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THE IMPACT OF HAIRDRESSING SALON EFFLUENTS ON THE HAEMATOLOGICAL PARAMETERS OF CLARIAS GARIEPINUS

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ABSTRACT
This study evaluated the impact of hairdressing salon effluents on the haematological parameters of Clarias gariepinus, a critical species for aquaculture and ecological balance. 75 Juvenile fish were exposed to increasing concentrations (10 ml, 20 ml, 30 ml, and 40 ml per 20 L) of the effluent for one week under controlled laboratory conditions. Haematological indices, including red blood cell count (RBC), haemoglobin (Hb), packed cell volume (PCV), and white blood cell count (WBC), were monitored. The results demonstrated significant dose dependent effects. At the highest effluent concentration (40 ml), RBC levels dropped to 2.94 ± 2.17 × 10 ^{6}/µL compared to 4.49 ± 0.91 × 10 ^{6}/µL in the control after a week of exposure. Similarly, Hb levels decreased to 8.35 ± 6.30 g/dL, compared to 12.97 ± 2.60 g/dL in the control and PCV declined to 25.33 ± 17.61% compared to 37.66 ± 6.65% in the control. WBC levels showed fluctuations without a clear dose-dependent trend, with the highest count observed at 10 mL (6.68 ± 1.31 × 10^{3}/µL). Other indices such as MCV, MCH, MCHC, and differential counts showed minimal variation and were not significantly affected (P > 0.05). These changes indicate severe anaemia and impaired oxygen transport. These findings highlight the toxic effects of untreated salon effluents on freshwater ecosystems, demonstrating physiological stress and health deterioration in Clarias gariepinus. This underscores the need for effective waste management and regulatory frameworks to mitigate pollution from small-scale businesses.

KEY WORDS: *Salon, Effluents, Haematological,* Clarias Gariepinus

1.0 INTRODUCTION

Clarias gariepinus, commonly known as the African catfish, is a highly resilient and widely distributed freshwater fish species found throughout Africa and parts of Asia. It is of considerable ecological, economic, and nutritional importance in many regions, especially in areas where freshwater resources support local fisheries and aquaculture. Ecologically, *Clarias gariepinus* plays a crucial role in maintaining the balance of aquatic ecosystems by serving as both predator and prey. As a carnivorous species, it helps regulate populations of smaller fish, invertebrates, and other aquatic organisms, thus contributing to the trophic structure of freshwater systems. Its adaptability to different water conditions, including low-oxygen environments, allows it to thrive in diverse habitats, making it an important component of the biodiversity in tropical freshwater ecosystems [1].

The increasing urbanization and industrial activities in many parts of the world have led to the widespread contamination of aquatic ecosystems. Among the various pollutants, wastewater from hairdressing salons has emerged as an understudied yet significant contributor to environmental degradation, particularly in developing countries where regulatory frameworks and wastewater treatment infrastructure are often inadequate. The disposal of untreated or poorly treated salon effluent poses a significant risk to freshwater organisms, especially fish species like *Clarias gariepinus*, which are crucial both ecologically and economically in many African countries [1].

Despite the resilience of *Clarias gariepinus*, which is known for its ability to tolerate suboptimal water conditions, the introduction of toxic substances from hairdressing salon effluent can have detrimental effects on its health and survival. One of the key ways to assess the impact of environmental pollutants on fish is through haematological analysis, which examines blood parameters such as red blood cell (RBC) counts, white blood cell (WBC) counts, and haemoglobin concentration. These parameters serve as important biomarkers of physiological stress and can provide early warning signs of environmental degradation [2]. Research has shown that exposure to pollutants can significantly alter these haematological parameters, leading to compromised immune function, impaired oxygen transport, and reduced overall health in fish [3]. However, there is limited research specifically addressing the impact of hairdressing salon effluents on the haematological parameters of *Clarias gariepinus,* despite the growing prevalence of this form of pollution. Given the importance of *Clarias gariepinus* in both natural ecosystems and aquaculture, there is an urgent need to investigate the specific effects of hairdressing salon effluent on this species.

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2.0 MATERIALS AND METHODS

2.1 Test Organism

Juveniles of *Clarias gariepinus* of mean length 16.0cm ± 1.4cm and mean weight 10.0gm ± 0.4gm were procured from the Oyinpere fish farm, a private fish farm in Yenagoa, Bayelsa state. They were transported in plastic containers under cool condition to the Laboratory of the Department of Biological Sciences, Niger Delta University, Wilberforce Island, Bayelsa State. Juveniles were chosen due to the more sensitive nature of juveniles than adult for toxicity test.

2.2 Toxicant

Hair-dressing solon effluents were gotten from gifted hand salon, Amassoma, Wilberforce Island, Bayelsa state, Nigeria. The effluents were collected in ten (10) litre plastic keg, and were transported to the laboratory.

Plate 1: Shampoo for Hair Washing

2.3 Acclimatization

The fish were acclimated in big plastic basins for 7 days and fed pelleted diets at an estimated 3% body weight. Mortality during acclamation did not exceed 3% of total fish population. Therefore, the fish stock was assumed to be fit and disease free

2.4 Range Finding Test

Fish were exposed to various concentrations of the hair dressing effluent for 24 hours in order to gauge the acceptable concentration required for the sublethal definitive test. Mortality was determined for the various concentrations. The concentration that did not produce any mortality was therefore used as the maximum concentration for the sublethal definitive test.

2.5 Definitive Test (Sublethal Toxicity Test)

Five (5) fish were put in each aquaria tank containing 20 litres (L) of water. A total of fifteen (15) aquaria tanks were used for the experiment. Exposure concentration of 10ml, 20ml, 30ml and 40ml of the toxicant were added to 20 litres (L) of water in each of the aquaria tank with a control (without toxicant). Therefore, toxicant concentrations of 10ml, 20ml, 30ml and 40ml of the toxicant with a control (without toxicant) were used. The toxicant concentrations decided were measured into each plastic tank using a calibrated syringe and marked accordingly. The control tank had no toxicant added to it. Proper mixing of the toxicant with the water was insured by stirred each water tank vigorously for 5minutes with a glass rod. During the test, each tank was also steered every 12hours to ensure proper mixing and proper circulation of oxygen. The fish were fed ad-libitum twice daily. Test solution was change and reconstituted every 24hrs to ensure good water quality and remove fouling materials.

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Plate 2: *Clarias gariepinus* (test organisms) in holding aquaria (basins)

2.6 Blood Collection Technique

Blood was collected after one week from one fish at a time in each plastic basin by cardiac puncture with physical restraint using a 21gauge hypodermic needles and syringes and inserted into a previously tagged anticoagulant bottles containing potassium salt of ethylene diamine tetra-acetic acid (EDTA) for laboratory analysis. Blood was subsequently collected weekly from one fish at a time in each plastic basin for 3 consecutive weeks. A total of 75 fish were sampled in this study. Freshly collected blood samples were taken immediately to the Haematology laboratory of the Federal Medical Centre Yenagoa Bayelsa State for analysis of plasma enzymes. Analysis of all blood samples took place less than 2 hours after time of collection.

2.7 Analysis of Blood

2.7.1 Hematocrit (HCT)

The collected blood samples were taking by capillary attraction into the capillary tubes up to three-quarter of the capillary tubes. The other end of the capillary tube was sealed up with plasticine and the capillary tubes were placed in a micro hematocrit centrifuge with the sealed end outward. The samples were centrifuged at 3000rpm for 5minutes and the capillary tubes were removed and placed in the groove of a hematocrit reader for the estimation of the PCV. This was done for all samples.

2.7.2 Haemoglobin (HB) Estimation

The dilution tube of the haemometer was filled to the 10 mark with freshly prepared 0.1M HCl and the blood sample was collected from the EDTA bottle with the haemometer pipette up to the 20mm mark. The tip of the pipette was wiped clean to prevent any excess blood sample, then the 20mm blood sample inside the pipette was gently blown the into the acid in the haemometer dilution tube. The pipette was carefully sucked up and down twice to mix thoroughly and allow all the red cells to haemolyse and form the acid hematin. The mixture was allowed to stand for exactly 5 minutes and distilled water was added drop-wise, while stirring with a glass rod and the colour of the haemolysed blood was compared against that of the haemometer standard in bright diffuse day light with a sheet of white paper as background. This was done continually until the dilution colour is slightly darker than the haemometer standard, then the reading of the meniscus level (X1%) was obtained. The addition of water is continued until the dilution was slightly lighter than the

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haemometer standard. The reading of the meniscus level (X2%) was also obtained. The mean of the readings (X%) was calculated. Since 100% in the Sahli scale represents a hemoglobin concentration of 14g/100ml of blood, the mean (X%) is converted to g/100ml by simple proportion.

2.7.3 Red Blood Cell Count

The blood sample was drawn exactly to the 0.5 mark on the pipette using gentle suction on the mouthpiece. The excess blood from the outside of the pipette was wiped to avoid transfer of cells to the diluting fluid. The diluting fluid was then sucked up to the 10 marks While rotating the pipette between the thumb and the forefinger to mix the sample and diluent.The mixing is continued for about 2minutes to ensure the blood and the diluting fluid were mixed properly and the cells were evenly distributed. The pipette was then kept horizontally for another 2 to 3minutes

A clean hemocytometer cover slip was placed on the counting chamber by moistening the shoulders of the counting chamber which the cover slip rests on (these aids in keeping the cover slip stuck to the counting chamber). Then 2 to 3 drops of the undiluted fluid are discarded from the pipette and then the pipette is placed about 450 angle and the tip of the pipette is placed on the counting chamber to allow the mixture flow in-between the cover slip and the counting chamber. The cells were allowed to settle for about 3 minutes in the counting chamber and then it was viewed under the microscope with magnification of X40. The cells in five small squares were counted and the result is as follow:

Calculation:

$$\text{RBC Count} = \frac{N \times DF \times 106}{A \times D}$$

Where:

N = Number of cells counted; DF= The dilution factor (201); 106 = Converts to cells per liter; A= Area of chamber counted (0.04mm2 x 5 = 0.2mm2); D = Depth of chamber (0.1mm)

2.7.4 White Blood Cell Count

The blood sample was drawn exactly to the 0.5 mark on the pipette using gentle suction on the mouthpiece. The excess blood from the outside of the pipette was wiped to avoid transfer of cells to the diluting fluid. The diluting fluid was then sucked up to the 11 marks While rotating the pipette between the thumb and the forefinger to mix the sample and diluent. The mixing is continued for about 2minutes to ensure the blood and the diluting fluid were mixed properly and the cells were evenly distributed. The pipette was then kept horizontally for another 2 to 3minutes

A clean hemocytometer cover slip was placed on the counting chamber by moistening the shoulders of the counting chamber which the cover slip rests on (these aids in keeping the cover slip stuck to the counting chamber). Then 2 to 3 drops of the undiluted fluid are discarded from the pipette and then the pipette is placed about 450 angle and the tip of the pipette is placed on the counting chamber to allow the mixture flow in-between the cover slip and the counting chamber. The cells were allowed to settle for about 3 minutes in the counting chamber and then it was viewed under the microscope with magnification of X10. The cells in four large squares were counted and the result is as follows:

Calculation:

$$\text{WBC Count} = \frac{N \times DF \times 106}{A \times D}$$

Where:

N = Number of cells counted; DF= The dilution factor (20); 106 = Converts to cells per liter A= Area of chamber counted (1mm2 x 5 =5 mm2); D = Depth of chamber (0.1mm)

2.7.5 White Blood Cell Differential Count

A small drop of the blood sample was placed at one end of a clean and dry microscope slide and was gently spread the drop of blood towards the other end of the slide. The procedure was done without pressing the slides together, as this would damage the cells. The blood sample was dried by waving it repeatedly in the air. The slide was viewed under low power microscope to ensure that the blood cells were evenly spread. Then the film was stained with Leishman's satin and then left for about 2minutes. Buffered distilled water was added via a pipette (twice the volume of stain). The slide was rocked gently several times for proper mixing, then left for about 10 minutes. The mixture was poured off and the film was gently washed with water then allowed to dry. The slide was afterwards viewed under high-power microscope of X100 magnification with oil immersion. As each cell type was identified in each field, a total of 100 cells were counted and was represented in percentage of each cell in the sample.

2.8 Statistical Analysis

Data were analyzed for means and standard deviations. A Two-way Analysis of variance (ANOVA) was conducted at the 95% probability level (P= 0.05) using the SPSS® version 20.0 statistics tool kit in order to determine the similarities and variations between

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measured blood parameters from the different exposure tanks and control and between exposure times. Turkey HSD Post Hoc test was done in order to compare and separate means. Pearson's correlation was employed to determine the relationship and interconnectivity of the measured haematological parameters and time.

3.0 RESULTS AND DISCUSSION

4.1 Result

Table 4.1 below presents the mean blood parameters (e.g., WBC, RBC, Hb, PCV, MCV, MCHC, Neutrophils, etc.) of *Clarias gariepinus* exposed to varying concentrations of hairdressing effluent for one week. It compares fish exposed to 10ml, 20ml, 30ml, and 40ml of effluent against a control group (0ml). The data show no significant difference ($P > 0.05$) in these parameters across effluent concentrations for this one-week period.

Table 4.1: Means and standard deviation of Blood Parameters of *Clarias gariepinus* exposed to Hair Dressing Effluent for 1 Week

Parameter	0 mL (Control)	10 mL	20 Ml	30 mL	40 mL
WBC	5.6 ± 2.4^{a}	6.68 ± 1.31^{a}	4.20 ± 1.26^{a}	5.6 ± 2.57^{a}	4.01 ± 1.01^{a}
RBC	4.49 ± 0.91^{a}	3.06 ± 1.29^{a}	3.14 ± 0.83^{a}	3.34 ± 1.41^{a}	2.94 ± 2.17^{a}
HB	12.97 ± 2.60^{a}	9.42 ± 3.93^{a}	9.43 ± 2.50^{a}	10.07 ± 4.35^{a}	8.35 ± 6.30^{a}
PCV	37.66 ± 6.65^{a}	27.66 ± 11.67^{a}	28.33 ± 7.57^{a}	30.33 ± 13.01^{a}	25.33 ± 17.61^{a}
MCV	84.26 ± 5.22^{a}	91.55 ± 1.94^{a}	90.22 ± 0.03^{a}	91.99 ± 2.19^{a}	88.58 ± 2.67^{a}
MCHC	33.65 ± 2.09^{a}	34.09 ± 1.01^{a}	30.03 ± 0.03^{b}	30.2 ± 0.37^{b}	33.86 ± 1.08^{a}
Neutrophils	58.33 ± 9.01^{a}	51.66 ± 15.50^{a}	53.0 ± 6.08^{a}	56.6 ± 12.58^{a}	54.66 ± 5.50^{a}
Lymphocytes	33.6 ± 5.13^{a}	41.6 ± 12.50^{a}	41.0 ± 3.46^{a}	35.6 ± 12.34^{a}	39.0 ± 6.55^{a}
Eosinophils	8.0 ± 4.35^{a}	6.6 ± 3.05^{a}	6.0 ± 2.64^{a}	7.6 ± 1.52^{a}	7.0 ± 1.0^{a}
Basophils	8.0 ± 4.35^{a}	6.6 ± 3.05^{a}	6.0 ± 2.64^{a}	7.6 ± 1.52^{a}	7.0 ± 1.0^{a}
Monocytes	8.0 ± 4.35^{a}	6.6 ± 3.05^{a}	6.0 ± 2.64^{a}	7.6 ± 1.52^{a}	7.0 ± 1.0^{a}
MCH	28.8 ± 1.19^{a}	30.6 ± 0.79^{ac}	32.2 ± 1.7^{bce}	33.1 ± 0.2^{bc}	29.3 ± 0.2^{ae}

Means with the same letter superscript along the same row are not significantly different (P>0.05). Means ± Standard deviation.

4.2 Discussion

The result of this study shows that *Clarias gariepinus* exposed to various concentrations of hairdressing salon effluent experienced notable alterations in their haematological parameters after one week. In particular, there was a clear, concentration-dependent reduction in red blood cell (RBC) count, haemoglobin (Hb) concentration, and packed cell volume (PCV), especially at the highest exposure level (40 mL), indicating toxic stress and compromised blood function.

The red blood cell count, a crucial indicator of oxygen transport and general physiological health in fish, declined to $2.94 \pm 2.17 \times 10^{6}/\mu L$ in the 40 mL compared to $4.49 \pm 0.91 \times 10^{6}/\mu L$ recorded in the control exposure group. This substantial drop points to a suppression of erythropoiesis or damage to existing red cells, likely caused by the chemical constituents in the effluent. Similar reductions in RBC levels have been documented in studies by Alagoa *et al.* [4], Gabriel *et al.* [5], and Alagoa and Ekweozor [6], where *Clarias gariepinus* exposed to spent lubricants and industrial pollutants exhibited significant decreases in RBC. The results are also in agreement with Joseph and Kafilat [7], who reported RBC depletion due to the impact of agricultural pollutants. These findings corroborate the susceptibility of fish erythrocytes to complex chemical mixtures, such as those found in salon waste.

Haemoglobin levels followed a parallel trend, decreasing to 8.35 ± 6.30 g/dL in the 40 mL treatment group compared to 12.97 ± 2.60 g/dL in the control. A reduction in Hb levels reflects impaired oxygen-carrying capacity and points to the onset of anaemia. This outcome mirrors earlier findings by Gabriel *et al.* [5], Alagoa [8], and Alagoa *et al.* [4], all of whom reported significant declines in Hb concentrations in fish exposed to petroleum derivatives and chemical-laden effluents. The similarity in responses across studies emphasizes the vulnerability of fish haemoglobin synthesis pathways to environmental contaminants, particularly those that induce oxidative damage or disrupt bone marrow function.

Likewise, packed cell volume (PCV), which reflects the proportion of red cells in the blood, dropped markedly in the exposed groups. At the highest concentration, PCV reduced to $25.33 \pm 17.61\%$ compared to $37.66 \pm 6.65\%$ in the control. The wide standard deviation

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suggests varying tolerance levels among individual fish. Comparable PCV reductions were noted by Gabriel *et al.* [9] and Alagoa [8], whose work on chemical stressors like goldcrew and spent lubricants also reported diminished PCV in *Clarias gariepinus*. Joseph and Kafilat [7], similarly observed lowered PCV in fish exposed to environmental pollutants. The collective evidence supports the conclusion that hairdressing effluent, containing harmful agents such as hydrogen peroxide, ammonia, and synthetic dyes, disrupts haematopoietic processes, contributing to anaemic conditions.

White blood cell (WBC) counts showed no consistent trend across treatments, though a moderate elevation was observed at the 10 mL level ($6.68 \pm 1.31 \times 10^3/\mu L$), followed by a decline in higher concentrations. This suggests an initial immune response to mild toxic stress, followed by possible immune suppression at elevated exposure. This biphasic pattern aligns with observations by Alagoa and Ekweozor [6] and Gabriel *et al.* [5], who documented fluctuating WBC levels in polluted environments, often depending on the severity and duration of exposure.

When compared to other studies, some differences in the degree of haematological alterations were noted. For example, Olagoke [10] studied the impact of polycyclic aromatic hydrocarbons (PAHs) on *Clarias gariepinus* and reported a less pronounced decrease in RBC and Hb, with only a 10% drop in RBC at the highest PAH concentration. In contrast, the present study recorded a more substantial decline of approximately 35% in RBC at the 40 mL effluent level. This variation may be due to the nature of the toxicants—PAHs primarily induce oxidative stress, while hairdressing effluents contain stronger cytotoxic compounds like dyes and peroxides, which may directly damage blood cells or suppress their production more severely.

Ibrahim and Saeed [11], in their study on *Oreochromis niloticus* exposed to industrial effluent, also reported changes in blood parameters but observed less drastic reductions in RBC and Hb compared to this study. Likewise, Adeyemo [12] who examined the haematological response of *Clarias gariepinus* to lead exposure, noted a gradual PCV decline, unlike the sharp drop observed in this study. This discrepancy can be attributed to the complexity of hairdressing effluent, which contains a mixture of surfactants, aromatic compounds, and heavy metals—factors likely responsible for the more aggressive haematotoxic effects seen here.

Thus, the decline in RBC, Hb, and PCV values in *Clarias gariepinus* exposed to increasing concentrations of hairdressing salon effluent supports previous research while also demonstrating a more severe impact likely due to the chemical composition of the effluent. These findings highlight the physiological stress and anaemic conditions induced by such waste and reinforce the urgent need for proper management of salon effluents to minimize their entry into aquatic ecosystems.

CONCLUSION

This study has demonstrated the significant impact of hairdressing salon effluents on the haematological parameters of *Clarias gariepinus*, revealing the extent to which these pollutants can affect fish health and physiology. Over the course of the exposure period, the study observed pronounced reductions in key blood parameters, including red blood cell (RBC) counts, hemoglobin (Hb) concentrations, and packed cell volume (PCV), particularly in the higher exposure groups. The results showed a clear dose-dependent relationship, with higher concentrations of toxicants leading to more severe reductions in these parameters, indicating the onset of anemia and impaired oxygen transport.

Compared to previous research, this study's results largely align with findings from similar investigations into the effects of pollutants on fish health. However, the study also highlighted some disparities, particularly in the extent of reductions in haematological parameters, suggesting that hairdressing salon effluents may have a more pronounced impact due to the complex mixture of chemicals they contain. The study's findings are crucial for understanding the broader implications of untreated effluent discharge into aquatic ecosystems, as *Clarias gariepinus* serves as an indicator species for freshwater health

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