

Kresno (2001) stated that an elevated leukocyte count suggests that the fish's immune system is reacting to the existence of foreign substances in the body. An elevation in leukocyte count indicates the effectiveness of the fish's immune system in generating a cellular and immunological response as a stimulus for an immune reaction. Suprayudi et al. (2006) suggested that fish enhance their ability to survive by augmenting the quantity of leukocytes, which serve as defensive cells. Sudiono (2014) reported that administering immunostimulants orally leads to a rise in the total WBC count. This reaction suggests that immunostimulants encourage fish to enhance their immune system by raising the quantity of leukocytes, which are involved in non-specific defensive mechanisms.

In the present study, the mean total WBC count in healthy fish treated with different immunostimulant-supplemented feeds ranged from 4077 ± 0.93 to 7535 ± 1.07 cells/mm³. In *Aeromonas* infected fish, the total WBC count with different immunostimulant mixed feeds ranges from 4342 ± 0.87 to 7757 ± 1.06 cells/mm³. These results demonstrated that the activities of leukocytes have decreased against bacterial infection significantly, when they were fed with different immunostimulant mixed feeds in compared to simple infection, which signifies the immunostimulatory activity of immunostimulants.

In addition, the vitamin E mixed feeds considerably enhance the white blood cell count in both healthy and *Aeromonas*-infected fish compared to other tested immunostimulants. The current results evident with the findings of Anderson and Jeney (1992) who observed that the injection of QAC resulted in an increase in the total WBC counts. Similarly, Harikrishnan et al. (2003) observed that elevated WBC counts in *C. carpio* following administration of *Azardicha indica* extracts. Lin et al. (2011) found that koi fish given β -1,3-glucan had noticeable increased peripheral leukocyte counts. Similarly, Sahoo and Mukherjee (2001) reported considerably higher leukocyte counts in *Labeo rohita* after administering β -1,3-glucan orally.

Furthermore, Sanchez-Martinez et al. (2017) found that a feed enriched with β -1,3/1,6-glucan led to a considerable increase in the number of leukocytes in *Ictalurus punctatus*. In their study, Selvaraj et al. (2005) found that the leukocyte counts in *Cyprinus carpio* remained unchanged when they were given yeast-derived β -glucan orally or by bath therapy. Indriani et al. (2020) reported that the total number of leukocytes in treatments A and B showed a greater rise compared to treatment C after receiving an immunostimulant till day 14. The post-day test challenge revealed a reduction in the overall number of leukocytes in all treatment groups of catfish when exposed to *Aeromonas hydrophila*.

The proportion of various cell types among the white blood cells is also a significant measure since it provides insight into the activation of the leukocytes (Fernandez et al., 2002). Leucocytes in vertebrates are classified based on their physical characteristics. This categorization allows for the identification of several types of cells, including eosinophils, basophils, lymphocytes, monocytes, and neutrophils (Ellis, 1977).

Granulocytes consist of three types of cells: eosinophils, basophils, and neutrophils. Granulocytes exhibit a response when foreign substances enter the body, although they do so without specifically recognising antigens. When an invasion occurs in tissues, these cells move and eliminate foreign particles either by phagocytosis or by destroying them through a cytotoxic reaction (Fernandez et al., 2002).

Lymphocytes possess a high metabolic capacity as a result of their many organelles in the cytoplasm, including the golgi apparatus, mitochondria, ribosomes, and endoplasmic reticulum. Lymphocytes are further categorised into B lymphocytes and T lymphocytes based on their maturation locations in the bone marrow and thymus, respectively. T cells are important for cell-mediated immunity and also aid B lymphocytes, which are accountable for producing antibodies against antigens (Ronald, 2001). Lymphocytes primarily serve to generate antibodies, establish immunological memory, and release regulatory substances known as lymphokines when subjected to the humoral and cell-specific immune systems (Campbell and Murru, 1990). Macrophages are crucial to the body's defence since they play a vital role in eliminating infections. Fernandez et al. (2002) established that macrophages, the primary phagocytic cells in fish, eliminate infections by two mechanisms: the release of harmful chemicals and phagocytosis.