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Potential benefits of Aloe vera derivative in aquaculture

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الفوائد المحتملة لمشتقات الصبار *(Aloe vera)*في تربية الأحياء المائية

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Abstract
There is a growing body of research on the use of medicinal plants as substitute chemicals, particularly to boost aquaculture systems' sustainability. Similar to this, (*Aloe vera*) biological qualities—such as being anti-inflammatory, immune-stimulating, antioxidant, and hepatoprotective—have drawn a lot of attention lately to its potential in fish farming. The present status of research on the application of *A vera* products in aquaculture was assessed in this study. Research revealed that the *A Vera* products improved general health, enhanced stress tolerance, and markedly increased fish Appetite. This study emphasizes the potential advantages of aloe vera in fish farming; it concentrates on the plant's hepatoprotective, immunosuppressive, antioxidant, and anti-inflammatory qualities.
Keywords: *Aloe vera*, Fish, Growth, Immune Response, Oxidative Status.

الملخص:
هناك مجموعة متزايدة من الأبحاث حول استخدام النباتات الطبية كبديل للمواد الكيميائية، وخاصة لتعزيز استدامة أنظمة تربية الأحياء المائية. وعلى غرار ذلك، فإن الخصائص البيولوجية للصبار (*Aloe vera*) - مثل كونه مضادًا للالتهابات، ومحفزًا للمناعة، ومضادًا للأكسدة، وواقيًا للكبد - قد لفتت الكثير من الاهتمام مؤخرًا إلى إمكاناته في تربية الأسماك. تم في هذه الدراسة تقييم الوضع الحالي للبحث العلمي حول تطبيق منتجات (*A vera*) في تربية الأحياء المائية. كشفت الأبحاث أن منتجات *(A vera)* تعمل على تحسين الصحة العامة، وتعزيز تحمل الإجهاد، وزيادة شهية الأسماك بشكل ملحوظ. تؤكد هذه الدراسة على المزايا المحتملة للصبار في تربية الأسماك؛ كما إنه يركز على خصائص النبات الوقائية للكبد والمثبطة للمناعة ومضادات الأكسدة والمضادة للالتهابات.

الكلمات الدالة: الصبار(*Aloe vera*) ،الاسماك،النمو،الاستجابةالمناعية،الحالةالتأكسدية.

1. Introduction

The cultivation of aquatic organisms, known as aquaculture, plays a critical role in meeting the increasing demand for seafood(Bilen et al., 2020; Fry et al., 2016; Salem et al., 2023). As aquaculture becomes more intensive, concerns about poor growth and health issues have led to the search for sustainable alternatives to traditional methods(Bilen et al., 2020; Lakwani et al., 2022). Medicinal plants have emerged as promising additives in aquaculture due to their positive effects on growth parameters and disease prevention(Mohamed et al., 2018; Salem et al., 2022; Taştan& Salem, 2021).

Aloe vera, a widely recognized plant with healing properties, has shown potential in enhancing growth and immune responses in various fish species(Alishahi&Abdy, 2013; Ibidunni

et al., 2018; Khan et al., 2018). Research has highlighted its beneficial impact on growth index, protein utilization, and gastro somatic index in fish species(Qasim& Mohsen, 2022; Salem et al., 2022; TAFI et al., 2018).The bioactive components present in *Aloe vera*, such as polysaccharides, amino acids, and enzymes, contribute to its efficacy as a feed additive. The use of herbal extracts provides a natural substitute for pharmaceutical drugs in promoting fish health and growth(ALİ et al., 2022; Mohamed et al., 2018; Salem et al., 2021). With the increasing focus on eco-friendly practices in aquaculture, exploring medicinal plants as growth enhancers becomes imperative(ALİ et al., 2022; Kadak& Salem, 2020). Ongoing research on optimal dosages, preparation techniques, and potential adverse effects aims to maximize the benefits of herbal extracts in aquaculture(Salem, 2017; Salem et al., 2022).

In summary, the incorporation of medicinal plants like *Aloe vera* into aqua feeds shows potential for boosting productivity while decreasing reliance on traditional treatments. By harnessing the bioactive properties of herbal extracts, aquaculture can progress towards more sustainable practices that prioritize both fish health and environmental well-being.

2. Biological Properties of *Aloe Vera*

Aloe vera is highly valued in aquaculture for its diverse biological properties that benefit fish farming(Farahii et al., 2012; Gabriel et al., 2017; Mehrabi, Firouzbakhsh, Rahimi-mianji, et al., 2019; Society et al., 2006). It has anti-inflammatory effects by reducing proinflammatory cytokines, boosting immunity through markers like lysozyme activity and IgM levels, and providing antioxidants such as SOD and GSH(Mehrabi, Firouzbakhsh, Rahimi-mianji, et al., 2019; Mehrabi&Firouzbakhsh, 2019; Mesbah et al., 2016; RainaManaf&Mohd. Daud, 2016; Safari et al., 2019). *Aloe vera* also promotes gut health by supporting beneficial gut microflora, leading to better nutrient absorption. Furthermore, it offers hepatoprotective properties, maintaining liver health in aquatic species. Overall, *Aloe Vera* extract shows promise in enhancing the health and performance of aquatic organisms in various ways (Gabriel et al., 2017; Parsa et al., 2016; Tafi et al., 2019).

Table 1. Effects of dietary *Aloe vera* derivatives supplementation on fish Biological Properties

Type of *Aloe Vera* derivative	Fish species,	number and weight	Dose and duration	Notable Biological results	References
Aloe vera juice	carp (*Labeo rohita* Ham.)	40 8-9 ± 0.6 g.	0.5 ml/L 21days	↑GPT, GOT, ACP	(Zodape, 2010)
Aloe vera Extract	Rainbow trout (*Oncorhynchus Mykiss*)	360 (20.87±0.25 g)	10 g per 1 kg for30days	↔ Growth ↑Survival rate ↑ WBC and Hct ↑Oxidative stability	(Farahii et al., 2012)
Aloe vera Latex	Nile tilapia, (*Oreochromis niloticus)*	150 30.38+0.16 g	0.5, 1, 1.5 or 2 ml/kg 60days	↑reproduction	(Kushwaha, 2013)
Aloe vera Extract	Common carps *(Cyprinus carpio)*	360 45±3 gr	0.1, 0.5 and 1% for 60 days	↑growth ↑Hematological parameters ↑Immunological parameters	(Alishahi&Abdy, 2013)
Aloe vera gel	Rainbow Trout (*Oncorhynchus mykiss*)	360 50.3 ± 5.4 g)	0.01%, 0.1% and 1% 6weeks	↑growth ↑gastrointestinal ↑skin morphology	(Heidarieh et al., 2013)
Aloe vera gel	Rainbow Trout (*Oncorhynchus mykiss*)	1200 2±0.2	1% for 8 weeks.	↔hematological ↑immunological indices	(Haghighi et al., 2014)

Aloe vera gel extract	Catfish *(Clariasg ariepinus)*	20 500-560g	2% and3% 5days	↑Spermiogram ↓motility ↓sperm count	(Owoyemi, A. O., Oyeyemi, M. O., Adeyemo, A. K. and Aina, 2015)
Aloe vera powder	GIFT-tilapia (*Oreochromis niloticus*)	NM 4.83 ± 0.02g	0.5, 1, 2, and 4 %/kg 8weeks	↑plasma lipid profile ↑antioxidant, ↑hepatoprotective enzyme activities	(Naftal et al., 2015)
Nanoparticles of dried *Aloe vera* extract	Siberian sturgeon (*Acipens erbaerii*)	300 10.95 ± 0.04 g	0.5%, 1% and 1.5% 60days	↑ hematological ↑immunological indices	(Moghaddam et al., 2017)
Aloe vera extract	Rainbow trout (*Oncorhynchus mykiss*)	600 13±0.05g	1% 8 weeks	↑ immunological indices parameters	(Haghighi et al., 2017)
Aloe vera powder	pacu (*Piaractusmeso potamicus*)	240 71.3 ± 3.3 g	(0.5%), (1%) and (2%) 10days	↑leukocyte ↑respiratory burst ↑ serum lysozyme ↑complement	(Zanuzzo et al., 2017)
Aloe vera gel and *Aloe vera* extract	Common Carp (*Cyprinus carpio* L.)	NM	1 and 2% 120 days.	↑growth	(Khan et al., 2018)

Aloe vera powder	Rainbow trout (*Oncorhynchus mykiss*)	264 (10.89 ± 0.67 g)	5, 10, and 15 g/ 8 weeks	↑growth ↑hematology indices ↑serum biochemical parameters ↑non-specific immunity indices	(Mehrabi, Firouzbakhsh, Rahimi-Mianji, et al., 2019)
Aloe vera extract	Shirbot (*Tor grypus*)	200 50-60 g	0.1% ,0.2,0.5% 2 months	↑growth ↑erythrocyte count ↑ packed cell volume ↑hemoglobin	(Safari et al., 2019)
Aloe vera extract	Nile Tilapia (*Oreochromis niloticus*)	840 7.516±0.05 g	0.5%, 1%, and 2.5%. 90 days	↔Growth	(Yılmaz et al., 2019)
Aloe vera powder	Rainbow trout (*Oncorhynchus mykiss*)	462 10.80 ± 0.59 g	0.5, 1, and 1.5% 4 weeks.	↑ Growth ↑hematological parameters ↑serum biochemical parameters	(Mehrabi&Firouzbakhsh, 2019)
Aloe vera powder	carp (*Labeo rohita* Ham.)	10,000 fingerlings	1%, 2% and 3% 6 months	↑ Growth	(Kaur&Ansal, 2020)
Aloe vera powder	carp (*Cyprinus carpio*)	200 41.71±0.78g	5g, 10g, 15g, 20g, and 25g 12weeks	↑ Growth	(Ayoola&Ishola, 2020)

Aloe vera extract	Koi fry (*Cyprinusrubrofuscus)*	300	150 ,300 ,450 and 600 mg kg^{-1} 14days	↑effective to treat fish infected with *A. hydrophila*	(Rosidah et al., 2021)
Aloe vera Extract	Nile Tilapia (*Oreochromis niloticus*)	8.0 ± 0.922 g	0, 5, 10 and 15 g / kg 14days	↑Growth ↑Hematological Performance	(Yunus et al., 2021)
Aloe vera Extract	Nile Tilapia (*Oreochromis niloticus*)	4.04 ± 0.03 g	1%, 2%, and 3% 105days	↑Growth ↑Hematological Performance	(Syed et al., 2022)
Aloe vera gel and dried leaves	common carp *(Cyprinus carpio* L)	90 2 ± 45 g	0.5, 1, 1.5, 2%	↑growth	(Qasim& Mohsen, 2022)
Aloe vera powder	gilthead sea bream (*Sparus aurata*)	144 142.13 ± 0.92	0.5%, 2.5% and 5% 8 weeks	↑catalase ↑glutathione S transferase ↑igf-i expression	(Gharred et al., 2022)

3. Progress of Research on Aloe Vera in Aquaculture

Studies have shown promising outcomes in aquaculture through the utilization of Aloe vera products. Research has illustrated that incorporating *Aloe vera* into the diet of fish can significantly boost their growth and overall health(Ayoola&Ishola, 2020; Qasim& Mohsen, 2022; Yunus et al., 2021). For instance, a study focusing on rainbow trout revealed that the introduction of high doses of *Aloe vera* supplement led to a notable improvement in growth performance(Mehrabi, Firouzbakhsh, Rahimi-mianji, et al., 2019; Mehrabi&Firouzbakhsh, 2019). Similarly, in *Oreochromisniloticus* fries, the administration of *Aloe vera* extract resulted in enhanced growth metrics compared to those in the control group(Yılmaz et al., 2019). The inclusion of *Aloe vera* in aquaculture has been associated with improved feed utilization and digestibility, along with displaying antistress and antioxidant properties(Naftal et al., 2015). Furthermore, investigations have suggested that *Aloe vera* products can positively impact fish appetite and immunity. For example, experiments conducted on Koi fry(*Cyprinus rubrofuscus*)fed with *Aloe vera* extract diet demonstrated an increase in lysozyme activity and phagocytic activity following a challenge with *A. hydrophila* infection(Rosidah et al., 2021). This implies that dietary supplementation with natural products like *Aloe vera* can fortify the immunity of fish against infections(Andayani et al., 2020; Gabriel et al., 2015; Kumar et al., 2015).

In addition to its effects on growth and appetite, *Aloe vera* products have been found to enhance overall health in fish. The presence of polysaccharides in *Aloe vera* leaves has been linked to prebiotic characteristics that stimulate gut microflora and enhance feed utilization(Parsa et al., 2016). These advantages can result in better health outcomes for fish by promoting growth performance and the immune system(Farahii et al., 2012; Yunus et al., 2021).Moreover, research has indicated that *Aloe vera* products can increase resistance to physiological stressors in fish. Studies have shown that incorporating *Aloe vera* extracts into the diet can prevent deficiencies in innate immune activity following stressful conditions or bacterial infections. This suggests that *Aloe vera* acts as an immunostimulant, aiding fish in better coping with environmental stressors(Syed et al., 2022; Zanuzzo et al., 2017).

Overall, ongoing research on *Aloe vera's* impact on aquaculture underscores its potential benefits for enhancing fish growth, appetite, general health, and resilience to physiological stressors. By integrating natural products like *Aloe vera*, aquaculture practices can become more sustainable and environmentally friendly while simultaneously improving production outcomes for fish farming.

4. Limitations and Prospects of *Aloe Vera* Use in Aquaculture.

The potential advantages of plant extract for aquaculture practices have been highlighted, but there are specific drawbacks and possibilities that must be taken into account before widespread implementation in the industry(ALİ et al., 2022; Mohamed et al., 2018; Salem et al., 2022). One drawback of utilizing *Aloe vera* extract in aquaculture is the risk of toxicity associated with high doses. Research has indicated that excessive intake can result in side effects, both internally and externally. It is essential to ensure precise dosing to avoid any side effects on aquatic life(Salem, 2022; Zodape, 2010).

Moreover, the effectiveness of plant extract in preventing lipid peroxidation is limited, which may hinder its antioxidant properties in aquaculture environments. While it can scavenge reactive oxygen species (ROS) due to phenolic compounds, it might not offer sufficient protection against lipid oxidation, crucial for maintaining fish health(Dracena, 2018; Salem et al., 2021).

Additionally, the inhibitory effect of *Aloe vera* extract on nitric oxide (NO) production could create challenges in maintaining balance in aquatic ecosystems(Kumar et al., 2015). NO plays a vital role in various biological functions, such as regulating blood flow and immune responses. The suppressive nature of *Aloe vera* extract on NO synthesis could disrupt these processes and impact overall fish well-being. Despite these challenges, there are opportunities for incorporating *Aloe vera* extract into aquaculture practices. Its potential hepatoprotective effects demonstrated in animal studies suggest it could benefit liver health in aquatic species. Furthermore, the antioxidant properties of *Aloe vera* extract could help alleviate oxidative stress and enhance immune function among fish populations.

Conclusion

In conclusion, while *Aloe vera* extract shows promise for improving aquaculture practices through its biological properties, it is crucial to address concerns related to toxicity, lipid peroxidation prevention, and NO production inhibition. By carefully considering these factors and exploring its potential benefits through further research and experimentation, aloe vera extract could prove to be a valuable asset for sustainable aquaculture management.

References

ALİ, G. A. L. İ. M., Bilen, S., &Güney, K. (2022). Growth promoter, immunostimulant and antioxidant for rainbow trout (Oncorhynchusmykiss): Terebinth (Pistaciaterebinthus) extract. *Marine Science and Technology Bulletin*, *11*(1), 98–112.

Alishahi, M., &Abdy, E. (2013). Effects of different levels of Aloe vera L. extract on growth performance, hemato-immunological indices of Cyprinuscarpio L. *Iranian Journal of Veterinary Science and Technology*, *5*(2), 33–44.

Andayani, S. R. I., Dadiono, M. S., Elwira, W. T. R. I., &Setyawan, F. H. (2020). Potency of aloe extract as immunostimulant for carp (Cyprinuscarpio) against Aeromonassalmonicida. *BIODIVERSITAS*, *21*(3), 860–864.
https://doi.org/10.13057/biodiv/d210302

Ayoola, S. O., &Ishola, H. O. (2020). The growth performance and genotoxicity effect of dietary Aloe vera on Oreochromisniloticus juveniles. *Aceh Journal of Animal Science*, *5*(2), 92–97. https://doi.org/10.13170/ajas.5.2.16044

Bilen, S., Altief, T. A. S., Özdemir, K. Y., Salem, M. O. A., Terzi, E., &Güney, K. (2020). Effect of lemon balm (Melissa officinalis) extract on growth performance, digestive and antioxidant enzyme activities, and immune responses in rainbow trout (Oncorhynchusmykiss). *Fish Physiology and Biochemistry*, *46*, 471–481.

Dracena, C. De. (2018). *Oxidative stress and fish immune system : phagocytosis and leukocyte respiratory burst activity*. *90*, 3403–3414.

Farahii, A., Kasirii, M., Sudagari, M., Iraei, M. S., &Zorriehzahra, S. M. J. (2012). EFFECT OF DIETARY SUPPLEMENTATION OF Melissa Officinalis and Aloe Vera ON HEMATOLOGICAL TRAITS , LIPID OXIDATION OF CARCASS AND PERFORMANCE IN RAINBOW TROUT (OncorhynchusMykiss). *Online Journal of Animal and Feed Research*, *2*(1), 1–5.

Fry, J. P., Love, D. C., MacDonald, G. K., West, P. C., Engstrom, P. M., Nachman, K. E., & Lawrence, R. S. (2016). Environmental health impacts of feeding crops to farmed fish. *Environment International*, *91*, 201–214. https://doi.org/10.1016/j.envint.2016.02.022

Gabriel, N. N., Qiang, J., He, J., Ma, X. Y., Kpundeh, M. D., &Xu, P. (2015). Dietary Aloe vera supplementation on growth performance, some haemato-biochemical parameters and disease resistance against Streptococcus iniae in tilapia (GIFT). *Fish and Shellfish Immunology*, *44*(2), 504–514. https://doi.org/10.1016/j.fsi.2015.03.002

Gabriel, N. N., Qiang, J., Ma, X. Y., Xu, P., &Nakwaya, D. N. (2017). Effects of dietary *Aloe vera* crude extracts on digestive enzyme activities and muscle proximate composition of GIFT tilapia juveniles. *South African Journal of Animal Science*, *47*(6), 904. https://doi.org/10.4314/sajas.v47i6.18

Gharred, T., Haouas, Z., Guerbej, H., Hosni, K., Navarro, I., &Jebali, J. (2022). Dietary supplementation with Aloe vera induces hepatic steatosis and oxidative stress together with a disruption of cellular signaling pathways and lipid metabolism related genes ' expression in gilthead sea bream (Sparusaurata). *Aquaculture*, *559*(June). https://doi.org/https://doi.org/10.1016/j.aquaculture.2022.738433

Haghighi, M., Rohani, M. S., Samadi, M., Tavoli, M., &Yusefi, R. (2014). Study of effects Aloe vera extract supplemented feed on hematological and immunological indices of rainbow trout (Oncorhynchusmykiss). *International Journal of Advanced Biological and Biomedical Research*, *2*(6), 2143–2154.

Haghighi, M., Sharif, R. M., Pourmoghim, H., Samadi, M., Tavoli, M., Eslami, M., &Yusefi, R. (2017). Enhancement of immune responses of rainbow trout (Oncorhynchusmykiss) fed a diet supplemented with Aloe vera extract. *Iranian Journal of Fisheries Sciences*, *16*(3), 884–896.

Heidarieh, M., Mirvaghefi, A. R., Sepahi, A., Sheikhzadeh, N., Ali, A., &Akbari, M. (2013). Effects of Dietary Aloe Vera on Growth Performance , Skin and Gastrointestine Morphology in Rainbow Trout (Oncorhynchusmykiss). *Turkish Journal of Fisheries and Aquatic Sciences*, *13*, 367–373. https://doi.org/10.4194/1303-2712-v13

Ibidunni, S., Samuel, A., Obasa, O., &Abdulraheem, I. (2018). *Growth performance , haematology and histopathology of African catfish (Clariasgariepinus) fed varying levels of Aloe barbadensis leaves*. *6*(1), 553–562. https://doi.org/10.17017/jfish.v6i1.2018.245

Kadak, A. E., & Salem, M. O. A. (2020). Antibacterial activity of chitosan, some plant seed extracts and oils against Escherichia coli and Staphylococcus aureus. *AlınteriZiraiBilimlerDergisi*, *35*(2), 144–150.

Kaur, H., &Ansal, M. D. (2020). *Efficacy of Aloe vera as a growth promoting additive in carp (Labeorohita Ham .) grow out feed*. *8*(2), 997–1002.

Khan, I., Dhawan, A., &Ansal, M. D. (2018). Effect of Aloe vera Supplemented Feed on Survival and Growth of Common Carp (Cyprinuscarpio L.) . *Indian Journal of Animal Nutrition*, *35*(2), 206. https://doi.org/10.5958/2231-6744.2018.00031.2

Kumar, P. P. N. V., Shameem, U., &Kollu, P. (2015). Green Synthesis of Copper Oxide Nanoparticles Using Aloe vera Leaf Extract and Its Antibacterial Activity Against Fish Bacterial Pathogens. *BioNanoSci*, *5*, 135–139. https://doi.org/10.1007/s12668-015-0171-z

Kushwaha, M. P. (2013). Effects of Aloe vera (Liliaceae) on Gonad development in Nile tilapia, Oreochromisniloticus (L.) during intensive aquaculture. *International Journal of Fisheries and Aquatic Studies*, *1*(2), 56–60.

Lakwani, M. A. S., Kenanoğlu, O. N., Taştan, Y., &Bilen, S. (2022). Effects of black mustard (Brassica nigra) seed oil on growth performance, digestive enzyme activities and immune responses in rainbow trout (Oncorhynchusmykiss). *Aquaculture Research*, *53*(1), 300–313.

Mehrabi, Z., &Firouzbakhsh, F. (2019). Short-term effects of feeding powdered Aloe vera (Aloe barbadensis) and nettle (Urticadioica) on growth performance and stimulation of innate immune responses in rainbow trout (On ... Short-term effects of feeding powdered Aloe vera (Aloe barbadens. *Comparative Clinical Pathology*. https://doi.org/10.1007/s00580-019-03068-w

Mehrabi, Z., Firouzbakhsh, F., Rahimi-mianji, G., &Paknejad, H. (2019). immune response , immune gene expression , and experimental challenge with Saprolegniaparasitica in rainbow trout (Oncorhynchusmykiss). *Aquaculture*, *503*(April 2018), 330–338. https://doi.org/10.1016/j.aquaculture.2019.01.025

Mehrabi, Z., Firouzbakhsh, F., Rahimi-Mianji, G., &Paknejad, H. (2019). Immunostimulatory effect of Aloe vera (Aloe barbadensis) on non-specific immune response, immune gene expression, and experimental challenge with Saprolegniaparasitica in rainbow trout (Oncorhynchusmykiss). *Aquaculture*, *503*(April 2018), 330–338. https://doi.org/10.1016/j.aquaculture.2019.01.025

Mesbah, M., Mohammadian, T., Alishahi, m, &Jangarannejad, A. (2016). Effects of dietary Aloe vera and Echinacea on some nonspecific immunity in shirbot (Barbusgrypus). *Iranian Journal of Aquatic Animal Health*, *2*(1), 24–36. https://doi.org/10.18869/acadpub.ijaah.2.1.24

Moghaddam, B. S., Haghighi, M., Rohani, S. M., Hamidi, M., &Ghasemi, M. (2017). The effects of different levels of Aloe vera extract on some of the hematological and non-specific immune parameters in Siberian sturgeon (Acipenserbaerii). *Iranian Journal of Fisheries Sciences*, *16*(4), 1234–1247.

Mohamed, G. A., Amhamed, I. D., Almabrok, A. A., Barka, A. B. A., Bilen, S., &Elbeshti, R. T. (2018). Effect of celery (Apiumgraveolens) extract on the growth, haematology, immune response and digestive enzyme activity of common carp (Cyprinuscarpio). *Marine Science and Technology Bulletin*, *7*(2), 51–59.

Naftal, N., Jun, G., Yu, X., Jie, M., Pao, H., Kai, X., & Liu, J. H. Á. P. X. Á. K. (2015). Dietary Aloe vera improves plasma lipid profile , antioxidant , and hepatoprotective enzyme activities in GIFT-tilapia (Oreochromisniloticus) after Streptococcus iniae challenge. *Fish PhysiolBiochem*. https://doi.org/10.1007/s10695-015-0088-z

Owoyemi, A. O., Oyeyemi, M. O., Adeyemo, A. K. and Aina, O. O. (2015). Reproductive Potential of Male Catfish Treated with Gel Extract of Aloe Vera Plant. *NIGERIAN VETERINARY JOURNAL*, *36*(4), 1341–1350.

Parsa, A., Bahramian, S., &Sharifpour, I. (2016). Effect of oral consumption of Aloe vera gel on intestinal microflora and liver tissue of rainbow trout. *Iranian Journal of Fisheries Sciences*, *15*(1), 590–596.

Qasim, M. A. A., & Mohsen, T. S. (2022). Effect of adding different levels of gel and coating dried Aloe vera leaves to the diets on Cyprinuscarpio performance. *International Journal of Health Sciences*, *6*(April), 3642–3651. https://doi.org/10.53730/ijhs.v6nS3.6589

RainaManaf, S., &Mohd. Daud, H. (2016). The Effects of Vitextrifolia, Strobilanthescrispus and Aloe vera Herbal-mixed Dietary Supplementation on Growth Performance and Disease Resistance in Red Hybrid Tilapia (Oreochromis sp.). *Journal of Aquaculture Research & Development*, *07*(04). https://doi.org/10.4172/2155-9546.1000425

Rosidah, R., Nugraha, A., Andriani, Y., Haetami, K., Anne, O., &Purnomo, A. H. (2021). Potential of Aloe vera for Treatment of Infection with Aeromonashydrophila Bacteria on Koi Fry. *Sarhad Journal of Agriculture*, *37*(S1). https://doi.org/10.17582/journal.sja/2021/37.s1.64.74

Safari, M., ChelemalDezfoulNejad, M., Mesbah, M., &JangaranNejad, A. (2019). Effects of Aloe vera extract on growth and some hematological parameters of shirbot, Tor grypus (Heckel, 1843). *Iranian Journal of Fisheries Sciences*, *18*(3), 445–456. https://doi.org/10.22092/ijfs.2018.118042

Salem, M. O. A. (2017). *Karahindiba (Taraxacumofficinalis) vesakalyosunu (Usneabarbata) içerenyemlerlebeslenengökkuşağıalabalığıyavrularında (Oncorhynchusmykiss) antioksidanenzimaktivitelerininbelirlenmesi*. Fen BilimleriEnstitüsü.

Salem, M. O. A. (2022). *Akhardal (sinapis alba) veketentohumu (linumusitatissimum) yağlarınıngökkuşağıalabalıklarının (oncorhynchusmykiss) büyümeperformansı, bağışıklıkyanıtı, kanparametreleri, sindirimenzimleriveantioksidanenzimaktivitelerineetkileri*. KastamonuÜniversitesi.

Salem, M. O. A., Salem, T. A., YürütenÖzdemir, K., Sönmez, A. Y., Bilen, S., &Güney, K. (2021). Antioxidant enzyme activities and immune responses in rainbow trout (Onchorhynchusmykiss) juveniles fed diets supplemented with dandelion (Taraxacumofficinalis) and lichen (Usneabarbata) extracts. *Fish Physiology and Biochemistry*, *47*(4), 1053–1062.

Salem, M. O. A., Taştan, Y., Bilen, S., Terzi, E., &Sönmez, A. Y. (2022). Effects of white mustard (Sinapis alba) oil on growth performance, immune response, blood parameters, digestive and antioxidant enzyme activities in rainbow trout (Oncorhynchusmykiss). *Fish & Shellfish Immunology*, *131*, 283–299.

Salem, M. O. A., Taştan, Y., Bilen, S., Terzi, E., &Sönmez, A. Y. (2023). Dietary flaxseed (Linumusitatissimum) oil supplementation affects growth, oxidative stress, immune response,

and diseases resistance in rainbow trout (Oncorhynchusmykiss). *Fish & Shellfish Immunology*, *138*, 108798.

Society, N., Production, A., Journal, N., & Production, A. (2006). *Body weight changes, nutrient utilization and intestinal microflora of African catfish (*.

Syed, R., Masood, Z., Ul Hassan, H., Khan, W., Mushtaq, S., Ali, A., Gul, Y., Jafari, H., Habib, A., Ishaq Ali Shah, M., Gabol, K., Gul, H., &Ullah, A. (2022). Growth performance, haematological assessment and chemical composition of Nile tilapia, Oreochromisniloticus (Linnaeus, 1758) fed different levels of Aloe vera extract as feed additives in a closed aquaculture system. *Saudi Journal of Biological Sciences*, *29*(1), 296–303. https://doi.org/10.1016/j.sjbs.2021.08.098

Tafi, A. A., Meshkini, S., Tukmechi, A., Alishahi, M., &Noori, F. (2019). Effect of Aloe vera and Salvia officinalis extract supplemented diet on hematology, histopathology, and hypoxia resistance in rainbow trout. *Iranian Journal of Veterinary Science and Technology*, *11*(2), 59-68+84. https://doi.org/10.22067/veterinary.v11i2.81124

TAFI, A. A., MESHKINI, S., TUKMECHI, A., ALISHAHI, M., & NOORI, F. (2018). GökkuşağıAlabalığı (Oncorhynchusmykiss)'nda Salvia officinalisve Aloe veraEkstraktıileBeslemeninİmmunolojikveAntistreptokokalEtkileri. *KafkasUniversitesiVeterinerFakultesiDergisi*, *24*(3), 365–370. https://doi.org/10.9775/kvfd.2017.18973

Taştan, Y., & Salem, M. O. A. (2021). Use of Phytochemicals as Feed Supplements in Aquaculture: A Review on Their Effects on Growth, Immune Response, and Antioxidant Status of Finfish. *Journal of Agricultural Production*, *2*(1), 32–43. https://doi.org/10.29329/agripro.2021.344.5

Yılmaz, E., Çoban, D., Kırım, B., &Güler, M. (2019). Effects of Extracts of Feed Additives Including Rosemary (Rosmarinusofficinalis) and Aloe Vera (Aloe barbadensis) on the Growth Performance and Feed Utility of Nile Tilapia (Oreochromisniloticus). *Turkish Journal of Agriculture - Food Science and Technology*, *7*(6), 866–870. https://doi.org/10.24925/turjaf.v7i6.866-870.2438

Yunus, Y. E., Anshary, H., & N. Zainuddin, E. (2021). Effect of Aloe Vera (Aloe vera) Extract on Growth and Hematological Performance in Nile Tilapia (Oreochromisniloticus). *International Journal of Scientific and Research Publications (IJSRP)*, *11*(2), 574–580. https://doi.org/10.29322/ijsrp.11.02.2021.p11072

Zanuzzo, F. S., Sabioni, R. E., Montoya, L. N. F., Favero, G., &Urbinati, E. C. (2017). Aloe vera enhances the innate immune response of pacu (Piaractusmesopotamicus) after transport stress and combined heat killed Aeromonashydrophila infection. *Fish & Shellfish Immunology*, *65*, 198–205. https://doi.org/10.1016/j.fsi.2017.04.013

Zodape, G. V. (2010). Effect of Aloe vera juice on toxicity induced by arsenic in Labeorohita (Hamilton). *Journal of Applied and Natural Science*, *2*(2), 300–304.