fish as a result of increases intestinal amylase levels (do Carmo Gominho-Rosa *et al.*, 2015). Additionally, coriander oil may contribute to reducing the impact of anti-nutritional factors in fish feed, such as phytates and tannins, which can interfere with nutrient absorption as reported by (Gherescu and Grozea, 2023).

Also, Ashry *et al.* (2024) showed coriander is a rich source of essential nutrients, including vitamins (A, C, and K), minerals (calcium, potassium, and magnesium), and dietary fiber.

In the same manner, Das *et al.,* (2023) concluded that, coriander essential oil can be used for better growth performance, intestinal nutrient absorption and antioxidant activity. The antioxidant activity is mediated by the reductive structure of the compound, which contains aromatic rings, phenolic compounds, and a high concentration of hydroxyl groups (Dawood *et al.*, 2022).

SOD and GSH are important enzymes involved in enzymatic mechanisms to alleviate oxidative stress in fish (Hoseini *et al.*, 2021). These enzymes could act to maintain normal redox homeostasis and improve the reactive oxygen species (ROS) imbalance in biological systems (Abdel-Daim *et al.*, 2019). SOD and GSH activities in the present study were highly elevated in groups of 5BO5CO, 5BO, and 5CO. This result was in agreement with (El-Ashram et al., 2017), they are suggesting that BO has an antioxidant activity due to its high content of phenolic compounds, which are probably responsible for the powerful antioxidant activity observed. In this regard, Mohamed *et al.* (2021) found that *O. basilicum* oil was predominantly composed of methyl chavicol (51.9%) followed by linalool (20.0%), which showed higher total antioxidant activity.

In the same trend, this result was in agreement with studies have found that coriander supplementation can increase the activity of SOD and decrease MDA in fish fed 5BO5CO, leading to a more robust immune response against pathogens (Das *et al.*, 2023).

In the present study, the increase of CP with decreasing fat content in the bodies of fish fed with 10CO followed by 5BO5CO is in harmony with the positive effects of this level on the growth. These positive effects may be reflected in the important role of the caraway essential oil or its bioactive compounds in the synthesis of protein in the body of fish by improving the metabolic of fat and energy production.

In this context, Lin *et al.* (2006) discovered that for white shrimp, *Litopenaeus vannamei*, the apparent digestibility coefficients of lipids rose in tandem with the amounts of dietary traditional Chinese medicines.

On the other hand, there were no appreciable changes in the amounts of ash, moisture, crude protein, or total lipids. Similar to the findings of Abdel-Latif *et al.* (2020), they observed no notable changes in the whole-body protein, lipid, and ash contents of common carp fed diets supplemented with essential oil of oregano (*Origanum vulgare* L.). High concentrations of bioactive substances in essential oils can generally result in certain distributions in the body's metabolism process that have a negative impact on the treated fish's muscle composition (Mehrim *et al.*, 2024).

Besides, increases in intestinal villi length improve the digestive tract's absorptive surface area and plays a critical role in nutritional digestion and absorption (Munglue *et al.*, 2019). Our results showed that fish-fed blend oils of coriander and basil had the best histomorphology in the intestine especially the group of 5BO+5CO.

Several studies affirmed the positive effects of dietary essential oil as Özel et al. (2022) showed that different doses (50, 100, 200, and 400 mg kg^{-1}) of oregano EO had a positiveeffects or no effect on the intestinal histomorphology of Black Sea trout.

Also, Abd El-Naby *et al.* (2019) offering dietary thymol to fingerling Nile tilapia, which revaled a considerable increase in the length of the intestinal villi fish's. The intestinal morphology of young yellowtail tetras (*Astyanax altiparanae*) improved linearly when fed diet containing oregano oil for 90 days, according to (Ferreira *et al.*, 2016).

On the contrary, Carneiro *et al.* (2021) found that intestinal histomorphometry was not affected by oregano oil. Moreover, Valladão *et al.* (2019) who found that feeding dietary thyme (*Thymus vulgaris*) essential oil not significantly effect on the intestinal villi length of Nile tilapia. Generally, the positive effect of dietary Eos on physiological characteristics may differently according different factors such as fish species, type of essential oils, composition levels, and trial durations as reported by (Özel *et al.*, 2022).

5. CONCLUSION

According to the study's findings, adding a blend of coriander and basil essential oils to tilapia diets as 5 g of each/ kg diet improved all biological and physiological indices compared to the control group or using coriander oil or basil oil alone.

The combination of basil and coriander oils demonstrated a synergistic effect, mitigating the adverse impacts observed with basil oil alone, such as villus atrophy and epithelial cell apoptosis, while promoting enhanced intestinal structure, villus elongation, and improved nutrient absorption and growth. This suggests that coriander oil may counteract the negative effects of high-dose basil oil, potentially through complementary antioxidant, anti-inflammatory, and protective mechanisms.

ACKNOWLEDMENT

Authors would like to thank all staff members of Aquaculture Department, Faculty of Aquaculture and Marine fisheries, Arish University, Egypt for supporting this work.

Authorship contribution statement

Y. talaat; Shymaa M. Shalaby; A.Y. El-Dakar; M.M. Rashad, M.F. Abdel-Aziz: conceptualization, data curation, formal analysis, investigation, methodology, resources, validation, visualization. M.F. Abdel-Aziz: Writing – original draft, Writing – review & editing.

Funding: No funding

Conflict of interest
The authors declare no conflict of interest.

Data availability statement
Data will be available upon request from authors

REFERENCES

Abascal, K., & Yarnell, E. 2012. Cilantro—Culinary Herb or Miracle Medicinal Plant? *Alternative and Complementary Therapies*, 18(5), 259-264.

Abd El-Naby, A. S., Al-Sagheer, A. A., Negm, S. S. &Naiel, M. A. 2020. Dietary combination of chitosan nanoparticle and thymol affects feed utilization, digestive enzymes, antioxidant status, and intestinal morphology of *Oreochromis niloticus*. *Aquaculture*, 515, 734577.

Abdel-Aziz, M. F. A., Hassan, H. U., Yones, A. M., Abdel-Tawwab, Y. A. & Metwalli, A. A. A. T. 2021. Assessing the effect of different feeding frequencies combined with stocking density, initial weight, and dietary protein ratio on the growth performance of tilapia, catfish and carp. *Scientific African*, 12, e00806.

Abdel-Aziz, M. F., El Basuini, M. F., Teiba, I. I., & Metwally, M. M. 2023. Growth Performance, Feed Utilization, Hematological Parameters, and Histological Features of Nile Tilapia (*Oreochromis niloticus*) Fed Diets with Supplementary Herbal Extracts Under Prolonged Water Exchange. *Annals of Animal Science*, 23, 1147.

Abdel-Daim, M., Eissa, I. A., Abdeen, A., Abdel-Latif, H., Ismail, M., Dawood, M., & Hassan, A.2019. Lycopene and resveratrol ameliorate zinc oxide nanoparticles-induced oxidative stress in Nile tilapia, *O. niloticus*. *Environmental Toxicology and Pharmacology*, 69, 44-50.

Abdelkhalek, N. K., Risha, E., Mohamed, A., Salama, M. & Dawood, M. A. 2020. Antibacterial and antioxidant activity of clove oil against Streptococcus iniae infection in Nile tilapia (*Oreochromis niloticus*) and its effect on hepatic hepcidin expression. *Fish & shellfish immunology*, 104, 478-488.

Abdel-Latif, H., Abdel-Tawwab, M., Khafaga, A. F., & Dawood, M. A. 2020. Dietary origanum essential oil improved antioxidative status, immune-related genes, and resistance of common carp *Cyprinus carpio* to Aeromonas hydrophila infection. *Fish & shellfish immunology*, *104*, 1-7.

Abdel-Tawwab, M., El-Ashram, A. M., Tahoun, A. A., Abdel-Razek, N. & Awad, S. M. 2021. Effects of dietary sweet basil (*Ocimum basilicum*) oil on the performance, antioxidants and immunity welfare, and resistance of Indian shrimp (*Penaeus indicus*) against *Vibrio parahaemolyticus* infection. *Aquaculture nutrition*, 27: 1244-1254.

Abdou Said, A., M Reda, R. &M Abd El-Hady, H. 2021. Overview of herbal biomedicines with special reference to coriander (*Coriandrum sativum*) as new alternative trend for the development of aquaculture. *Egyptian Journal of Aquatic Biology and Fisheries*, 25(2), 539-550.

Adineh, H., Naderi, M., Nazer, A., Yousefi, M., & Ahmadifar, E. 2021. Interactive effects of stocking density and dietary supplementation with Nano selenium and garlic extract on growth, feed utilization, digestive enzymes, stress responses, and antioxidant capacity of grass carp, *C. idella*. *Journal of the World Aquaculture Society*, 52(4), 789-804.

Alagawany, M., Farag, M. R., Abdelnour, S. A., & Elnesr, S. S. 2021. A review on the beneficial effect of thymol on health and production of fish. *Reviews in Aquaculture*, 13(1), 632-641.

AOAC. 2000. International Official methods of analysis of AOAC International. Vol. 17. No. 1-2. *AOAC international*

Ashry, A. M., Habiba, M. M., Abdel-wahab, A., Younis, E. M., Davies, S. J., Elnakeeb, M. A. & El-Sebaey, A. M. 2024. Dietary effect of powdered herbal seeds on zootechnical performance, hemato-biochemical indices, immunological status, and intestinal microbiota of European sea bass (*D. labrax*). *Aquaculture Reports*, 36, 102074.

Bernfeld, Peter. 1955. "[17] Amylases, α and β." : 149-158.

Beutler, E. & Mary, K. Y. 1963. Erythrocyte glutathione reductase. Blood, 21(5), 573-585.

Bignami, S., Sponaugle, S., and Cowen, R. K. 2013. Response to ocean acidification in larvae of a large tropical marine fish, R achycentron canadum. *Global change biology*, 19(4), 996-1006.

Bondad-Reantaso, M. G., Subasinghe, R. P., Josupeit, H., Cai, J.& Zhou, X. 2012. The role of crustacean fisheries and aquaculture in global food security: past, present and future. *Journal of invertebrate pathology*, 110(2), 158-165.

Carneiro, C. L. D. S., de Assis, C. E., Modesto, A. L. S., Maciel, J. F. R., Campelo, D. A. V., Luz, R. K. & Salaro, A. L. 2021. Oregano essential oil (*Origanum vulgare*) dietary supplementation improved growth performance, body protein retention and muscle hyperplasia of the Neotropical catfish *Lophiosilurus alexandri*. *Aquaculture Nutrition*, 27(4), 1221-1231.

Carson, C. F., & Hammer, K. A. 2011. Chemistry and bioactivity of essential oils. *Lipids and essential oils as antimicrobial agents*, 203-238.

Chalechale, A., Zangeneh, M. M., Zangeneh, A., Hamzavi, Y. & Valadkhani, Z. 2019. Chemical characterization and anti-parasitic property of essential oil of *Coriandrum sativum* leaf against *Trichomonas vaginalis*. Iranian *Journal of Pharmacology & Therapeutics*, 17(1).

Chung, S., Ribeiro, K., Melo, J. F. B., Teixeira, D. V., Vidal, L. V. O. & Copatti, C. E. 2021. Essential oil from ginger influences the growth, haematological and biochemical variables and histomorphometry of intestine and liver of Nile tilapia juveniles. *Aquaculture*, 534, 736325.

Copatti, C. E., Felix e Silva, A., Lorenzo, V. P., da **Costa, M. M. & Melo, J. F. 2022.** Addition of essential oil from lemongrass to the tambaqui (*Colossoma macropomum*) diet: Effects on growth, intestinal enzymes, haematological and metabolic variables, and antimicrobial challenge. *Aquaculture Research*, 53(16), 5656-5666.

Dambolena, J. S., Zunino, M. P., López, A. G., Rubinstein, H. R., Zygadlo, J. A., Mwangi, J. W. & Kariuki, S. T. 2010. Essential oils composition of *Ocimum basilicum* L. and *Ocimum gratissimum* L. from Kenya and their inhibitory effects on growth and fumonisin production by Fusarium verticillioides. *Innovative Food Science & Emerging Technologies*, 11(2), 410-414.

Das, K., Samanta, L. & Chainy, G. B. N. 2000. A modified spectrophotometric assay of superoxide dismutase using nitrite formation by superoxide radicals.

Das, S., Pradhan, C., Singh, A. K., Vineetha, V. P. &Pillai, D. 2023. Dietary coriander (*Coriandrum sativum* L) oil improves growth, nutrient utilization, antioxidant status, tissue histomorphology and reduces omega-3 fatty acid production in Nile tilapia (*O. niloticus*). *Animal Feed Science and Technology*, 305, 115774.

Dawood, M. A., El Basuini, M. F., Yilmaz, S., Abdel-Latif, H. M., Alagawany, M., Kari, Z. A., &Van Doan, H. 2022. Exploring the roles of dietary herbal essential oils in aquaculture: A review. *Animals*, 12(7), 823.

de Freitas Souza, C., Descovi, S., Baldissera, M. D., Bertolin, K., Bianchini, A. E., Mourão, R. H. V. & Martinez-Rodríguez, G. 2019. Involvement of HPI-axis in anesthesia with *Lippia alba* essential oil citral and linalool chemotypes: gene expression in the secondary responses in silver catfish. *Fish physiology and biochemistry*, 45, 155-166.

de Oliveira, D. M., Forde, B. M., Kidd, T. J., Harris, P. N., Schembri, M. A., Beatson, S. A., ..& Walker, M. J. 2020. Antimicrobial resistance in ESKAPE pathogens. *Clinical microbiology reviews*, *33*: 10-1128.

do Carmo Gominho-Rosa, M., Rodrigues, A. P. O., Mattioni, B., de Francisco, A., Moraes, G. & Fracalossi, D. M. 2015. Comparison between the omnivorous jundiá catfish (*Rhamdia quelen*) and Nile tilapia (*Oreochromis niloticus*) on the utilization of dietary starch sources: Digestibility, enzyme activity and starch microstructure. *Aquaculture*, 435, 92-99.

El-Ashram, A., Afifi, A. & Sakr, S. F. 2017. Effect of basil oil (*Ocimum basilicum*) on nonspecific immune response of Nile-tilapia (*Oreochromis niloticus*). Egyptian Journal for *Aquaculture*, 7(2), 15-31.

El-Dakar, A., Hassanien, G., Gad, S. & Sakr, S. 2008. Use of dried basil leaves as a feeding attractant for hybrid tilapia, *Oreochromis niloticus* ×*Oreochromis aureus*, fingerlings. *Mediterranean Aquaculture Journal*, *1*(1), 35-44.

El-Dakar a. Y., Shalaby, S. M., Elsheikh, E. A., El-Desoki, A. A., El Basuini, M. F., Ahmed-Farid, O. A. H.& Abdel-Aziz, M. F. 2023.

Assessing chamomile and marjoram meals as feed additives on growth indices and haematological parameters of Nile tilapia (*Oreochromis niloticus*) reared under biofloc system. *Scientific African*, 21, e01755.

EPA.2003. The Environment Protection (Water Quality) Policyían overview , both the overview and a copy of the Water Quality Policy with an accompanying explanatory report are available on the EPA web site-www.epa.sa.gov.au/pub.html-or call (08) 8204 2004.

Fadel, A., Metwally, M. M., Hassan, H. U., Abdelmageed, A. A., Arai, T., Ahmed, M. Z. & Abdel-Aziz, M. F. 2024. Growth, immunomodulatory, histopathological, and antibacterial effects of phytobiotic-incorporated diets on *Oreochromis niloticus* in unchanged water. *Frontiers in Marine Science*, 11, 1473053.

Ferreira, P. M., Caldas, D. W., Salaro, A. L., Sartori, S. S., Oliveira, J. M., Cardoso, A. J. & Zuanon, J. A. 2016. Intestinal and liver morphometry of the Yellow Tail Tetra (*Astyanax altiparanae*) fed with oregano oil. *Anais da Academia Brasileira de Ciências*, 88, 911-922.

Freccia, A., Sousa, S. M. D. N., Meurer, F., Butzge, A. J., Mewes, J. K. & Bombardelli, R. A. 2014. Essential oils in the initial phase of broodstock diets of Nile tilapia. *Revista Brasileira de Zootecnia*, 43, 1-7.

Furne, M., Hidalgo, M. C., Lopez, A., Garcia-Gallego, M., Morales, A. E., Domezain, A. & Sanz, A. 2005. Digestive enzyme activities in Adriatic sturgeon *Acipenser naccarii* and rainbow trout *Oncorhynchus mykiss*. *A comparative study. Aquaculture*, 250 (1-2), 391-398.

Gherescu, P. & Grozea, A. 2023. Effect of Dietary Coriander (*Coriandrum sativum*) on Fish-Review. Scientific Papers *Animal Science and Biotechnologies*, 56(1), 119-119.

Helmy, Y. A., Taha-Abdelaziz, K., Hawwas, H. A. E. H., Ghosh, S., AlKafaas, S. S., Moawad, M. M. &Mawad, A. M. 2023. Antimicrobial resistance and recent alternatives to antibiotics for the control of bacterial pathogens with an emphasis on foodborne pathogens. *Antibiotics*, 12(2), 274.

Hoseini, S. M., Hoseinifar, S. H. &Van Doan, H. 2021. Growth performance and hematological and antioxidant characteristics of rainbow trout, *Oncorhynchus mykiss*, fed diets supplemented with Roselle, *Hibiscus sabdariffa*. Aquaculture, 530, 735827.

Hoseinifar, S. H., Sohrabi, A., Paknejad, H., Jafari, V., Paolucci, M. &Van Doan, H. 2019. Enrichment of common carp (*Cyprinus carpio*) fingerlings diet with Psidium guajava: the effects on cutaneous mucosal and serum immune parameters and immune related genes expression. *Fish & shellfish immunology*, 86, 688-694.

Ismail, M. 2006. Central properties and chemical composition of *Ocimum basilicum*. essential oil. *Pharmaceutical biology*, 44(8), 619-626.

Koracevic, D., Koracevic, G., Djordjevic, V., Andrejevic, S. & Cosic, V. 2001. Method for the measurement of antioxidant activity in human fluids. *Journal of clinical pathology*, 54(5), 356-361.

Layton, C., Bancroft, J. D. & Suvarna, S. K. (2019). Fixation of tissues. *Bancroft's theory and practice of histological techniques, 8*.

Lin, H. Z., Li, Z. J., Chen, Y. Q., Zheng, W. H. & Yang, K. 2006. Effect of dietary traditional Chinese medicines on apparent digestibility coefficients of nutrients for white shrimp *Litopenaeus vannamei*, Boone. *Aquaculture*, 253(1-4), 495-501.

Marron, S. E., Tomas-Aragones, L.,and Boira, S. (2013). Anxiety, depression, quality of life and patient satisfaction in acne patients treated with oral isotretinoin. Acta dermato-venereologica, 93(6), 701-706.

Mehrim A. Abdelhamied, A. & Mekhemr, I. 2024. Impact of Caraway Essential Oil on Growth, Feed Utilization, and Flesh Quality of the Nile Tilapia, *Oreochromis niloticus*. *Egyptian Journal of Aquatic Biology and Fisheries*, 28(1), 1489-1508.

Meyers, T. R. (Ed.). 2009. Fish pathology section laboratory manual. Alaska Department of Fish and Game, Division of Commercial Fisheries. *Juneau Alaska, 99811-5526.*

Mohamed, R. A., Yousef, Y. M., El-Tras, W. F., & Khalafallaa, M. M. 2021. Dietary essential oil extract from sweet orange (*Citrus sinensis*) and bitter lemon (*Citrus limon*) peels improved Nile tilapia performance and health status. Aquaculture Research, 52(4), 1463-1479.

Morante, V. P., Copatti, C. E., Souza, A. L., da Costa, M. M., Braga, L. T., Souza, A. M. & Melo, J. F. 2021. Assessment the crude grape extract as feed additive for *Colossoma macropomum* an omnivorous fish. *Aquaculture*, 544, 737068.

Msaada, K., Hosni, K., Taarit M.B., Chahed, T., Kchouk, M.E. & Marzouk, B. 2007. Changes on essential oil composition of coriander (*Coriandrum sativum* L.) fruits during three stages of maturity. *Food Chem*.
https://doi.org/10.1016/j.foodchem.2006.06.046

Munglue, P., Rattana, K., Sangchanjiradet, S., Jankam, A. & Dasri, K. 2019. Growth performance and intestinal morphology of hybrid catfish (*Clarias macrocephalus*× *Clarias gariepinus*) fed diet supplemented with rice paddy herb (*Limnophila aromatica*) extract. Asia-Pacific *Journal of Science and Technology*, 24(2), 1-12.

Navarrete, P., Toledo, I., Mardones, P., Opazo, R., Espejo, R. & Romero, J. 2010. Effect of Thymus vulgaris essential oil on intestinal bacterial microbiota of rainbow trout, *Oncorhynchus mykiss* (Walbaum) and bacterial isolates. *Aquaculture Research*, 41(10), e667-e678.

Negm, S. S., Ismael, N. E., Ahmed, A. I., Asely, A. M. E. & Naiel, M. A. 2021. The efficiency of dietary *Sargassum aquifolium* on the performance, innate immune responses, antioxidant activity, and intestinal microbiota of Nile Tilapia (*Oreochromis niloticus*) raised at high stocking density. *Journal of Applied Phycology*, 33, 4067-4082.

Noorbakhsh, M.F, Ghaemi, M., Gholamhosseini, A. & Heidari, A. 2024. Effects of Dietary Supplement of Basil Extract on Biochemical and Immunological Parameters and Growth Performance in *Oncorhynchus mykiss*. *Aquaculture Nutrition*, (1), 5388049.

Ohkawa, H., Ohishi, N., andYagi, K. (1979). Assay for lipid peroxides in animal tissues by thiobarbituric acid reaction. *Analytical biochemistry*, 95(2), 351-358.

Özel, O. T., Çakmak, E., Gürkan, S. E., Coskun, İ. & Türe, M. 2022. Evaluation of oregano essential oil supplementation on growth performance, digestive enzymes, intestinal histomorphology and gut microbiota of Black Sea salmon. *Annals of Animal Science*, 22(2), 763-772.

Roldán, L. P., Díaz, G. J. & Duringer, J. M. 2010. Composition and antibacterial activity of essential oils obtained from plants of the Lamiaceae family against pathogenic and beneficial bacteria. *Revista Colombiana de Ciencias Pecuarias*, 23(4), 451-461.

Tammam, M. S., Wassef, E. A., Toutou, M. M. & El-Sayed, A. F. M. 2020. Combined effects of surface area of periphyton substrates and stocking density on growth performance, health status, and immune response of Nile tilapia (*Oreochromis niloticus*) produced in cages. *Journal of Applied Phycology*, 32, 3419-3428.

Thabet, R. Y., El-Dakar, A. Y., Elshorbagy, A., Rabea Mohamed, H. & Abdel-Aziz, M. F. A. 2023. Assessment of lavender (*Lavandula angustifolia*) essential oil as a natural anesthetic and sodium bicarbonate as a sedative on physiological and histopathological status of *Tilapia zilli* during the transport practices. *Mediterranean Aquaculture Journal*, 10(2), 1-13.

Thapa, D., Louis, P., Losa, R., Zweifel, B. &Wallace, R. J. 2015. Essential oils have different effects on human pathogenic and commensal bacteria in mixed faecal fermentations compared with pure cultures. *Microbiology*, 161(2), 441-449.

Valladão, G. R., Gallani, U., Kotzent, S., Assane, I. M. & Pilarski, F. 2019. Effects of dietary thyme essential oil on hemato-immunological indices, intestinal morphology, and microbiota of Nile tilapia. *Aquaculture international*, 27, 399-411.

Yang, F., Hu, S., Lu, Y., Yang, H., Zhao, Y. & Li, L. 2015. Effects of coatings of polyethyleneimine and thyme essential oil combined with chitosan on sliced fresh C hanna argus during refrigerated storage. *Journal of Food Process Engineering*, 38: 225-233.

Yousefi, M., Ghafarifarsani, H., Hoseinifar, S. H., Rashidian, G., and Van Doan, H. 2021. Effects of dietary marjoram, *Origanum majorana* extract on growth performance, hematological, antioxidant, humoral and mucosal immune responses, and resistance of common carp, *Cyprinus carpio* against Aeromonas hydrophila.
Fish & Shellfish Immunology, 108, 127-133.

Zeng, X., Dong, H., Wu, J., Wang, W., Duan, Y., Chen, J. & Zhang, J. 2022. Essential oil of *Magnolia denudata* is an effective anesthetic for spotted seabass (*Lateolabrax maculatus*): a test of its effect on blood biochemistry, physiology, and gill morphology.*Fish Physiology and Biochemistry*, 48: 1349-1363.

Zhang, Y., Li, D., Lv, J., Li, Q., Kong, C. & Luo, Y. 2017. Effect of cinnamon essential oil on bacterial diversity and shelf-life in vacuum-packaged common carp (*Cyprinus carpio*) during refrigerated storage. *International Journal of Food Microbiology*, 249, 1-8.