Scholars Academic Journal of Biosciences
Abbreviated Key Title: Sch Acad J Biosci
ISSN 2347-9515 (Print) | ISSN 2321-6883 (Online)
Journal homepage: https://saspublishers.com
NIH National Library of Medicine National Center for Biotechnology Information
NLM ID:101629416



Biosciences

# Ectoparasitic State of Nile Tilapia Fed with Feed Supplemented with Vitamins in Jean LOROUGNON GUÉDÉ University Farm (Daloa, Côte d'Ivoire)

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**DOI:** https://doi.org/10.36347/sajb.2026.v14i09.001 | **Received:** 04.07.2026 | **Accepted:** 22.08.2026 | **Published:** 02.09.2026

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**Abstract** **Original Research Article**

Faced with the unavailability and high cost of vitamins intended for farmed fish, fish farmers are forced to use vitamins intended for terrestrial animals. To address this problem, this study aims to develop a high-quality feed capable of improving the health and growth of farmed Nile tilapia. To achieve this objective, a complete randomization technique was used to randomly assign the fish to different groups. This approach ensures that each individual has the same probability of belonging to an experimental group, thus reducing bias and increasing the reliability of the results. During the experiment, three types of feed were administered to the fish. Parasitological analysis identified the presence of three ectoparasite species: *Trichodina magna*, *Trichodina compacta*, and *Cichlidogyrus* sp. The results of infestation rates, parasite prevalence, and parasite abundance analyses showed that parasite diversity is higher in fish fed Baloomax+ FishGrowth and lower in fish fed Baloomax alone. The most suitable choice for fish farmers concerned with maintaining the health and productivity of their fish stocks is Baloomax alone. This study highlights the importance of a balanced and appropriate diet to reduce the impact of parasites and improve fish performance in aquaculture, thus contributing to sustainable and profitable production.

**Keywords:** Parasite indices, Nile trevally (*Oreochromis niloticus*), Parasites, Vitamins, Côte d'Ivoire.



## INTRODUCTION

Nile tilapia is one of the world's leading aquaculture species, second only to carp. It is valued for its rapid growth, tolerance to diverse environmental conditions, economic and nutritional value, and reproductive capacity in captivity. Today, it is farmed in over 120 countries, both in Africa (its region of origin) and in Asia, the Americas, and the Middle East. By 2024, global tilapia production (mostly Nile tilapia) is estimated at approximately 7 million tons, dominated by China, Indonesia, and Egypt (FAO, 2024). Egypt is the leading African producer with over 1 million tons per year. Nile tilapia farming is a strategic activity for global food security. Thanks to its hardiness and economic value, it is considered a fish of the future for aquaculture, particularly in Africa and Asia, where it represents a vital source of animal protein and income for local populations. According to the FAO, in 2020, 56% of fish intended for human consumption came from aquaculture, the majority in freshwater in regions such as Asia (particularly China). In all fish farming activities, feed represents the main expense and plays a crucial role in growth performance; its study is therefore essential. Fish feed is a key factor for their growth, health, and reproduction. It varies according to the species, age, environment, and production method (wild or farmed). Two main contexts are distinguished: natural feeding and fish farming (artificial or supplementary feeding). However, both present several problems and constraints. Problems related to fish feed primarily concern high cost, insufficient nutritional quality, inadequate ration management, environmental impacts, and input availability. In many African countries, feeding costs represent the majority of fish farming expenditures, reaching up to 80% of production costs. This burden is exacerbated by the volatility of commodity prices such as maize and soybeans, as well as by the devaluation of local currencies, forces producers to use imported feeds that are often of lower quality and taste. It is important to emphasize the significance of micronutrients, particularly vitamins, which play a vital role in growth, health, and disease resistance. Although they do not provide energy directly, they are necessary for various biological processes. Vitamins are organic substances of low molecular weight, with no energy value, essential for growth, reproduction, and the functioning of the organism, which cannot synthesize them itself. They play a crucial role in the nutrition, health, growth, and performance of fish in aquaculture (Meddour *et al*., 2009). They influence various physiological aspects, including metabolism, the immune system, reproduction, and disease resistance (FAO, 2016). Besides the importance of vitamins for maintaining fish health and growth, it is also crucial to consider their role in resistance to infections and parasites, which pose a frequent threat to fish well-being and productivity. Parasites are organisms that live at the expense of a host, obtaining food and sometimes shelter from it. They can affect the health, growth, and survival of fish and play an important role in the aquatic ecosystem. According to Appy & Burt (1982), the spatial distribution of fish parasites is influenced by both abiotic factors such as salinity and depth, and by biotic factors related to the host, including its ethology, diet, and physiological state. Parasites can have multiple detrimental consequences for fish, both individually and at the population level. Physiologically, they cause tissue damage, metabolic disorders, and reduced growth (Adlard & Lester, 1994). From a behavioral standpoint, parasitized fish often exhibit changes in their feeding, swimming, or reproductive patterns, which can affect their survival and competitiveness in fish farms. Parasitic infestations can lead to significant economic losses related to mortality, reduced yield, and decreased final product quality (Eissa, 2010). It is within this context that the present study was conducted to develop a high-quality feed for the optimal health of farmed Nile tilapia. The study aims to:

- determine the main abiotic parameters of the water used in the experimental rearing of Nile tilapia;
- identify the vitamin supplement that provides an optimal ectoparasite status for farmed Nile tilapia.

# I. MATERIALS AND METHODS

## 1.1. Study environment

This study was conducted in West Africa, specifically in the city of Daloa, Côte d'Ivoire, located in the central-west region of the country (Figure 1). Daloa covers an area of 5,450 km². Its latitude is between 6°53' north and 6°27' west (Sangaré *et al*., 2009). The city itself covers 3,876 hectares and comprises 42 neighborhoods, with a population of 421,879 inhabitants according to the 2021 General Population and Housing Census (RGPH). The Daloa department is bordered to the north by the Vavoua department, to the south by the Issia department, to the west by the Zoukougbeu department, and to the east by the Zuénoula and Bouaflé departments. Daloa is one of the country's major cities economically, particularly due to its agricultural and commercial activities. Apart from transport and trade, the department of Daloa has enormous tourism potential.

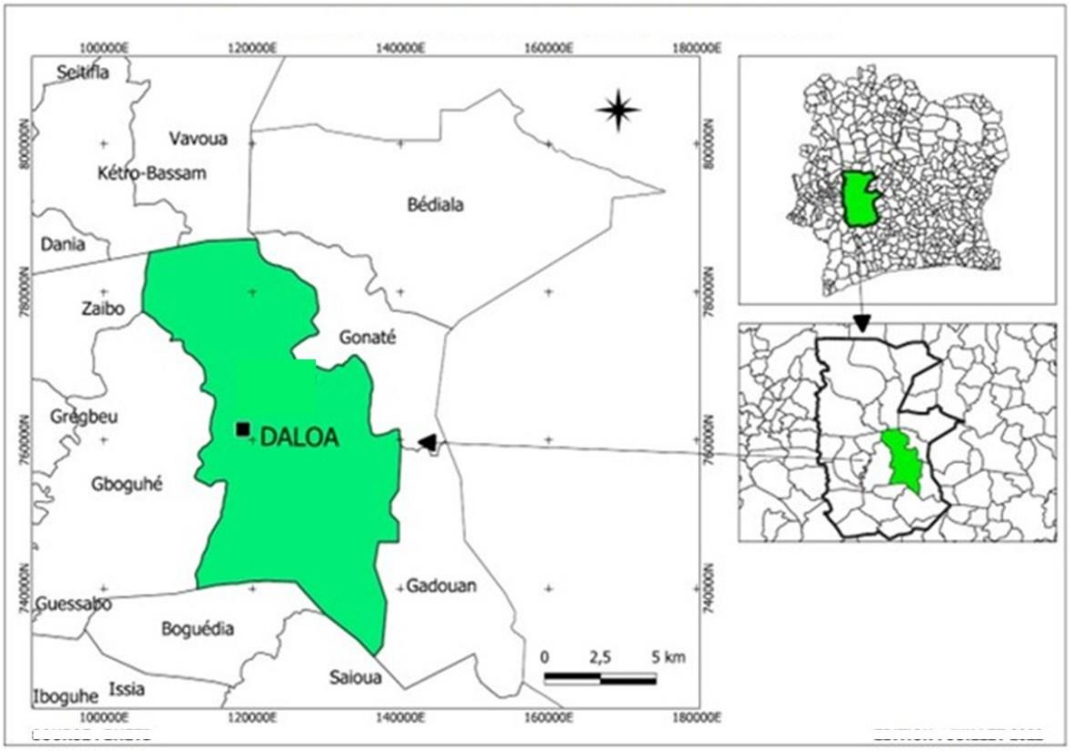


**Figure 1: Presentation of the study area**

## 1.2. Description of the experimental station

The study was conducted at the fish farm (Figure 2) of Jean LOROUGNON GUÉDÉ University, located at the university's teaching field. Data were collected over a 45-day period on *Oreochromis niloticus* fish in the first growth phase.

**Figure 2: Jean LOROUGNON GUÉDÉ University Fish Farm**

## 1.3. Determination of Abiotic Parameters

The measurement of physicochemical parameters (dissolved oxygen, pH, and temperature) was carried out in situ between 6:00 a.m. and 9:00 a.m. on each sampling batch using a multiparameter instrument to minimize the influence of photosynthetic activity. The instrument's specific probes, previously calibrated, were immersed in water, and the corresponding function was selected to display the stabilized value of the measured parameter.

## 1.4. Experimental Design

The experimental design implemented was a complete randomization design, also called simple randomization or basic randomization. This is a random assignment method in which each subject or experimental unit has an equal and independent probability of being placed in a group (treatment or control). For example, this can be achieved through a classic random draw, such as drawing a ball from an urn or tossing a coin. This method ensures that each unit has an equal chance of being assigned to a given group, but does not necessarily guarantee an exact balance of units between groups in a finite sample due to random fluctuations. Complete randomization (or a completely randomized design) is an experimental design technique in which treatments are randomly assigned to experimental units without any restrictions. This means that each experimental unit has the same probability of receiving any treatment (Gomez & Gomez, 1984). Statistical Procedures for Agricultural Research. 2nd Edition, John Wiley & Sons.

## 1.5. Treatments Applied

A premix is a concentrated blend of micronutrients (vitamins, minerals, amino acids, etc.) intended to be added to the basic feed ration. Here, Baloomax was supplemented with two vitamins: Vitaflash and Fish Growth. This supplementation was carried out according to the manufacturer's recommendations printed on the product. Since Vitaflash and Fish Growth are water-soluble vitamins, the solvent is water. In our case, mineral water was used as the solvent. To do this, we first weighed the required amount of vitamin (4g for Vitaflash and 2g for Fish Growth) and placed each in separate containers of 300ml of water. The resulting solution was then carefully wrapped in clear plastic wrap to protect it from light.

We administered three treatments, two of which were supplemented with Vitaflash and Fish Growth vitamins.

- The first treatment consisted of Baloomax plus Vitaflash solution.
- The second treatment consisted of Baloomax plus Fish Growth solution.
- The third treatment consisted of Baloomax only.

## 1.6. Parasitological Analyses

The fish were immediately observed with the naked eye to detect the possible presence of macroscopic ectoparasites (annelids, insects, and crustaceans) on the skin and in the oral cavity.

For the smear, a thin layer of biological material was spread on a microscope slide for observation.

For the mucus smear, a mucus sample was taken from the fins and body of the fish. This mucus was spread on a slide and fixed with a few drops of methanol, then allowed to dry. The slides were then placed in silver nitrate for 15 minutes and subsequently placed in a tray containing distilled water and exposed to light for 2 hours. Once the slides were removed from the sun they were observed under an optical microscope at 10 x 40 magnification (Berkani *et al.,*2017).

The dissection was performed by opening the gill cavity, separating the operculum, and then severing the dorsal and ventral attachments of each gill arch.

Using scissors, the right and left gill arches were carefully freed and then detached by making an incision on each side of the head. After their removal, each gill arch was placed in a Petri dish containing distilled water and then examined under a binocular microscope. This method allows for the analysis and detection of any parasitic infestations.

### 1.7. Parasite Identification

Parasite identification was performed by microscopic observation, based on their morpho-anatomical characteristics, at different magnification levels (10x, 40x, 100x) using the identification keys established by Paprena (1982) and Beghora & Chaibi (2014).

### 1.8. Determination of Parasite Indices

Parasite prevalence is the ratio of the number of hosts infested by a given parasite species [NPI] to the number examined [NPE]. It is expressed as a percentage:

**$Pr = NPI / NPE \times 100$ (1)**

The classification adopted is that of (Beghora, 2014):
"Dominant species" (prevalence > 50%);
"Satellite species" (prevalence ≤ 50%);
"Rare species" (prevalence < 10%).

The average infestation intensity is a parasitological indicator that expresses the average number of parasites per host. In practice, the total number of parasites identified (n) is divided by the number of infested hosts (N).

**$I = n / N$ (2)**

The classification adopted is that of (Beghora, 2014):
$Im < 10$: very low average intensity;
$10 < Im < 50$: low average intensity;
$50 < Im < 100$: medium intensity;
$Im > 100$: high average intensity

The condition factor K is a biological indicator used to assess the health, body size, or well-being of a fish.

**$K = W/L^3 \times 100$ (3)**
W = Weight of the fish (in grams)
L = Total length of the fish (in centimeters)
100 = Conversion factor to make K easier to read

### 1.9. Statistical Analysis

The data from the various measurements were entered into an Excel 2016 spreadsheet, which was used to create the various graphs. The Kruskal-Wallis test was used to compare prevalences and intensities in the different groups to assess significance. These analyses were performed using R software (version 4.1.3), and the results were considered significant at a 95% confidence level ($p < 0.05$).

## II. RESULTS

### 2.1. Physicochemical Characteristics of the Fish Farming Water

Figure 3 shows the values of temperature, pH and dissolved oxygen of the waters of the fish pond of the Jean LOROUGNON GUÉDÉ University.

The water temperature values range from 23.3 to 29.3 °C. The minimum value was recorded in June, while the maximum was obtained in August. The recorded temperature values did not differ significantly between June and August (Kruskal-Wallis test, $p > 0.05$).

The pH values of the water ranged from 6.6 to 7.8. The minimum and maximum values were recorded in June. The pH values did not differ significantly between June and August (Kruskal-Wallis test, $p > 0.05$). The dissolved oxygen levels ranged from 4.2 to 6.3 mg/L. The minimum value was recorded in June, while the maximum was obtained in August. The dissolved oxygen levels did not differ significantly between June and August (Kruskal-Wallis test, $p > 0.05$).

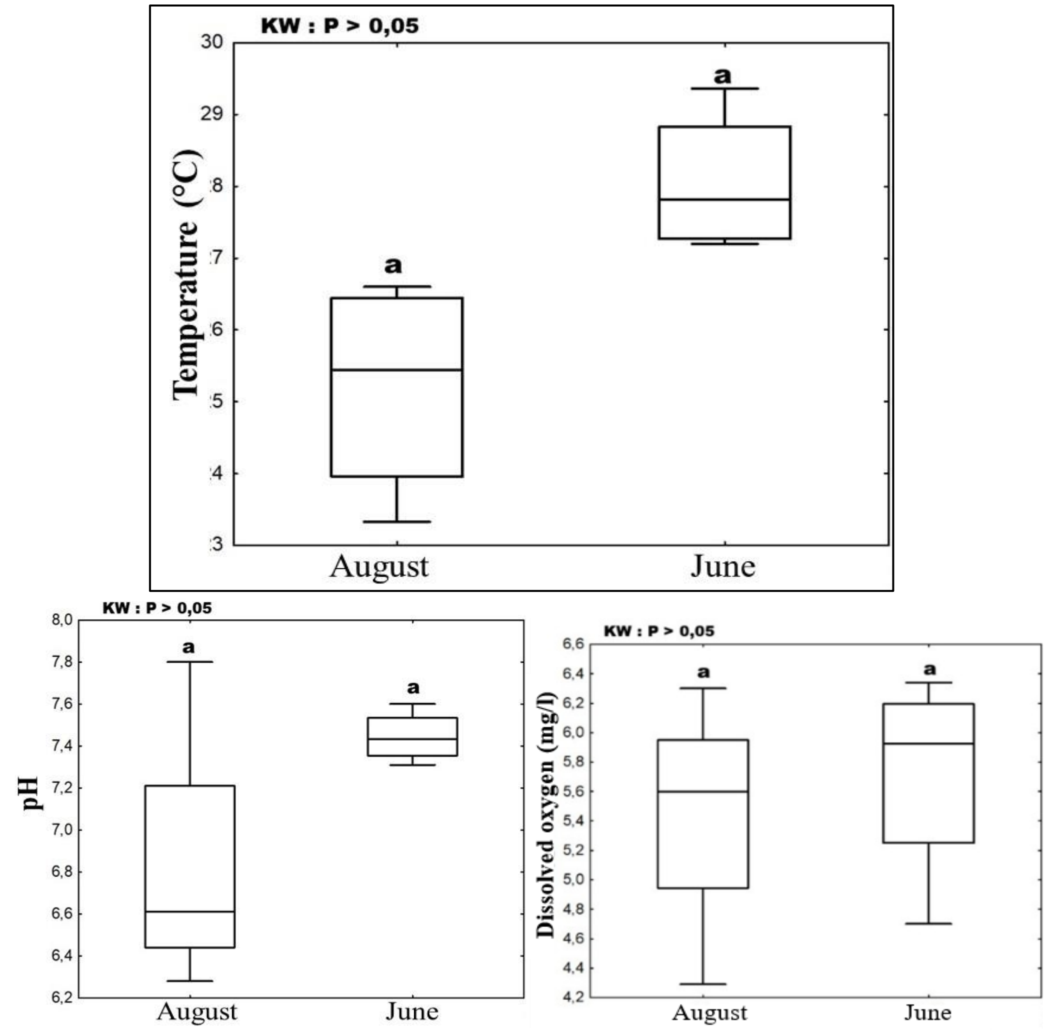


**Figure 3: Temperature, pH and dissolved oxygen values of the waters of the fish pond at the Jean LOROUGNON GUÉDÉ University**

### 2.2. Ectoparasitic Status of Nile Tilapia

#### 2.2.1. Parasite Diversity

Table I presents the parasite diversity and infested organs of fish collected from the fish farm at the Jean LOROUGNON GUÉDÉ University of Daloa. In this study, three parasite species were identified. These species belong to two genera and two families. The collected species are *Trichodina magna*, *Trichodina compacta*, and *Cichlidogyrus* sp. Overall, two species are common to fish fed Baloomax only, Baloomax + fishgrowth, and Baloomax + vitaflash. These are *Trichodina magna* and *Cichlidogyrus* sp. Fish fed vitaflash are parasitized by the greatest number of species (3), while the fewest (2) are recorded by fish fed Baloomax only and Baloomax + vitaflash.

Regarding the infested organ, the gills and the body of the fish each harbor three species of parasites, one of which is common to both attachment sites (*Trichodina magna*). *Trichodina compacta* is found only on the skin and fins, while *Cichlidogyrus* sp. is also found on the gills.

**Table 1: Parasite Diversity and Infested Organs**

| Species | Types of fish | | | Infested organs | |
|---|---|---|---|---|---|
| | Fish fed with Baloomax | Fish fed with Baloomax + Vitaflash | Fish fed with Baloomaxs + Fish growth | Skin and fins | Gills |
| *Trichodina magna* | ** | ** | ** | ** | * |
| *Trichodina compacta* | - | * | - | * | - |
| *Cichlidogyrus* sp. | *** | *** | *** | - | *** |

** = accessory species; *** = constant species; * = accidental species; - = absence

#### 2.2.2. Parasite Indices

#### 2.2.3. Parasite prevalence

The prevalence of infestation according to the type of feed for *Oreochromis niloticus* specimens examined at the Jean LOROUGNON GUÉDÉ University fish farm is shown in Figure 4.

Parasite prevalence ranged from 37.5% to 72.5%. The lowest prevalence was recorded for fish fed Baloomax. Conversely, the highest prevalence was recorded for fish fed Baloomax + Fishgrowth. The chi-square test performed on the parasite prevalence of the two types of fish showed no significant difference ($p > 0.05$).

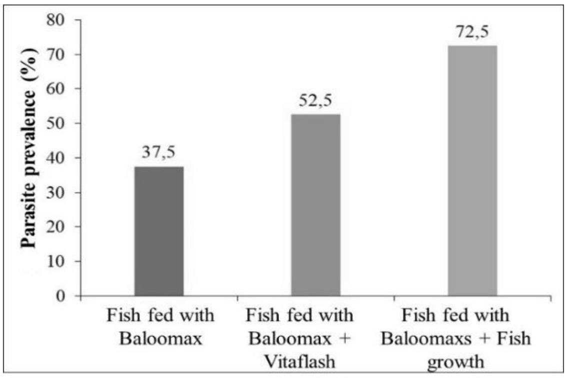


**Figure 4: Infestation Prevalence According to Feed Type**

**2.2.3.1.Parasite Intensity**

The parasite infestation intensity according to the type of feed for the *Oreochromis niloticus* specimens examined at the Jean LOROUGNON GUÉDÉ University fish farm is illustrated in Figure 5.

Parasite intensity ranged from 0.73 to 1.14. The lowest value for this intensity was observed in fish fed Baloomax. Conversely, the highest value for this parameter was recorded in fish fed Baloomax + fishgrowth. The chi-square test performed on the parasite prevalence of the two fish types showed no significant difference ($p > 0.05$).

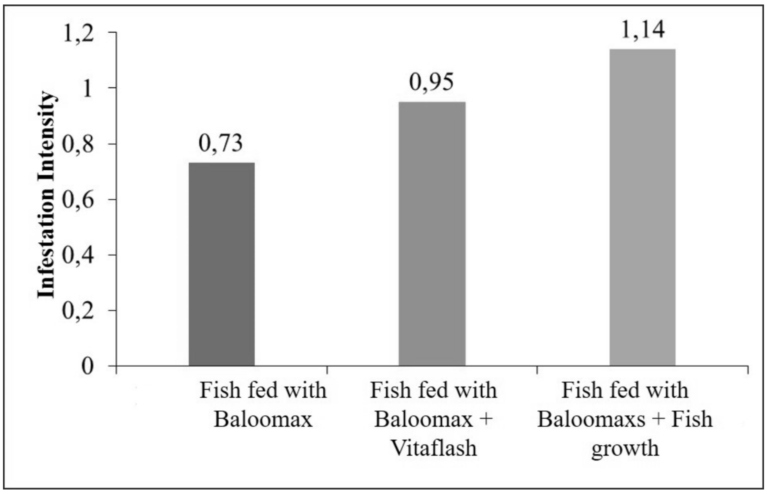


**Figure 5: Infestation Intensity According to Feed Type**

**2.2.3.2. Parasite Abundance**

The parasite abundance according to feed type class of *Oreochromis niloticus* specimens examined at the Jean LOROUGNON GUÉDÉ University fish farm is illustrated in Figure 6.

Parasite abundance ranged from 0.28 to 0.83. The lowest value for this abundance was recorded for fish fed Baloomax. Conversely, the highest value for this parameter was recorded for fish fed Baloomax + Fishgrowth. The Chi-square test performed on the parasite abundances of the two fish types showed no significant difference ($p > 0.05$).

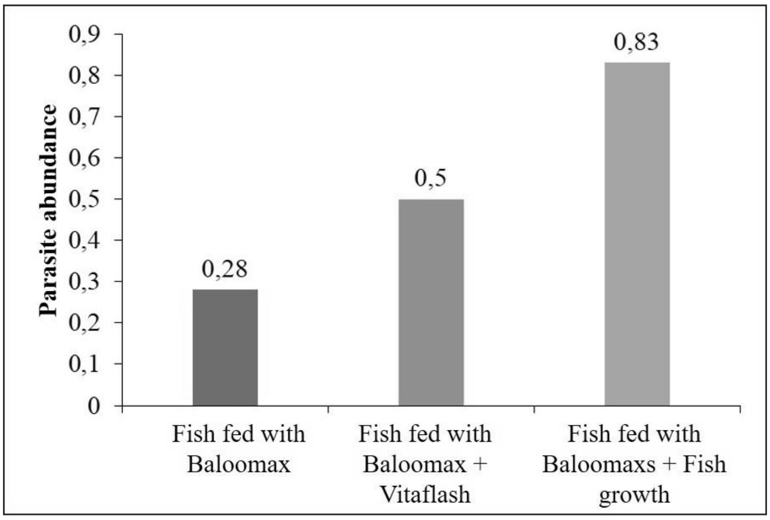


**Figure 6: Parasite Abundance According to Feed Type**

## III. DISCUSSION

The water temperature of the fishpond at Jean LOROUGNON GUÉDÉ University varied between 23.3 and 29.3 °C, with a minimum in June and a maximum in July. These values fall within the optimal range for the development of aquatic organisms, particularly tropical fish. Similar results were reported by Yao & Koffi (2018) in the fishponds of Koumassi (Abidjan, Côte d'Ivoire), where temperatures varied between 24 and 30 °C, reflecting a strong influence of local climatic conditions. Similarly, Ahouansou *et al.,*(2013) observed values between 22 and 30 °C in Lake Nokoué in Benin, confirming that the temperatures recorded in the studied pond correspond to trends observed in water bodies in the tropical region.

The water's pH, ranging from 6.6 to 7.8, indicates generally neutral water, with little variation between sampling months. Similar values were recorded by Konan *et al.,*(2017) in the fish ponds of Bouaké (Côte d'Ivoire), where the pH ranged from 6.5 to 7.5, which remains favorable for fish production. Furthermore, Kouamé *et al.,*(2011) reported pH values ranging from 6.2 to 7.9 in the lakes of Yamoussoukro, which corresponds to the results of the present study. These results show that the acid-base balance of the fishpond at Jean LOROUGNON GUÉDÉ University is comparable to that observed in other aquatic ecosystems in the region.

Dissolved oxygen levels ranged from 4.2 to 6.3 mg/L, indicating moderate concentrations sufficient to maintain fish life, although below the optimal values for some sensitive species. Similar observations were reported by Atse *et al.,*(2009) in the Grand-Lahou lagoons (Côte d'Ivoire), where dissolved oxygen ranged from 3.5 to 6.8 mg/L. In fishponds in central Cameroon, Oumou *et al.,*(2015) also recorded values between 4 and 7 mg/L, confirming that the variations observed in Daloa are characteristic of tropical ponds subject to seasonal climatic fluctuations.

The study conducted at the Jean LOROUGNON GUÉDÉ University fish farm in Daloa revealed the presence of three parasite species belonging to two genera and two families: Trichodina magna, *Trichodina compacta*, and *Cichlidogyrus* sp. The recorded species diversity is relatively low, which aligns with the observations of Tombi and Bilong Bilong (2004) who, in fish ponds in Yaoundé, Cameroon, identified primarily monogeneans and ciliates in *Oreochromis niloticus*. Similarly, Akoll *et al.,*(2011) in Uganda highlighted the predominance of the genera *Trichodina* and *Cichlidogyrus* in aquaculture systems, due to the close proximity of the fish and the culture conditions.

The results show that two species, *Trichodina magna* and *Cichlidogyrus* sp., are common to fish fed Baloomax, Baloomax + Fishgrowth, and Baloomax + Vitaflash. This broad distribution of generalist parasites is similar to that described by Douëllou (1993) in Zimbabwean lakes, where trichodinids and monogeneans colonized multiple organs regardless of diet. These observations also corroborate those of Paperna (1996) in Israel, who showed that broad-host-spectrum parasites are often less influenced by dietary variations than by density and environmental conditions.

The presence of three parasite species in fish fed Vitaflash, compared to only two in those receiving Baloomax and Baloomax + Vitaflash, suggests a potential influence of feed type on parasite susceptibility. A similar trend was observed by Omoniyi and Agbon (2008) in ponds in Nigeria, where protein-rich artificial feeding increased the parasite load of tilapia, probably due to an indirect effect on host physiology and water quality.

Organ infestation revealed that the gills and skin harbored all identified parasite species, with Trichodina magna present at both attachment sites. This finding is consistent with the work of Madanire-Moyo and Barson

(2010) in the Mazowe River in Zimbabwe, which indicated that ciliates of the genus *Trichodina* preferentially colonize the skin and gills of fish due to their direct role in exchanges with the aquatic environment. In contrast, *Cichlidogyrus* sp. was found exclusively on the gills, which corresponds to the results of Tombi and Bilong Bilong (2004) in Cameroonian ponds, showing that monogeneans are highly specialized to gill tissues.

Regarding parasite prevalence according to diet, it varied from 37.5% to 72.5%, with the lowest value recorded in fish fed Baloomax and the highest in those fed Baloomax + Fishgrowth. Although the Chi-square test did not show a significant difference, this trend is consistent with the observations of Akoll *et al.,*(2012) in Lake Victoria (Uganda), where tilapia fed supplements exhibited higher levels of infestation, likely due to increased parasite density resulting from intensive farming conditions.

Parasite infestation intensity, as a function of feed type, ranged from 0.73 to 1.14. The lowest value was observed in fish fed Baloomax, while the highest was recorded with Baloomax + Fishgrowth. Although the chi-square test did not reveal a significant difference ($p > 0.05$), this trend is consistent with the observations of Akoll *et al.,*(2011) in fish farms in Uganda, who showed that high-protein diets can indirectly influence parasite load by altering water quality and fish immunity. Furthermore, Omoniyi and Agbon (2008), in ponds in Nigeria, reported that enriched feeds sometimes promote higher parasite intensity due to higher fish density and increased organic matter available to parasites.

Parasite abundance varied from 0.28 to 0.83 according to feed type class. The lowest value was recorded in fish fed Baloomax, while the highest was observed in those fed Baloomax + Fishgrowth. Although the difference was not statistically significant ($p > 0.05$), this trend indicates that nutritional intake influences parasite abundance. Similar results were reported by Akoll *et al.,*(2011) in Uganda, where tilapia fed more complete diets exhibited increased parasite abundance, attributed to high population density and greater resource availability for parasites. Omoniyi and Agbon (2008), in Nigerian ponds, also showed that protein-rich feeds indirectly promote higher parasite abundance by altering host physiology and water quality.

## CONCLUSION

The study conducted in the fishpond at Jean LOROUGNON GUÉDÉ University showed that the physicochemical parameters of the water, particularly temperature, pH, and dissolved oxygen, are generally within ranges favorable to fish production, despite moderate oxygen levels.

The differences in abiotic parameter values recorded for the various groups of fish tested cannot, therefore, influence the parasite index values obtained based on the type of feed given to the fish.

Regarding parasites, three species of ectoparasites were identified (*Trichodina magna*, *Trichodina compacta*, and *Cichlidogyrus* sp.), indicating relatively low overall diversity. The parasite index results showed that parasite diversity is lower in fish fed with the standard Baloomax feed (control). Looking ahead, these trials should be extended to other phases of Nile tilapia farming in order to complete the cycle.

## ACKNOWLEDGMENT

The authors express sincere thanks to the head of Laboratory of Biodiversity and Tropical Ecology, Jean LOROUGNON GUÉDÉ University for the facilities provided to carry out this research work.

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