

The mean ESR values in healthy fish fed with immunostimulant mixed feed such as control, vitamin C, vitamin E, chitin, chitosan, and levamisole were found to be 0.39 ± 0.17 , 0.33 ± 0.12 , 0.27 ± 0.13 , 0.37 ± 0.14 , 0.35 ± 0.14 , and 0.33 ± 0.13 cm/hour respectively. As well as, the mean ESR in *Aeromonas* infected fish fed with immunostimulant mixed feeds such as control, vitamin C, vitamin E, chitin, chitosan, and levamisole were found to be 0.45 ± 0.14 , 0.33 ± 0.11 , 0.34 ± 0.15 , 0.43 ± 0.15 , 0.39 ± 0.17 , and 0.33 ± 1.13 cm/hour respectively.

In this study, the ESR insignificantly varies between healthy and *Aeromonas* infected fish from all the treatment groups. The *p* - values for the ESR between healthy and *Aeromonas* infected fish in the treatment groups of control, vitamin C, vitamin E, chitin, chitosan, and levamisole were measured as 0.624, 1.00, 0.552, 0.656, 0.736, and 1.00 respectively. These results demonstrated that the tested immunostimulants insignificantly increased the ESR in both healthy and *Aeromonas* infected fish when compared to the control control-fed group.

4 Discussion

Aquaculture offers a sustainable source of cost-effective and nutritious protein for humans to consume, thus enhancing human health. Regrettably, the occurrence of epidemics of diseases remains a substantial hindrance to the attainment of profitable production through technological improvement. Researchers in the aquaculture field are currently studying a number of biologically safe and environmentally acceptable substances that have the potential to regulate the immune system, enhance growth performance, and prevent diseases in fish (Mansour et al., 2021).

In addition, they serve the purpose of safeguarding aquaculture organisms against many environmental factors such as water pollution, low temperatures, and excessive population density (Refaey et al., 2022). Immunostimulants positively affect growth rate efficiency and enhance the sustainability of aquaculture (Yossa et al., 2018). Immunostimulants have significant value in maintaining fish diseases and can be beneficial in fish farming. Studies have demonstrated the immunostimulatory properties of glucan, chitin, lactoferrin, and levamisole in fish and crustaceans. Vitamin B and C, growth hormone, and prolactin are also known to have immunostimulatory effects.

Immunostimulants enhance the activity of natural killer cells, complement, lysozyme, and antibody reactions in fish. The stimulation of these immune activities is linked to the enhanced defence against infectious pathogens (Sakai, 1999). Hence, the present research aims to assess the potential impacts of different immunostimulants on the growth performance and morphometric parameters of the *Catla catla*. The growth performance of the fish in all groups of treatment was evaluated by measuring the total biomass gain (TBG), weight gain (WG), and feed conversion ratio (FCR).

The findings of this study showed that the inclusion of immunostimulant mixed feed resulted in a significant increase in overall biomass gain compared to control. Based on these findings, vitamin E has superior growth-promoting characteristics compared to the other immunostimulant diets. The research conducted by Aathi et al. (2013), supports the argument that adding chitosan mixed fish feed can enhance the proximate value of crude protein in Indian large carp, *Labeo rohita*. The observed outcomes can be attributed to the augmentation of digestive enzymes, which aid in enhancing nutrition and facilitating the absorption of nutrients in the intestines. Consequently, this leads to a rise in fish growth (Abdel-Tawwab et al., 2020).

The present study revealed a significant rise in the weight gain of fish that were fed with immunostimulant diet compared to the control group after a period of 30 days. The FCR (Feed Conversion Ratio) of all the groups that received treatment was greater than that of the control group. These results were in accordance with the observations made by Abdelkhalek et al. (2008) and Awad et al. (2013) who found that nourishing sea bream with *Nigella sativa*, or synthetic immunostimulants, over a period of 30 to 60 days led to a substantial rise in weight gain and the rate of survival.

The findings of this study correlate with the research conducted by Rozi et al. (2018) who showed that including chitosan in the diet resulted in a significant rise of 12.19 ± 3.45 g in the relative weight growth of *Oreochromis niloticus*. In another study, Sarker et al. (2023) found that the average weight gain of fish at the end of the experiment was 6.88 ± 0.046 , 8.97 ± 0.042 , 5.94 ± 0.036 , and 4.65 ± 0.051 in the treatment groups T1, T2, T3, and the