

Research Article

Effect of *Moringa oleifera* and *Arthrospira platensis* leaf meal on reproductive performance of guppy, *Poecilia reticulata* (Peter, 1860)

Mayank Bisht¹, Avdhesh Kumar¹, Tarang Kumar Shah², Madhu Sharma², Prasenjit Dhar²

¹Department of Aquaculture, G.B. Pant University of Agriculture and Technology, Pantnagar, India

²Department of Fisheries, C.S.K. Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India

Corresponding author: Tarang Kumar Shah; kunnushah4545@gmail.com

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Abstract

The present experiment aimed to evaluate the effect of *Moringa oleifera* and *Arthrospira platensis* leaf powder on the breeding performance of guppies, *Poecilia reticulata*. Four hundred eighty (480) healthy fish were divided into eight treatment groups including control (T0), 5% (MT1), 10% (MT2), and 15% (MT3) moringa powder in the fish diet, as well as control (T0), 5% (ST1), 10% (ST2), and 15% (ST3) spirulina powder in the fish diet. The fry weight of fish fed all spirulina diets was significantly higher in ST1 (6.93 ± 0.09), ST2 (7.00 ± 0.06), ST3 (7.13 ± 0.03) compared to control (6.80 ± 0.06). No significant increase in fry weight was observed in moringa diet treatments although some increase in fry weight was observed with an increase in moringa concentration in the diet. The fry length of fish that were given spirulina diets showed a significant increase in ST1 (7.13 ± 0.03), ST2 (7.17 ± 0.03), ST3 (7.17 ± 0.03) when compared to the control group (6.97 ± 0.03). In moringa diet treatments MT1 (7.10 ± 0.00), MT2 (7.13 ± 0.03), MT3 (7.13 ± 0.03) also a significant increase in fry length as compared to the control (6.97 ± 0.03). The increase in fertility of brooders was also observed with an increase in the concentration of both spirulina and moringa concentration in the fish diet. No significant difference in fry survival percentage from control for both spirulina and moringa treatments. The findings of the current investigation indicate that incorporating moringa and spirulina into the feed can result in favorable reproductive outcomes.

Keywords: Spirulina, moringa, breeding performance, ornamental fish, fry

1. Introduction

The trade of ornamental fish has experienced a significant increase in value over the last 20 to 30 years. There are over 2,500 species of ornamental fish being cultivated globally, with 60% being freshwater and 40% marine.

From 2000 to 2011, the global exports of ornamental fish saw a rise in value from US\$ 181 million to US\$ 372 million. Singapore stands out as the top exporter worldwide, with the majority of the market's supply originating from Asian nations. India possesses immense potential for the cultivation of ornamental fish. Although India's contribution to the global ornamental fish trade is currently less than 1%, the export of Indian ornamental fish has experienced a significant positive compound growth rate (Sharma, 2020). In terms of export value, this growth rate stands at 14.4%, while in terms of quantity exported, it is 12.1%, and in terms of unit value, it is 2.1% (Rani et al., 2013). Ornamental fish species like guppy and neon fish make up more than 14% and 25% of the market in terms of value and volume, respectively (Kaur et al., 2017). Guppies are among the most common tropical fish globally and are also known by other names like million fish and rainbow fish. They are the most popular freshwater aquarium fish species worldwide (Shah et al., 2017; Bisht et al, 2023). Guppies belong to the Poeciliidae family, which includes many other ornamental fish species (Bisht et al, 2023).

Protein is a vital nutrient that fish require in their diet. When there is an adequate amount of fat and carbohydrates present in their diet, protein is utilized for the purpose of growth and development. Dietary protein is crucial for both the somatic growth and reproduction processes of Poeciliidae for fry production to be optimized and studies have shown that a minimum of 30% protein is necessary for fish brood stock (Alexander et al., 2004; Ujjwala & Avdhesh, 2020). The influence of dietary protein on fish reproduction has been extensively studied (Shim et al., 1989). Female fish need to consume sufficient protein to facilitate the growth of eggs/embryos and ensure successful reproduction. Protein is also necessary for the formation of follicles and other ovarian

tissues, as well as for the growth and development of embryos.

Fish meal is the most preferred protein source in aquaculture-formulated fish feed as it has high protein content, balanced amino acid profile, high digestibility, palatability, and a good source of essential fatty acids (Hardy and Tacon, 2002; Jackson, 2006). As demand is surging not only from aquaculture but also from the livestock and poultry feed industry pressure on the limited fish meal supply is increasing and it has become costly (Gatlin et al., 2007; Tacon and Metian, 2008; IFFO, 2008). At present, there is ongoing research to find sustainable replacements for fish meals in ornamental fish culture. Unconventional feeds like spirulina and moringa, which have protein levels of 62% and 29.4% amino acid content in dried form, are being explored as protein sources (Bisht et al, 2020; Bisht et al, 2023). These alternatives not only replace fish meal but also provide essential nutrients such as vitamins, carotenoids, and beneficial minerals. Additionally, increasing the use of plant protein in fish diets could potentially decrease the cost of fish meal and feeds, ultimately reducing its demand (Lim and Lee, 2009).

Moringa oleifera Lam. is a rapidly growing nutritional plant that is part of the Moringaceae family. It is commonly found in tropical and subtropical regions and plays a significant role in the food and medicinal industries (Foidl et al 2001). The moringa plant contains all ten essential amino acids, as well as Vitamins A, B complex, C, E, and carotenoids. The leaves of this plant are particularly rich in carotenoids (Moyo et al 2011). Studies have shown that moringa leaves contain flavonoids, phenolic acids, carotenoids, minerals, vitamins, moringinine, alkaloids, sterols, moringine, phytoestrogens, and caffeoylquinic acids, all of which have immune modulation properties (Al-Malki & Rabey,

2015; Anwar et al, 2007). Recently, moringa has been reported to reduce stress biomarker levels in different animals (Abdel-Latif et al, 2018).

Microalgae are essential in aquaculture as they provide vital nutrients for aquatic animals like mollusks, shrimp, and fish. Various algal species are utilized as a source of nutrition in aquaculture (Muller-Feuga, 2000). Spirulina (*Arthrospira platensis*) is one of the most commonly used microalgae in aquatic animal feeds due to its high protein, vitamin, and antioxidant content (Nakagawa and Montgomery, 2007). It is a rich source of raw protein and contains seven essential vitamins: A1, B1, B2, B6, B12, C, and E. Therefore, the current study was carried out to assess and compare various dosages of moringa and spirulina in relation to the breeding performance of guppy, *Poecilia reticulata*.

2. Materials and Methods

Experimental site:

The current study was carried out in the Wet Laboratory, Department of Aquaculture, G. B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) over a period of 90 days.

Experimental Fish and Design:

Four hundred eighty (480) healthy and disease-free guppy fry (mean weight, 0.13 ± 0.01 g & mean length, 2.29 ± 0.02 cm) were purchased from a local commercial aquarium fish supplier, who procured them from Kolkata and then introduced into a glass aquarium. These fry were

acclimatized under controlled indoor conditions with adequate aeration for a period of 15 days. This study did not require any approval from the Experimental Animal Committee of GBPUAT, Pantnagar, as per ethical guidelines. Subsequently, the acclimatized fish were evenly distributed among 24 experimental groups, with each group consisting of 20 individuals.

Preparation of leaf powder:

Leaves of *M. oleifera* and *A. platensis* were collected from the local area. The collected leaves were washed adequately with tap water for 2–3 times, followed by the collected leaves was soaked in distilled water for 30 min to remove the dust. After that, they were dried in the shade for seven days and then grinded. After the grinding, leaves powder was stored at 4°C.

Experimental feed:

The experimental fish diets consisted of moringa and spirulina at different percentages: 5% (MT1), 10% (MT2), and 15% (MT3) for moringa, and 5% (ST1), 10% (ST2), and 15% (ST3) for spirulina. The control group (T0) did not contain any moringa and spirulina.

Proximate composition of experimental feed:

At the beginning of the study, proximate analysis was carried out following AOAC (1995) guidelines to determine the moisture, crude protein, crude fat, crude fiber, and ash content in the experimental diets. The composition of the fish feed ingredients can be found in Tables 1 & 2.

Table 1: Percentage and Proximate composition of control and moringa experimental diets

Ingredients	Dietary group (%)			
	Control Diet	Moringa Diet		
	T0	MT1	MT2	MT3
Fish meal	35.20	33.84	32.45	31.05
Rice bran	41.50	37.86	34.25	30.65
Soya bean meal	22.30	22.30	22.30	22.30
Premix Vitamins + Minerals	1.00	1.00	1.00	1.00
Moringa leaves powder		5.00	10.00	15.00
PROXIMATE COMPOSITION				
Moisture (%)	8.56±0.31	8.59±0.31	8.63±0.28	8.67±0.24
Crude Protein (%)	39.80±0.58	39.82±0.94	39.81±0.22	39.80±0.59
Lipid (%)	10.50±0.18	9.89±0.18	9.29±0.20	8.68±0.19
Ash (%)	10.07±0.23	10.22±0.18	10.38±0.14	10.54±0.22
Crude fibre (%)	9.63±0.16	9.86±0.26	10.10±0.21	10.34±0.20

Table 2: Percent and Proximate composition of control and Spirulina experimental diets

Ingredients	Dietary group (%)			
	Control Diet	Spirulina Diet		
	T0	ST1	ST2	ST3
Fish meal	35.20	31.05	26.90	22.85
Rice bran	41.50	40.65	39.80	38.85
Soya bean meal	22.30	22.30	22.30	22.30
Premix Vitamins + Minerals	1.00	1.00	1.00	1.00
Spirulina Powder		5.00	10.00	15.00
PROXIMATE COMPOSITION				
Moisture (%)	8.56±0.31	8.46±0.12	8.37±0.14	8.19±0.26
Crude Protein (%)	39.80±0.58	39.8±0.85	39.79±0.16	39.85±0.22
Lipid (%)	10.50±0.18	10.41±0.15	10.32±0.26	10.04±0.16
Ash (%)	10.07±0.23	9.78±0.20	9.48±0.20	9.11±0.23
Crude fibre (%)	9.63±0.16	9.64±0.30	9.66±0.21	9.45±0.27

Physico-chemical parameters of water

During the experimental period, the physico-chemical parameters of water including water temperature, dissolved oxygen, pH, free carbon dioxide, and total alkalinity were monitored on a weekly basis (APHA, 2012).

Breeding method:

To impregnate female guppies, mature male and female fishes were kept in a ratio of 1:4 in a separate aquarium. The gravid female has a swollen belly with fries inside her. Impregnated gravid females have a dark gravid spot near her anal fin and a large bulging belly. The gravid spot is caused by the fry's eyes pressing against the female's scales. The gravid females were kept in separate aquariums in a breeding net made up of iron wires, as the fish has the habit of feeding on their own newborn fries. Once the fish released the fries, the brooders were removed from the aquarium, and the fries were counted. The fries were then provided with the same diet as the brooder fish.

Statistical Analysis:

The breeding performance data were analyzed using one-way analysis of variance (ANOVA) through SPSS 22.0 software. The results were presented as mean $\pm$ standard error. The variation among the treatments, which was tested for significance using analysis of variance techniques, was described (Gomez and Gomez 1984).

3. Results & Discussion:

In the present studies, fertility per gram of brooders, fry survival, and fry length and weight were the parameters used to assess the breeding performance of the guppy. The breeding performance parameters of the brooder fish for different treatments with natural carotenoids supplemented with spirulina and moringa (Table 3 & 4).

The overall weight and length of fry ranged between 6.80 ± 0.06 mg to 7.13 ± 0.03 mg and 6.97 ± 0.03 mm to 7.17 ± 0.03 mm respectively from different spirulina and moringa treatment. The highest weight and length of fry were obtained from ST3, while the lowest was from T0. The analysis of variance showed significant differences in the length of fries within both spirulina and moringa treatments. The post hoc Tukey's test in spirulina treatments showed a significant increment in fry length in spirulina-supplemented diets as compared to control ($p \leq 0.05$) but, no significant difference was shown in fry length with increasing spirulina concentration. In fishes fed with moringa supplemented diet similar results as the spirulina diet were found by Tukey's test in terms of fry length. In spirulina treatments, a significant difference was observed in fry weight ($p \leq 0.05$), while in moringa treatments, no significant difference in fry weight was found by analysis of variance. The post hoc Tukey's test on fry weight of spirulina treatments showed that a significant increment in the weight of fish was observed only between T0 and ST3 treatment, while in other treatments no significant increment was found.

Fertility is the number of young ones produced by an individual. The fertility of brooders from different treatments are given in Tables 3 & 4. The highest fertility was found in ST3 treatment (26.17 ± 0.85 fry/g brood weight) among spirulina diet and in MT3 treatment (25.85 ± 1.61 fry/g brood weight) among moringa diets, while the lowest fertility was found in T0 treatment. Analysis of variance in spirulina treatments found a significant difference in fertility. The post hoc Tukey's test on spirulina treatment showed that, only in control and ST3 treatments significant increment in fertility occurred while in other treatments no significant increment in the fertility were found. In the moringa treatments, there was no significant difference in fertility,

although an increment in mean fertility was found with the increasing moringa concentration in the diet.

The survival rate of fries in spirulina and moringa treatment is presented in Figures 1 & 2. The survival rate of fry was calculated after one month of their birth. ST3 treatment had the highest survival rate ($76.00 \pm 0.58\%$) in

the spirulina diet, while MT3 treatment had the highest survival rate ($75 \pm 1.15\%$) in the moringa diet. The control group T0 had the lowest survival rate ($71.33 \pm 2.19\%$). There was no significant difference in survival rates between the spirulina and moringa treatments, but higher concentrations of both led to increased fry survival rates.

Table. 3: Effect of Spirulina meal on breeding performance of Guppy (Mean $\pm$ SD)

Parameter	T0	ST1	ST2	ST3
Brood Weight (g)	0.63 ± 0.01^a	0.73 ± 0.03^b	0.85 ± 0.02^{ab}	1.08 ± 0.05^c
Fry Weight (mg)	6.80 ± 0.06^a	6.93 ± 0.09^b	7.00 ± 0.06^{ab}	7.13 ± 0.03^c
Fry Length (mm)	6.97 ± 0.03^a	7.13 ± 0.03^b	7.17 ± 0.03^{ab}	7.17 ± 0.03^{ab}
Fertility/Gram Brood (No. Of Eggs Per Gram Brood)	20.15 ± 1.40^a	23.69 ± 1.30^b	25.43 ± 1.26^{ab}	26.17 ± 0.85^c

Values are expressed as means $\pm$ SD of three replications. Different superscript letters (a,b,ab,c) showed significant differences in the row ($P < 0.05$).

Table. 4: Effect of Moringa meal on breeding performance of Guppy (Mean $\pm$ SD)

Parameter	T0	MT1	MT2	MT3
Brood Weight (g)	0.63 ± 0.01^a	0.66 ± 0.02^b	0.89 ± 0.03^{ab}	0.93 ± 0.01^c
Fry Weight (Mg)	6.80 ± 0.06^a	6.87 ± 0.03^b	6.93 ± 0.03^{ab}	6.93 ± 0.09^c
Fry Length (Mm)	6.97 ± 0.03^a	7.10 ± 0.00^b	7.13 ± 0.03^{ab}	7.13 ± 0.03^{ab}
Fertility/Gram Brood (No. Of Eggs Per Gram Brood)	20.15 ± 1.40^a	23.82 ± 1.25^b	25.15 ± 2.74^{ab}	25.85 ± 1.61^c

Values are expressed as means $\pm$ SD of three replications. Different superscripts letters (a,b,ab,c) showed significant difference in the row ($P < 0.05$).

Proximate composition of different diets used is given in Table 1 & 2. All the seven formulated diets were isonitrogenous and isocaloric. Results of water quality analysis conducted at weekly intervals showed no significant difference between the treatments. The water used for reserach had a tempearture of 23 to 26 °C, dissolved oxygen of 7.1 to 8.0 mgL⁻¹, free carbon dioxide of 1.4 and 2.4 mgL⁻¹, total alkalinity of 125 to 150 mgL⁻¹ and pH of 7.4 to 7.7.

Several research has shown that plants have the capacity to control or enhance fish reproduction. Many bioactive compounds found in plants can effectively control the reproductive processes in fish (Gabriel, 2019). There have been reported cases of plants containing androgenic compounds that can disrupt the reproductive cycle of fish (Abaho et al., 2022).

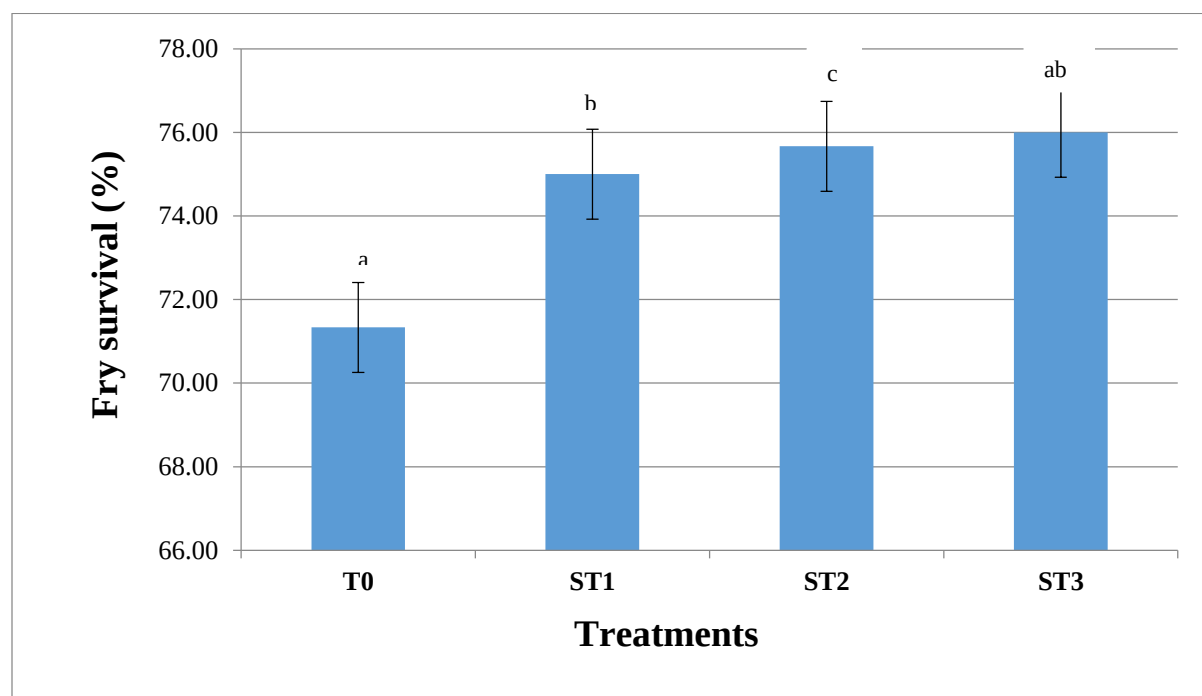


Figure 1: Effect of Spirulina on fry survival of guppy. Values are means $\pm$ SD of three replications. Mean value with different superscripts (a,b,ab,c) after significantly ($P < 0.05$)

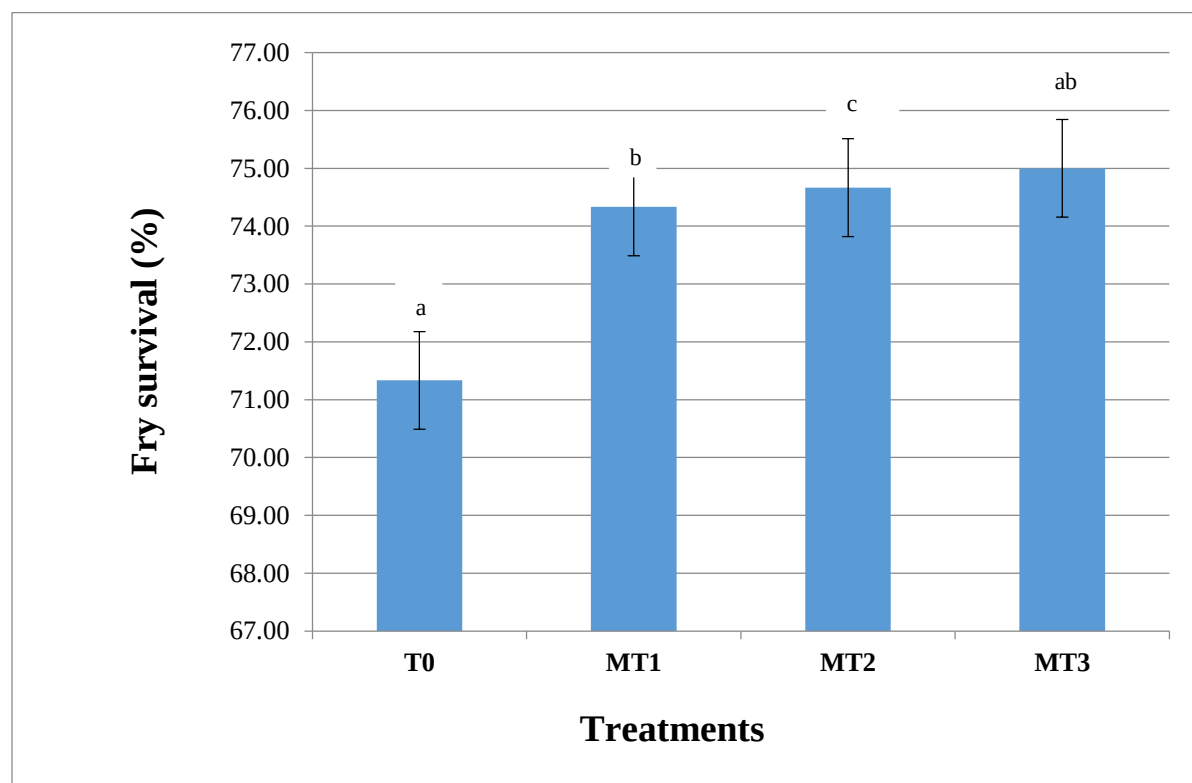


Figure 2: Effect of moringa on fry survival of guppy. Values are means $\pm$ SD of three replications. Mean value with different superscripts (a,b,ab,c) after significantly ($P < 0.05$)

Many plants that have been shown to improve fertility in fish contain bioactive compounds known for promoting overall fish health by assisting in detoxification and reducing oxidative stress caused by free radicals. This is known to regulate and improve various essential body functions (Oke et al., 2019).

Previous research conducted by Sampath and Pandian (1984), James and Sampath in 1993, and Jobling in 1998 has shown that the protein and lipid levels in the diet of broodstock significantly impact the successful reproduction and survival of offspring. The results of our study confirm that including 5% spirulina in diets can enhance reproductive performance, which aligns with the findings of other researchers (Ghosh et al, 2007; Ujjawal & Avdhesh, 2020). Ghosh et al, (2007) reported that incorporating probiotics into the diet had a notable effect on the breeding success of livebearing fish. The findings indicated a rise in fertility, a higher gonadosomatic index, better survival rates for offspring, decreased mortality and deformities among fry, and improved growth in terms of weight and length. The significant increase in fertility and weight in ST3 than T0 can be attributed to the increased carotenoid concentration in the ST3 diet, which is supported by the study of Giroy et al., (2012) on yellow tail cichlid *Pseudotropheus sp. acei*, assess the effect of dietary spirulina meal as a carotenoid source. They found that egg production and hatching rate (%) of fish, fed with spirulina diets were significantly higher as compared to the control diet. Sawanboonchun et al. (2008) found an increase in the number of eggs per batch spawned, the number per batch of floating eggs/kg female and the number per batch of fertilized eggs/kg female, when Atlantic cod was fed with dietary supplementation carotenoid astaxanthin. Moringa olifera seeds are found to enhance of reproductive performance (Gad et al., 2019, Bisht et al., 2020).

In present results, there was no significantly difference in the fertility, although increment in mean fertility was found with the increasing moringa concentration in the diet. These results were attributed to the balanced amino acid profile of moringa, in addition, the bioactive peptides present enhance fish's physical performance (Aksnes et al., 2006). Despite having a higher amount of carotenoids than spirulina the non-significant increase in fertility and weight in moringa treatments can be attributed to the presence of anti-nutritional factors in the moringa leaves (Richter et al., 2003; Makkar and Becker, 1997).

4. Conclusion:

The results clearly show that spirulina & moringa meal could be used in guppy diets to replace up to 15% of the dietary fish meal without causing any adverse effects on reproductive performance. Indeed, all fish fed with spirulina & moringa diets exhibited higher broodstock performance. The Spirulina & moringa meal clearly much potential for inclusion in diets for guppy broodstock.

5. Statement and Declaration

Ethical Statements: All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

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6. References:

- Abaho I, Masembe C, Akoll PM, Jones CLW, 2022. The use of plant extracts to control tilapia reproduction: current status and future perspectives. J World Aquac Soc, 53:593–619. 10.1111/jwas.12863.
- Abdel-Latif M, Sakran T, Badawi Y, and Abdel-Hady DS, 2018. Influence of *Moringa oleifera* extract, vitamin C, and sodium bicarbonate on heat stress-induced HSP70 expression and cellular immune response in rabbits. Cell Str Chapter, 23, 975–984. <https://doi.org/10.1007/s12192-018-0906-1>
- Aksnes A, Hope B, Høstmark Ø, Albrektsen S, 2006. Inclusion of size fractionated fish hydrolysate in high plant protein diets for Atlantic cod, *Gadus morhua*. Aquacul, 261, 1102–1110.
- Alexander SCC, Saraitul D, Zulfaizuddin O, and Roshada H, 2004. Effect of dietary protein level on the reproductive performance of female swordtails *Xiphophorus helleri* (Poeciliidae). Aquacul, 234(1-4): 381-392.
- Al-Malki AL, and Rabey HA, 2015. The antidiabetic effect of low doses of *Moringa oleifera* Lam. Seeds on streptozotocin induced diabetes and diabetic nephropathy in male rats. BioMed Research International, 2015, 381040. <https://doi.org/10.1155/2015/381040>
- Anwar F, Latif S, Ashraf M, and Gilani AH, 2007. *Moringa oleifera*: A food plant with multiple medicinal uses. Phytoth Res, 21, 17–25. <https://doi.org/10.1002/ptr.2023>
- AOAC, 1995. Official Methods of Analysis. 16th Edition, Association of Official Analytical Chemists, Washington DC.
- APHA-AWWA-WEF, 1998. Standard methods for the Examination of Water and Wastewater, 20th edn. American Public Health Association, American Water Works Association, Water Environment Federation, Washington DC.
- Bisht M, Kumar A, and Shah T, 2020. Effect of *Moringa oleifera* leaf powder on skin mucosal immune responses and growth performance of guppy, *Poecilia reticulata* (Peter, 1860). Aquacul Res, 00; 1–7.
- Bisht M, Kumar A, and Shah TK 2023. Effect of Spirulina Powder (*Arthrospira platensis*) as a Dietary Additives Ornamental Guppy, *Poecilia reticulata*: Growth Performance, Survival and Skin Colouration. Aquacul Stud, 23, AQUAST931. <http://doi.org/10.4194/AQUAST931>.
- Foidl N, Makkar HPS, and Becker K, 2001. The potential of *Moringa oleifera* for agricultural and industrial uses. In The miracle tree: the multiple attributes of *Moringa* (ed. LJ Fuglie). CTA Publication, Wageningen, The Netherlands, 45-76pp.
- Gabriel NN, 2019. Review on the progress in the role of herbal extracts in tilapia culture. Cogent Food Agric, 5:1619651. 10.1080/23311932.2019.1619651.
- Gad EM, Abd El-RAA, Shalaby AM, and Metwally SM, 2019. Biochemical changes of *Moringa* seeds extracts on Nile Tilapia breeding fish. Egypt J Aquacul, 9: 77–95.
- Gatlin DM, Barrows FT, Brown P, Dabrowski K, Gaylord TG, Hardy RW, Herman E, Hu G, Krogdahl

- A, Nelson R and Overturf K, 2007. Expanding the utilization of sustainable plant products in aquafeeds: a review. *Aquacul Res*, 38(6): 551-579.
- Ghosh S, Sinha A, Sahu C, 2007. Effect of probiotic on reproductive 18-526.methods by GC/MS. *Afri J Trad Complem Altern Medic*, 11(2):277-279.
- Giiroy B, Izzet S, Serhan M and Selin K, 2012. Spirulina as a natural carotenoid source on growth, pigmentation and reproductive performance of yellow tail cichlid *Pseudotropheus acei*, *Aquacult Int*, 20(5): 869–878.
- Gomez KA and Gomez AA, 1984. Statistical procedures for agricultural research (2nd ed., p. 680). New York: Wiley.
- Hardy RW and Tacon AG, 2002. Fish meal: historical uses, production trends and future outlook for sustainable supplies. *Resp Marine Aquacult*, 311-325.
- IFFO (International Fishmeal and Fish Oil Organization), 2008. IFFO Update No. 187 IFFO (International Fishmeal and Fish Oil Organization) February 2008. 11 pp.
- Jackson AJ, 2006. The importance of fishmeal and fish oil in aquaculture diets. *Interna Aquafeed*, 9(6): 18-21.
- Kaur R & Shah TK, 2017. Role of feed additives in pigmentation of ornamental fishes. *International Journal of Fisheries and Aquatic Studies*, 5: 684-686.
- Lim SJ and Lee KJ, 2009. Partial replacement of fish meal by cottonseed meal and soybean meal with iron and phytase supplementation for parrot fish *Oplegnathus fasciatus*. *Aquacult*, 290(3): 283-289.
- Makkar HPS and Becker K, 1997. Nutrients and antiquality factors in different morphological parts of the *Moringa oleifera* tree. *The J Agri Sci*, 128(03): 311-322.
- Moyo B, Masika PJ, Hugo A and Muchenje V, 2011. Nutritional characterization of Moringa (*Moringa oleifera* Lam.) leaves. *Afri J Biotech*, 10(60): 12925-12933.
- Muller-Feuga A, 2000. The role of microalgae in aquaculture: situation and trends. *J Appl Phyco*, 12(3-5): 527-534.
- Nakagawa H and Montgomery WL, 2007. Algae. In: Dietary supplements for the health and quality of cultured fish. Edited by Nakagawa, H., Sato, S. and Gatlin III. D. CABI North American Office Cambridge, MA 02139 USA, 133-168 pp.
- Oke IO, Dada AA, Saliu OR and Kuyoro EB, 2019. Dietary effects of desmodium (*Desmodium adscendens*) leaves on the reproductive indices in African catfish (*Clarias gariepinus*) broodstock. *Aquac Stud*, 19:133–7. 10.4194/2618-6381-v19_2_06
- Rani P, Immanuel S, Ananthan PS, Ojha SN, Kumar NR and Krishnan M, 2013. Export performance of Indian ornamental fish- an analysis of growth, destination and diversity. *Indian J Fish*, 60(3): 81-86.
- Richter N, Siddhuraju P and Becker K, 2003. Evaluation of nutritional quality of moringa (*Moringa oleifera* Lam.) leaves as an alternative protein source for Nile tilapia (*Oreochromis niloticus* L.). *Aquacult*, 217(1): 599-611.
- Sampath K and Pandian TJ, 1984. Interaction of feeding frequency and density on feed utilization in air breathing murrel, *Channa striatus*. *Proc Indian Acad Sci*, 93: 445-453.

- Sawanboonchun J, Roy WJ, Robertson DA and Bell JG, 2008. The impact of dietary supplementation with astaxanthin on egg quality in Atlantic cod broodstock (*Gadus morhua*, L.). *Aquacult*, 283(1):97-101.
- Shah T, Saini V, Ojha M and Raveender B, 2017. Effect of temperature on growth and survival of guppy (*Poecilia reticulata*). *J Exper Zool- India*, 20, 505–510.
- Sharma M, 2020. Ornamental fish rearing and breeding- a new dimension to aquaculture entrepreneurship in Himachal Pradesh. *Intern J Fisher Aqua Stud*, 8(2): 157-162.
- Shim KF, Landesman L and Lam TJ, 1989. Effect of dietary on growth, ovarian development and fecundity in the dwarf gourami *Colisa lalia* (Hamilton). *J Aquacult Tropi*, 4: 111-123.
- Tacon AG and Metian M, 2008. Global overview on the use of fish meal and fish oil in industrially compounded aquafeeds: Trends and future prospects. *Aquacult*, 285(1): 146-158.
- Ujjwala U and Avdhesh K, 2020. Effect of dietary Spirulina on the breeding behaviour of *Poecilia reticulata*. *The Phar Innova J*, 9(11): 366-368.

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