Asian Journal of Fisheries and Aquatic Research

4(2): 1-9, 2019; Article no.AJFAR.50777

Alternations in Enzyme Activities of *Clarias gariepinus* Infected with *Aeromonas hydrophila* and *Pseudomonas aeruginosa*

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJFAR/2019/v4i230053
Editor(s):
(1) Dr. Luis Enrique Ibarra Morales, Research Professor, Faculty of International Trade, State University of Sonora, Sonora, Mexico.
Reviewers:
(1) Mwajar Ngeiywa, University of Eldoret, Kenya.
(2) Mamoud Mansaray, Njala University, Sierra Leone.
Complete Peer review History: http://www.sdiarticle3.com/review-history/50777

Original Research Article

Received 15 June 2019
Accepted 20 August 2019
Published 31 August 2019

ABSTRACT

Clarias gariepinus were infected with *Aeromonas hydrophila* and *Pseudomonas aeruginosa*, and blood samples were collected weekly for biochemical analysis to analyse their enzyme activities and pathogenesis for four weeks. The enzymes includes: aspartate aminotransferase (AST), alkaline phosphastase (ALP), acid phosphastase (ACP) and lactate – dehydrogenase (LDH). The fish were distributed in three different groups in triplicates as: control (C_1 C_2 C_3), *A. hydrophila* (A_1, A_2, A_3) and *P. aeruginosa* (P_1, P_2, P_3). After two weeks of acclimatization, A_1 – A_3 were injected with 1.5 ml of 10^6 cfu/ml of *A. hydrophila*, P_1-P_3 were injected with 1.5 ml of 10^6 cfu/ml of *P. aeruginosa*, while C_1-C_3 were pathogen free. At the end of the experiment, it was observed that there was a constant increase, in the enzyme activities of the infected fish, indicating increase in virulence with respect to weeks of exposure but *P. aeruginosa* had higher pathogenicity compared to *A. hydrophila*.

Keywords: P. aeruginosa; A. hydrophila; enzyme; virulence; pathogenicity.

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1. INTRODUCTION

Aquaculture remains the fastest growing food industry in the world [1], because of the high demand for protein by man and other animals. The importance of aquaculture by man can never be over emphasized. The high demand for aquacultural products has led to employment opportunities in both developed and developing societies [2]. Water is an essential factor in aquaculture, because the physcio-chemical parameters of the aquatic environment determines the success of aquaculture in that environment. The source of water for the practice of aquaculture plays a key role and the biological or industrial activities in the area of practice affects the water quality [3,4].

Aquacultural products such as fish are open to a wide range of bacterial pathogens [5], which have the capacity to cause diseases. These pathogens can only cause infections, disease and death if the fish is immunosuppressive as a result of nutritional imbalance or stress, arising from ill practice [6].

Diseases are the major causes of mortality in aquaculture. Of all the disease causing micro organisms, *Pseudomonas aeruginosa* and *Aeromonas hydrophila* are known to cause high mortality in farms, with common symptoms such as skin ulcers, fin rot, haemorrhages, absess etc. [7,8]. The presence of these organisms in farms have led to severe economic loses and reduction in productivity [9]. Their effects are mostly in fish organs, immune system and blood parameters [10,11]. Though the type of feed administered to fish promotes the growth and survival of some micro organisms in the fish environment [12], with good pond management and farm practice, the rate of disease occurrence and economic loses in aquaculture can be drastically reduced.

This research is not only focused on the effect of the pathogens on the fish, but also on the pathogenesis/pathogenecity.

2. MATERIALS AND METHODS

2.1 Fish

A total of 90 (ninety) *Clarias gariepinus* weighing between 110 – 120 g were purchased from IDI-ONYANA farm along Ahoada – Abua Road in Rivers State, Nigeria. They were transported to the project site in Port Harcourt by the use of anaeshetics. They were acclimatized for two weeks (14 days) to ascertain their health status.

2.2 Feeding and Experimental Set-up

Feeding with commercial feeds (coppens) started twenty four (24) hours after stocking. After two weeks of feeding, ten (10) fish per tank were randomly distributed for *A. hydrophila, P. aeruginosa* infections, and control in triplicate (A_1, A_2, A_3 and P_1, P_2, P_3. and C_1, C_2, C_3).

2.3 Bacterial Challenge

The bacterial pathogens were purchased from the National Veterinary Research Institute, Vom, in Jos, Plateau State in Nigeria. 1.5 ml of 10^6 cfu/ml of an overnight grown bacterial pathogen was injected intraperitoneally into the fish in each tank accordingly, using 2 ml injection syringe, but the control was not injected with pathogen.

Feeding continued after the bacterial challenge for four weeks, while observations were made on the fish.

2.4 Biochemical Test for Enzymes

At the end of each week, blood samples were randomly collected from the fish in each tank via caudal venous puncture method, using 5 ml injection syringe. The collected blood samples were transferred into LITHUM HEPARIN tube and sent to the laboratory for biochemical analysis within twelve (12) hours. They were assayed for aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), acid phosphatase (ACP) and lactate-dehydrogenase (LDH). This was done by the use of “Evolution 3000 machine” an auto-analyzer, the screen master model, manufactured by Biochemical system. It was used according to manufacturers instructions.

2.5 Statistical Analysis

One way analysis of variance (ANOVA) was used to analyse the results, while Durcan multiple range test was used to evaluate differences between treatments.

3. RESULTS

No mortality was recorded at the end of the experiment. Physical Examination of the fish showed serious ulceration on the fish’s skin between the first and the second week of the *A. hydrophila* infected fish (Fig. 1), but recovery

process started from the third week. The fish infected with *P. aeruginosa* had red blood patches on the skin and reduction in weight progressed to the end of the experiment (Fig. 2).

There were significant differences in all the enzymes activities of the experimental fish compared to the control in all the weeks (Tables 1-4).

Enzyme activities were constant in the control groups, but they were increased as the period of infection of the bacteria increased, though at different rates in the infected fish.

Fig. 1. Physical diseases signs shown on fish infected with *A. hydrophila,* at the end of the second week

Fig. 2. Physical diseases signs shown on fish infected with *P. aeruginosa* at the end of the second week

Table 1. Changes in enzymes activities in *C. gariepinus* challenged with *Aeromonas* and *Pseudomonas Spp* bacteria in the first week of exposure

Enzymes (µ/l)	Control fish	*Aeromonas* challenged fish	*Pseudomonas* challenged fish
AST	84.56±4.16[a]	110.00±2.00[b]	107.33±13.61[b]
ALT	9.00±2.00[a]	15.66±3.21[b]	26.33±3.05[c]
ALP	7.66±4.16[a]	19.35±1.52[b]	38.66 ± 6.65[c]
ACP	62.00 ± 12.16[a]	75.35 ± 5.68[b]	85.35±7.25[c]
LDH	220.61± 12.16[a]	269.71± 16.50[b]	295.71± 15.86[c]

Means within the same row with different superscripts are significantly different (P<0.05)

Table 2. Changes in enzymes activities in *C. gariepinus* challenged with *Aeromonas* and *Pseudomonas Spp* bacteria in the second week of exposure

Enzymes (µ/l)	Control Fish	*Aeromonas* challenged fish	*Pseudomonas* challenged fish
AST	86.33±3.78[a]	121.17±8.08[b]	130.15±15.27[b]
ALT	9.66±2.18[a]	25.00±4.00[b]	31.67± 4.16[c]
ALP	8.00±3.26[a]	30.66±5.13[b]	48.68 ± 8.07[c]
ACP	63.60 ± 16.09[a]	85.66 ± 11.13[b]	104.00±11.11[c]
LDH	221.61± 28.18[a]	299.11± 12.41[b]	327.19± 13.54[c]

Means within the same row with different superscripts are significantly different (P<0.05)

Table 3. Changes in enzymes activities in *C. gariepinus* challenged with *Aeromonas* and *Pseudomonas Spp* bacteria in the third week of exposure

Enzymes (µ/l)	Control Fish	*Aeromonas* challenged fish	*Pseudomonas* challenged fish
AST	87.66±2.51[a]	131.67±5.16[b]	143.33±3.78[b]
ALT	10.06±2.51[a]	30.00±2.64[b]	40.66± 1.52[c]
ALP	9.66±3.21[a]	37.33±8.62[b]	65.67 ± 2.51[c]
ACP	63.01 ± 18.12[a]	92.68 ± 17.00[b]	119.00±17.32[c]
LDH	221.67± 28.96[a]	335.00± 51.91[b]	376.00± 10.04[c]

Means within the same row with different superscripts are significantly different (P<0.05)

Table 4. Changes in enzymes activities in *C. gariepinus* challenged with *Aeromonas* and *Pseudomonas Spp* bacteria in the fourth week of exposure

Enzymes (µ/l)	Control Fish	*Aeromonas* challenged fish	*Pseudomonas* challenged fish
AST	88.33±3.78[a]	142.00±6.00[b]	160.33±4.16[b]
ALT	11.00±3.60[a]	38.33±3.05[b]	64.33± 6.42[c]
ALP	10.00±2.64[a]	41.33±8.02[b]	77.33 ± 7.66[c]
ACP	62.66 ± 12.22[a]	104. ± 14.74[b]	148.00±16.82[c]
LDH	222.71± 37.23[a]	366.78± 29.67[b]	446.14± 42.01[c]

Means within the same row with different superscripts are significantly different (P<0.05)

The pathogenecity of the bacteria in all the treated fish is shown in Figs. 3-7. It indicates the rate of virulence of the bacteria on the infected fish.

4. DISCUSSION

Physical observation of the fish infected with *Pseudomonas aeruginosa and Aeromonas hydrophila* showed severe hemorrhage and ulceration on the skin and fins of the fish, this is in agreement with previous results and reports [13,7], it also confirmed the findings of [14], who reported skin hemorrhage, deep ulcers and fin rot, when Nile tilapia was infected with *A. hydrophila.* Fish exhibits non-specific responses to checkmate disturbances or stress and maintain physiological balance [15].

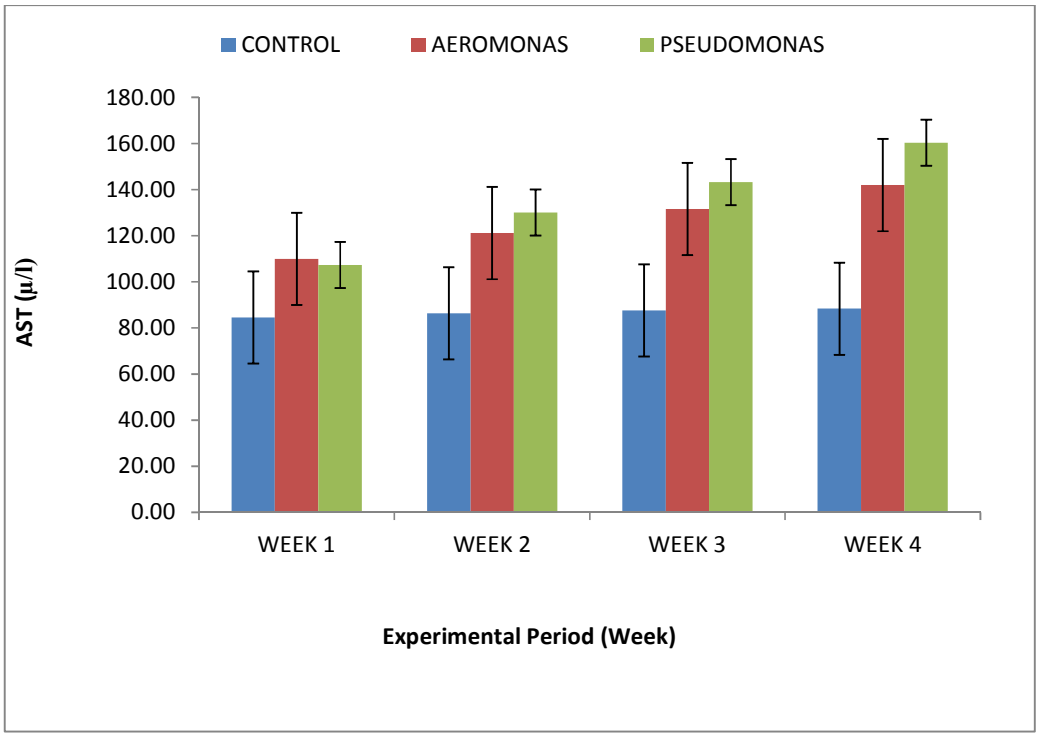

Fig. 3. Comparative AST activities in the plasma of *C. gariepinus* challenged with two species of bacteria

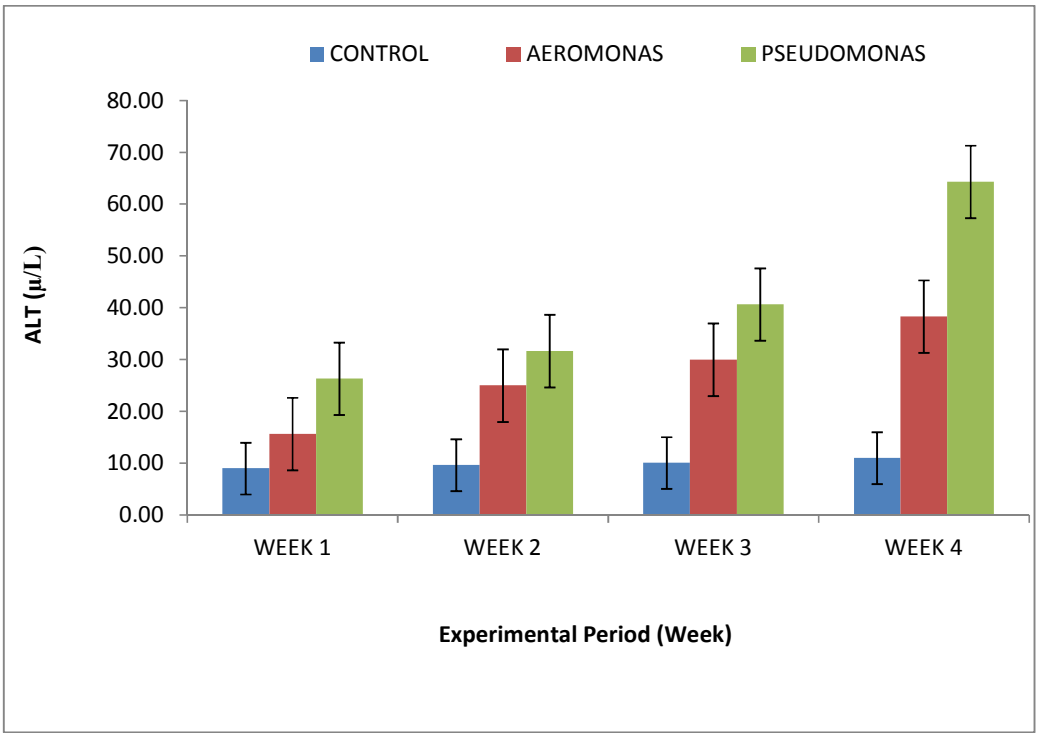

Fig. 4. Comparative ALT activities in the plasma of *C. gariepinus* challenged with two species of bacteria

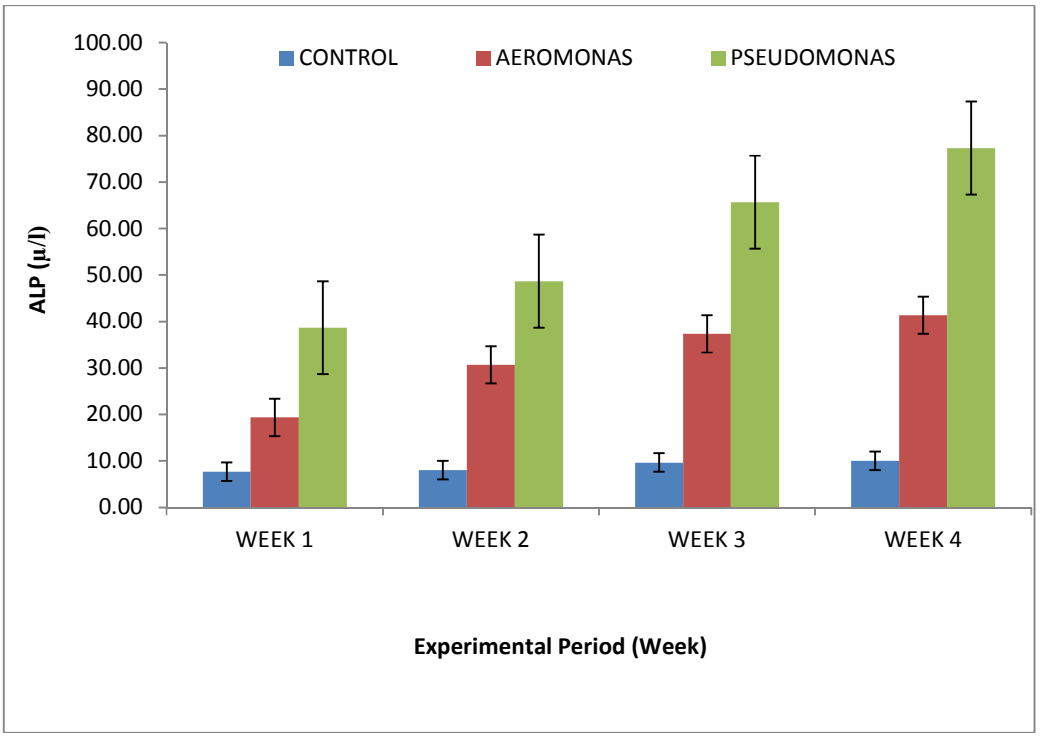

Fig. 5. Comparative ALP activities in the PLASMA of *C. gariepinus* challenged with two species of bacteria

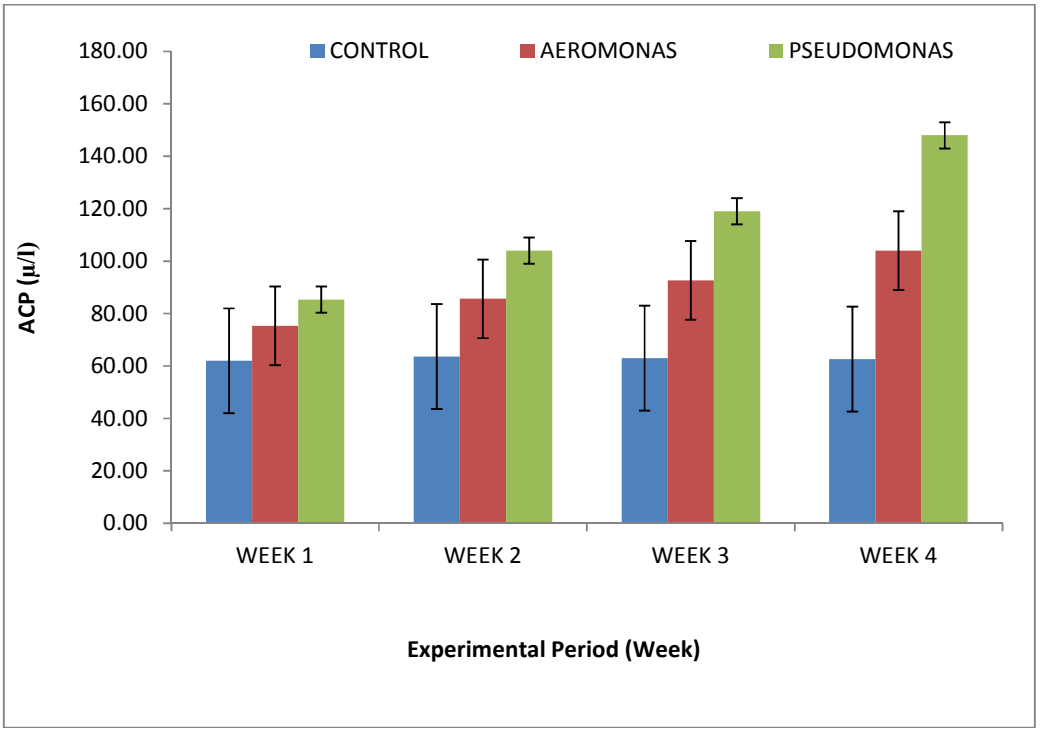

Fig. 6. Comparative ACP activities in the plasma of *C. gariepinus* challenged with two species of bacteria

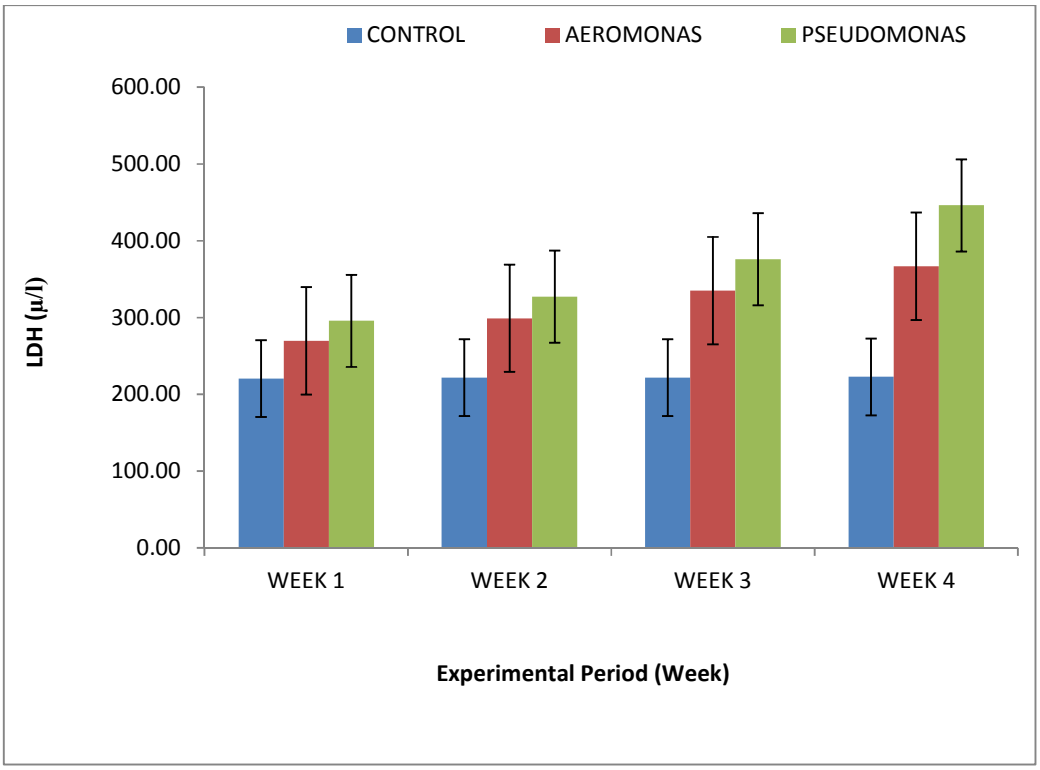

Fig. 7. Comparative LDH activities in the plasma of *C. gariepinus* challenged with two species of bacteria

But the fish's health is usually affected negatively, if the said stress is sustained. Some of these stress caused by contaminants, pollutants, pathogens etc can be detected in the blood, by analyzing some of its components for disease conditions and metabolic alterations in the fish [16]. AST, ALT, ACP and ALP are known to be biomarkers in assessing the level of damage to body organs and health status of animals [17,18]. Some of the conditions that leads to the increase in the LDH of animals includes pulmonary infarction, hypatic dysfunction, haemolysis and myopathy [19]. The increase in LDH values is also an indication of acute cell damage that leads to its presence in the blood [20].

The increase in the AST, ALT, ALP, ACP and LDH activities in the A. *hydrophilla* and *P. aeruginosa* infected fish, compared to the control indicates that the effects of the pathogens on the infected fishes stimulated the activities of AST and ALT enzymes. This may be due to hepatic cells injury or increased synthesis of the enzymes by the liver, [21]. Aspartate aminotransferase catalyzes the reversible transfer of a L-amino group between aspartate and glutamate thereby making it an important enzyme in amino acid metabolism. AST is found in the liver, heart, skeletal muscle, kidneys, brain, and red blood cells. Serum AST level, serum ALT level, and their ratio (AST/ALT) are commonly measured clinically, as biomarkers for liver health. Alanine aminotransferase is found in plasma and in various bodily tissues, but is most commonly associated with the liver. It catalyzes the transfer of an amino group from L-alanine to α-Ketoglutarate, the products of this reversible transamination reaction being pyriuvate and L-glutamate. Elevated levels of ALT often suggest the existence of other medical problems such as viral hepatitis, diabetes, liver damage, bile duct problems, congestive heart failure, infectious mononucleosis or myopathy [22], and the results of this work with elevated level of ALT in the fish infected with the pathogens suggests that there is organ damage in the infected fish.

Acid phosphatase is an enzyme that acts to liberate phosphate under acidic conditions and is made in the liver, spleen, bone marrow and prostate gland. Elevations are usually due to infections, injury or cancer of the prostate. The increase observed here is as a result of the effect

of the pathogens (*A. hydrophilla and P. aeroginosa*).

Damaged or injurious fishes release more LDH into the blood stream. It is increased in liver disease, heart attack, anaemia, trauma, bone fracture, cancer and infections such as meningitis and encephalitis [23]. The LDH enzyme catalyzes the conversion of lactate to pyriuvate. This is an important step in energy production in cells, heart, kidneys, liver and muscle. It is increased when cells are damaged or destroyed in lymphoma, leukaemia, testicular or ovanian cells, and also in non cancerous cells such as heart, lungs or kidney disease and high levels of LDH indicates acute or chronic cell damage [24]. The organs of the fish infected with *P. aeruginosa* and *A. hydrophilla* were damaged according to [24]. This is in disagreement with several authors concerning bacterial infection [25], who observed that the tilapia infected with *streptococcus agalactiate* did not alter the enzymes of the fish. But it is in agreement with [9], who observed that increase in enzymatic activities of the plasma was associated with organs damage in *Aguilla Anguilla* infected with *vibro anguillarum.*

The increase in the LDH, AST, ALP could be as a result of damages to the heart, liver, brain, blood cells and lungs [20]. Though both pathogens showed damaging effects on the organs of fish as revealed by the enzymatic activities in this research work, the results show that *A. hydrophila* caused the production of more AST in the first week of infection compared to *P. aeroginosa,* but the *P. aeruginosa* became more virulent from the second to the forth week of the experiment. For the other enzymes, (ALT, ALP, ACP, and LDH), the rate of increase in their production was higher in *P. aeroginosa* than *A. hydrophila* throughout the experiment.

5. CONCLUSION

P. aeroginosa and *A. hydrophila* have been observed as infectious bacteria causing diseases such as ulcers and hemorrhage in fresh water fish. This experiment showed that these bacteria increase the enzymatic activities of some plasma enzymes, which is an indication of organ damage in the fish. Though both pathogens have been confirmed to be harmful to the fish*, Pseudomonas aeruginosa* is seen in this experiment to be more virulent with higher pathogencity in *Clarias gariepinus,* when compared with *Aeromonas hydrophila*.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle3.com/review-history/50777