

1 **ACUTE TOXICITY OF AQUEOUS METHANOL ON JUVENILE GUINEAN TILAPIA**
2 **(*Tilapia guineensis*)**

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4
5 **ABSTRACT:**

6 This study was conducted to evaluate the acute toxicity of Juvenile *Tilapia guineensis* exposed to
7 aqueous methanol (Analytical grade). The fishes were obtained from the Nigeria Institute for
8 Oceanography and Marine Research (NIOMR), Buguma, Rivers State, Nigeria. The fishes were
9 acclimated to an aquarium for 14 days. A range-finding test of the toxicity of aqueous analytical
10 methanol was conducted. Based on the preliminary results, a definitive test was conducted at
11 0ml/l as control (0ml/l), 2.5 ml/l, 5.0ml/l, 10.0ml/l, 15.0ml/l, 20.0ml/l and 25.0ml/l respectively.
12 From the data, the concentration-response curves for fish mortality, the LC₅₀s, and the 95 percent
13 confidence intervals for test organisms at 24hr, 48hr, 72hr, and 96hr in a static system were
14 derived following the standard procedure. The mortality rates increased significantly ($p < 0.05$)
15 with an increase in the concentration of the test chemical. The LC₅₀ values at 24, 48, 72 and 96
16 hours recorded were 30.064ml/l, 26.562ml/l, 11.534ml/l, and 6.347ml/l respectively for the
17 aqueous analytical methanol. The LC₅₀ values showed that the test chemical is toxic to the
18 juvenile *T. guineensis*. Therefore, proper handling and discharge of this chemical into the aquatic
19 environment should be minimized to avoid possible toxic effects on the aquatic life therein.

20 **Keywords:** Acute Toxicity, methanol *Tilapia guineensis*, Water quality

21 **1. INTRODUCTION**

22 Pollution and contamination from modern waste especially industrial waste is a typical event in
23 the Niger Delta whose economies are generally subject to the oil refining and production
24 business. This is the situation found in Nigeria where exploration and exploitation are the main
25 wellsprings of income for many years [1]. These exercises have been advantageous in numerous
26 ways however, they have additionally brought about greater inconveniencing impacts,
27 particularly on the aquatic environment [2]. The oil and gas exploration and exploitation are
28 carried out both offshore and onshore mostly in the Niger Delta regions, delivering over 90% of
29 the unrefined petroleum in Nigeria and in this way facilitating the majority of the terminals of oil
30 exercises [3].

31 Nigeria has regulatory bodies such as the National Environmental Standards and Regulations
32 Enforcement Agency (NESREA), National Oil Spill Detection and Response Agency
33 (NOSDRA), The Federal Ministry of Environment (FME), and the Directorate of Petroleum

34 Resources (DPR) which are the regulatory bodies for these Oil and Gas Industries and their
35 environment in Nigeria with stipulated guidelines and safety standards for the management and
36 discharge of waste products in the water body and has set limits within which wastewater is
37 generated and managed from the activities of the petroleum industries in Nigeria [4]. This is
38 before its discharge into the aquatic ecosystem whether brackish or saline water. In an endeavor
39 to operate within these stipulated regulatory limits, most oil companies treat their wastewater
40 before they are discharged into the environment. Nevertheless, studies have discovered that some
41 forms of waste do not meet these limits about some of the guidelines, before being discharged
42 into the surrounding [5].

43 Methanol is a chemical very useful in different industries as a raw material for many products,
44 including pesticides, soap, solvents, and removers [6]. Due to the large use of this compound, it
45 can be found in the effluent of industries, being described as an environmental contaminant that
46 affects the aquatic biota[7]. Studies have shown that methanol exposure can cause damage to the
47 gastrulation stage of an aquatic organism and methanol is also recognized as a neurotoxin
48 capable of producing visual impairment or blindness, affecting the optic nerve and retina [8].
49 Some toxic chemical has the potential to change the characteristics of the receiving medium,
50 affecting aquatic life such as planktons; phytoplankton, zooplankton, micro, and macrobenthic
51 faunas, microbial community, macrophytes, and fishes, including shell and finfish groups) in
52 water[9].

53 Different wastes and other emissions from various oil and gas exploration activities end up in the
54 aquatic environment [10]. The released pollutants from these operations have been shown to
55 have toxic effects, causing hematological and histological abnormalities, death as well as biota
56 extinction [11]. The aquatic body has been the primary recipient of numerous anthropogenic and

57 natural pollutants and harmful compounds, which are the primary drivers of aquatic biota
58 population declines across the world [12]. Sub-lethal doses of most hazardous substances, on the
59 other hand, are disastrous for fish population, composition, and density [13].

60 Upon dissolution, these compounds can quickly diffuse through fish membranes into the
61 bloodstream, where they are transported to tissue cells and metabolized into more harmful
62 components that act on exposed fish macromolecules [14]. Concerns about pollution affecting
63 the health and genetic makeup of fin and shellfish supplies have grown in recent years [15].
64 These contaminants can have an impact on different stages of the aquatic food chain, causing
65 genotoxicity and finally causing ecological disruption and the extinction of the same fish species
66 [16]. The findings might be useful in the creation of environmental policy and as a model for
67 aquatic bio-monitoring.

68 Bioassays can be used to determine the degree of effluents' comparative toxicity potential or to
69 discover active ingredients that cause biological effects [17]. Different organisms have been
70 employed extensively to assess the environmental effects of various toxicants including
71 continental and aquatic organisms[18]. Toxicologists and environmental scientists mostly use
72 fish to measure the impact of wastewater and other chemicals on aquatic creatures [19]; [20].Fish
73 have been used in the water to assess the effects of toxicants such as pesticides and other
74 chemical compounds [21].The study aims to assess the acute toxicity of Analytical Methanolon
75 Guinean tilapia (*Tilapia guineensis*) Juvenile.

76 **2. MATERIALS AND METHODS**

77 **2.1. Source of Test Organisms**

78 Guinean tilapia (*Tilapia guineensis*) was used as the test organism. A total of 1,200 healthy
79 juveniles of *T. guineensis* with a mean length of 15.20 ± 0.2 cm, and a mean weight of 10.34 ± 0.3 g

80 was obtained from the Nigeria Institute for Oceanography and Marine Research (NIOMR),
81 Buguma, Rivers State, Nigeria and transported in plastic containers to the Laboratory. This
82 developmental stage (juvenile) of the test organism was chosen because of its high sensitivity to
83 environmental stress[22].

84 **2.2 Test Chemical**

85 The test chemical analytical grade of methanol (CH_3OH) with a molecular weight of 32.04mol^{-1}
86 and a density of 0.792g/cm^3 was collected in a 2.5 liter container from a chemical laboratory in
87 Choba, Port Harcourt, and was stored under ambient conditions before usage in the laboratory.
88 The chemical was available in liquid form and was treated directly in the test medium.

89 **2.3 Acclimation of The Test Organism**

90 The fish were acclimated to laboratory conditions in a 150 liters capacity glass aquarium tank for
91 14 days at a room temperature of $27\pm 0.3^\circ\text{C}$ to reduce mortality during the acclimatization period
92 in the test laboratory and were fed with commercial fish feed twice daily with a 2 mm imported
93 Coppens feed containing 45% crude protein at the rate of 3% body weight during the period.
94 Feeding was terminated 24 hours before the start of the experiment while uneaten feed and
95 wastes were removed daily with subsequent water replenishment [1]. During acclimation, the
96 tank was aerated continuously. The water in each glass tank was replaced with tap water from
97 the laboratory every 48 hours as suggested by [23]. The rate of mortality during acclimation was
98 used as an indicator of the healthy condition of the organisms.

99 **2.4. Range Finding Test**

100 Before the commencement of the definitive test procedures, a preliminary range-finding test was
101 conducted using the toxicants in logarithmic concentrations to determine the most appropriate
102 range of concentrations for exposure of the test organisms during the definitive toxicity test as

103 recommended by [24]. Six (6) different concentrations of the analytical grade of methanol were
104 prepared for this test and each tank was in triplicate with ten (10) juveniles per tank and was
105 exposed for 24 to 96hours during which mortality rate was estimated [25] and the dead fish were
106 discarded immediately to avoid pollution while the outcome provides the test concentrations for
107 the definitive test.

108 **2.5. Definitive Toxicity Test**

109 The Toxicity assessments followed a standard procedure and guidelines [26]. Feeding was
110 suspended 24 hours before and during the static assay and each test concentration (control (0
111 ml/l), 2.5 ml/l, 5.0ml/l, 10.0ml/l, 15.0ml/l, 20.0ml/l, and 25.0ml/l) was held in an aquarium tank
112 of 15 liters and filled to 10 mark. Ten fish were randomly selected and put in each of the test
113 concentrations. Each treatment was in triplicates. Each treatment group of fish was exposed for
114 96hours during which mortality was determined at 24, 48, 72, and 96-hour periods, and dead
115 fishes were removed immediately to avoid pollution. From the data, the concentration-response
116 curves for fish mortality, the LC_{50} , and the 95 percent confidence intervals for test organism at
117 24, 48, 72, and 96-hour in a static system was derived. A static nonrenewal bioassay option was
118 employed for this study.

119 **2.6. In-Situ Analysis of the Physico-chemical Parameters**

120 The various concentrations of the Physico-chemical Parameters analyzed were Dissolved
121 Oxygen (DO), Temperature, Hydrogen Ion Concentration (pH), Conductivity, and Total
122 Dissolved Solids (TDS) using portable meters following American Public Health Association
123 [27] procedures.

124 **2.7. Determination of Mortality**

125 The test organisms were proved dead when they do not respond to repetitive prodding. The
126 mortality rate of the test organisms was calculated with the formula:

$$\text{Mortality rate} = \frac{\text{Number of dead test organisms}}{\text{Total number of test organism exposed to the treated produced water}} \times 100$$

127
128

2.8. LC₅₀ and Toxicity Factor Determination

129 Mortality was employed as an indicator of toxicity. Dead organisms were removed and counted
130 for the following periods (0, 24, 48, 72, and 96h). The results at varying time intervals were
131 subjected to a probit analysis.

132 The percentage mortality was transformed to probit using Finney's table. The regression analysis
133 was carried out for probit values against the logarithm of the concentration using Microsoft
134 excel. The resultant x value and intercept value were substituted in the equation $Y = b + ax$ in
135 which variables x and b (intercept) were obtained from the regression analysis. The LC₅₀ was
136 thereafter calculated. The Toxicity factors were computed by dividing the LC₅₀ of the toxicant by
137 the LC₅₀ of the reference chemical.

2.9. Statistical Analysis

139 Statistical analysis was carried out using the SPSS version. Data were expressed as mean ±
140 standard deviation (descriptive statistics). Two-way ANOVA was performed to show the
141 significant variation in the treated produced water's Physico-chemical characteristics. Where
142 significant variations (p = 0.05) exist, Waller-Duncan test statistics were used to determine the
143 source of the variation. The charts were plotted using graph prism and Microsoft excel.

3.0. RESULTS

3.1. Definitive tests for *Tilapia guineensis* for 24 to 96 hours.

146 The number of mortalities recorded in the definitive test increased with an increase in the
147 concentrations of the test chemical from 24 to 96 hours of exposure (figure 2, 3 and table 1).

Comment [D1]: How about figure 1 and 4?

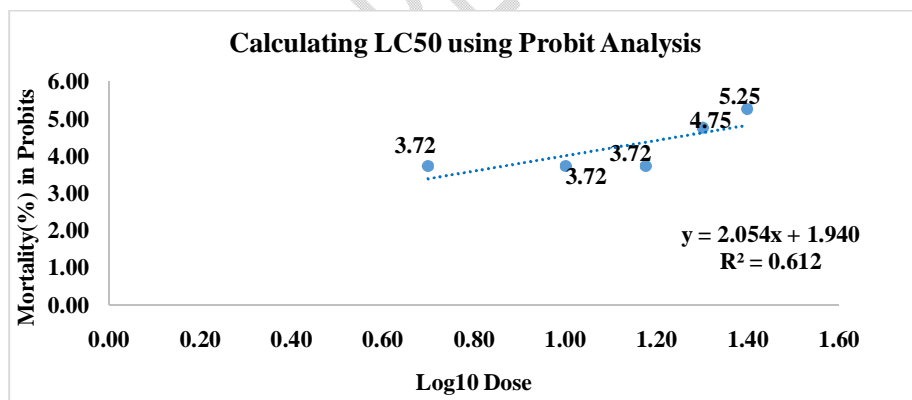
148 Unlike the control, no mortalities were recorded and no variation was observed after 96 hours.
 149 There was significance ($P < 0.05$) in the number of mortalities recorded among the different
 150 concentrations from 24 hours to 96 hours. The probit curve of mortality and regression equation
 151 of *T. guineensis* exposed to different concentrations of Methanol for 96 hours. The LC_{50} of 3.750
 152 was recorded for *T. guineensis* while the regression equation ($y = 1.5523x + 4.1095$ and $R^2 =$
 153 0.9595) is represented on table 1.

154 **Table 1:** Mean values of the mortality recorded after exposure for 24 to 96 hours.

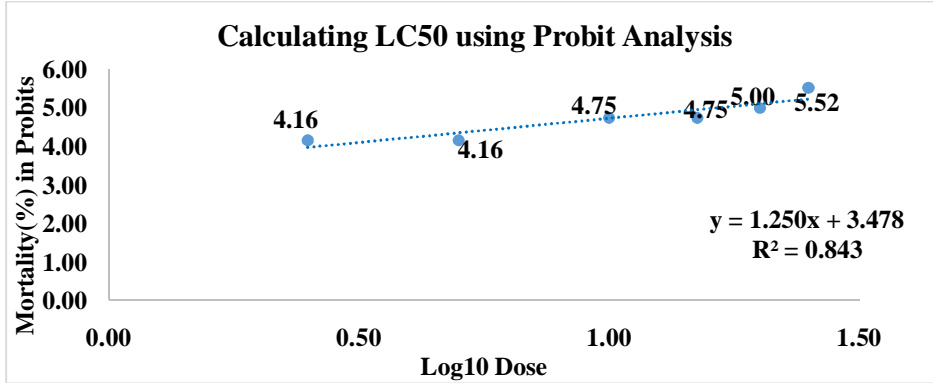
Conc. (ml/l)	Mean mortality				% Mortality	% Survival
	24hrs	48hrs	72hrs	96hrs		
0	0±0.01 ^a	0±0.001 ^a	0±0.00 ^a	0±0.000 ^a	0	100
2.5	0±0.01 ^d	2±0.001 ^c	3±0.33 ^b	4±0.577 ^a	40	60
5.0	1±0.01 ^d	2±0.001 ^c	3±0.58 ^b	5±0.577 ^a	60	40
10.0	2±0.01 ^d	4±0.001 ^c	6±0.33 ^b	7±0.000 ^a	70	30
15.0	2±0.33 ^d	4±0.001 ^c	6±0.33 ^b	8±0.000 ^a	80	20
20.0	4±0.01 ^d	5±0.001 ^c	7±0.33 ^a	9±0.577 ^a	90	10
25.0	6±0.33 ^c	7±0.001 ^{bc}	9±0.33 ^a	10±0.000 ^a	100	00

155 *Means with the same superscript down the column are not significantly different

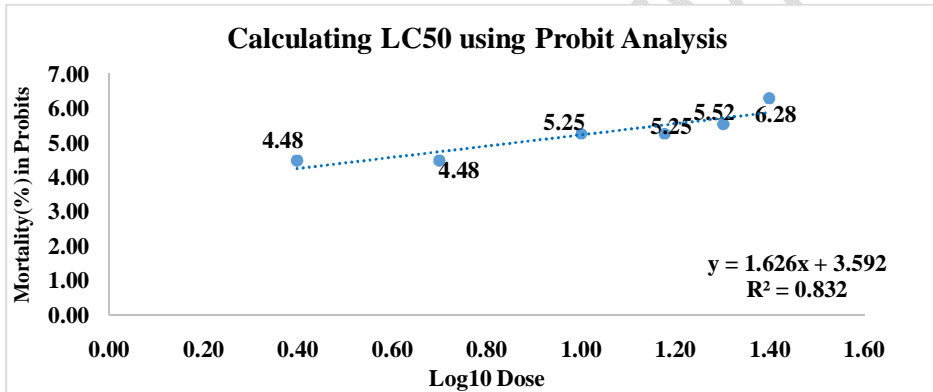
156 **Means with different superscripts down the column are significantly different.



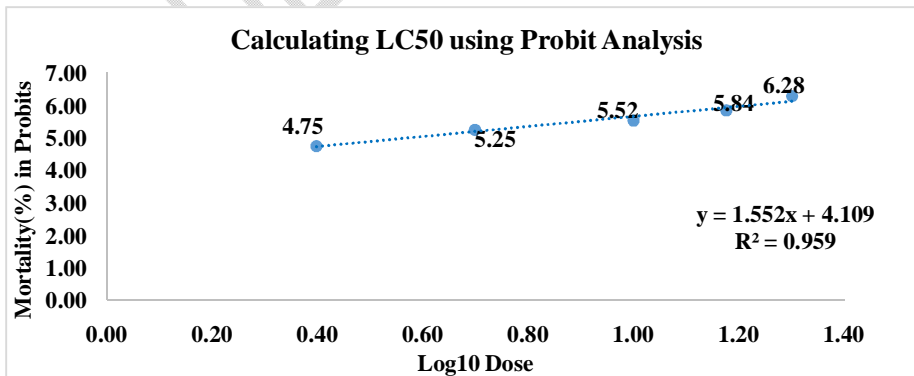
157 **Figure 1:** The Plot of Log of Concentration Versus Probit at 24Hrs for *Tilapia guineensis*
 158 exposed to exposure to Methanol
 159



160
161 **Figure 2.:** The Plot of Log of Concentration Versus Probit at 48Hrs for *Tilapia guineensis*
162 exposed to exposure to Methanol.



163
164 **Figure 3:** The Plot of Log of Concentration Versus Probit at 72Hrs for *Tilapia guineensis*
165 exposed to exposure to Methanol



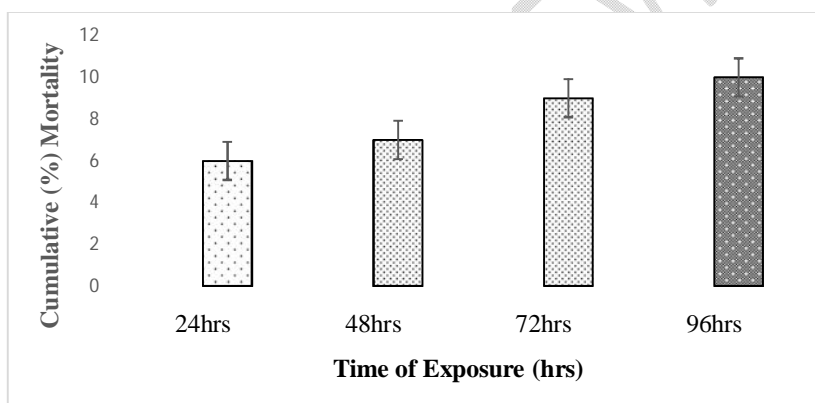
166

167 **Figure 4:** The Plot of Log of Concentration Versus Probit at 96Hrs for *Tilapia guineensis*
 168 exposed to exposure to Methanol.

169
 170 **Table 2:** The LC₅₀ and the Acute Toxicity Test After exposing *T. guineensis* to Methanol

Time (hrs.)	LC ₅₀	Lower 95%	Upper 95%	Regression Equation
24	30.361	19.620	46.984	$y = 2.0547x + 1.9405$ $R^2 = 0.6128$
48	16.585	9.002	30.553	$y = 1.2502x + 3.478$ $R^2 = 0.8438$
72	7.369	4.563	11.901	$y = 1.6262x + 3.592$ $R^2 = 0.8321$
96	3.750	2.203	6.383	$y = 1.5523x + 4.1095$ $R^2 = 0.9595$

171



172

173 **Figure 5:** Mortalities of *T. guineensis* exposed to different concentrations of Methanol

174 **3.2. Physicochemical Parameters after 96 hours**

175 The data on the physicochemical parameters are presented in Table 3. There was a slight
 176 variation observed in the parameter when compared with the controlled (0ml/l) group.

177 The observed values of the temperature varied relatively ranging from 26.6⁰C to 29.5⁰C across
 178 all test concentrations with the highest value (29.5±0.61) in the highest concentration of 25.0

179 ml/l and the least in the controlled unit (26.6±0.06) while the Dissolved Oxygen decreased (DO)

180 values varied from 3.5 to 5.2mg/l with a decrease in the concentration, the highest concentration

181 of DO was observed in the control ($5.2\pm 0.01\text{mg/l}$) and the least value ($3.5\pm 0.01\text{mg/l}$) observed in
 182 the highest concentration of 25.0ml/l. The pH values varied from 5.9 to 6.8. the highest value
 183 was observed in the controlled unit ($6.8\pm 0.03\text{ml/l}$) while the lowest value ($5.9\pm 0.0\text{ml/l}$) was
 184 reported in the concentration unit of 25.0 ml/l indicating slight variation from alkaline to a
 185 slightly acidic state.

186 The Total Dissolved Solids (TDS) value was highest ($337.2\pm 0.02\text{ ml/l}$) in the test concentration
 187 with 25.0ml/l of the test chemical while the least value ($180\pm 0.31\text{ ml/l}$) was observed in the
 188 controlled unit. The values range from 180 to 373.2ppm. The electrical conductivity varied from
 189 267 to $453\mu\text{s/cm}$. The conductivity increased from the lower concentration (0ml/l) to the higher
 190 concentration (25ml/l) of the toxicant. Where the highest value (453 ± 0.01) was observed in the
 191 concentration of 25ml/l while the least was recorded in the controlled group (267 ± 0.43)

192 **Table 3:** Mean water quality parameters after exposure for 96 hours.

Parameter s	Concentrations (ml/l)						
	0	2.5 ml/l	5.0 ml/l	10.0 ml/l	15.0 ml/l	20.0 ml/l	25.0 ml/l
Temperature (°C)	26.6 ± 0.0 6 ^c	27.2 ± 0.26 b	27.4 ± 0.2 3 ^b	27.8 ± 0.3 6 ^{ab}	28.5 ± 0.2 2 ^b	28.9 ± 0.1 6 ^a	29.5 ± 0.6 1 ^a
pH	6.8 ± 0.03 a	6.7 ± 0.00^a	6.5 ± 0.03^a	6.2 ± 0.03^a b	6.1 ± 0.02^b	6.0 ± 0.03^b	5.9 ± 0.01^b
Conductivity (µS/cm)	$267.0\pm 0.$ 0 ^d	284.1 ± 0.0 1 ^c	$314.0\pm 0.$ 02 ^b	$356.1\pm 0.$ 01 ^b	$367.1\pm 0.$ 02 ^b	422 ± 0.01 a	453 ± 0.01 a
Dissolved Oxygen (mg/l)	5.20 ± 0.0 1 ^a	5.1 ± 0.02^a	4.5 ± 0.01^a b	4.3 ± 0.01^a b	4.1 ± 0.02^b	4.1 ± 0.01^b	3.5 ± 0.01^c
Total Dissolved Solid (ppm)	$180.0\pm 3.$ 1 ^d	188.1 ± 0.0 2 ^{cd}	$192.2\pm 0.$ 03 ^c	$188.6\pm 0.$ 06 ^c	$198.5\pm 0.$ 06 ^c	$272.1\pm 0.$ 01 ^b	$373.2\pm 0.$ 02 ^a

193 *Means with different superscripts across the rows are significantly different.

194 *Means with the same superscript across the rows are not significantly different

195

196 **4. DISCUSSION**

197 **4.1. Physicochemical Parameters**

198 The rate of change in the physiological reproductive, and life cycle functions is regulated by the
199 temperature of the water, which is a determining factor for aquatic life[28]. The temperature
200 increased progressively from the lowest concentration to the highest with values ranging from
201 26.6⁰C to 29.5⁰C. There was a significant difference in the temperature value (P<0.05) observed
202 in the parameter when compared with the controlled (0ml/l) group. Increases in water
203 temperatures or broad fluctuations may be caused by metabolic processes, which can cause other
204 physicochemical parameters to speed up, slow down, or halt entirely [29]. Similar results were
205 reported by [30]in the physicochemical properties of the Aleto water body in Eleme, Rivers.
206 [28]also recorded a similar result in selected rivers in Port Harcourt, Niger Delta of Nigeria. The
207 increase in temperatures may be due to a large number of suspended solids from fecal waste
208 from the fish and the time of exposure is believed to have been influenced by the intensity of
209 sunlight at the time of collection of the result [31].

210 The present investigation indicated that the concentration of Dissolved Oxygen (DO) decreased
211 fluctuated from 3.5 to 5.2mg/l with a decrease in the concentration[32]. Dissolved oxygen (DO)
212 had a marked difference in the exposure media. A remarkable trend was observed in the different
213 exposure media tanks, where the mean Dissolved oxygen (mg/L) level in the control tank (0ml/l)
214 which was 5.2±0.01mg/l drastically dropped to (3.5±0.01mg/l) in the highest concentration of
215 25.0ml/l. The DO value was lower than the permissible limits of [33] and [34] of (>5mg/l)
216 standard in all for the drinking and aquatic life. The reduction was consistent across all
217 concentrations, with the control unit having the greatest reduction. This suggests that the effluent
218 is primarily an oxygen-limiting toxicant with a clear effect on the fish's health and physiology
219 [35]. According to [33], this water having declined DO level may indicate the presence of

Comment [D2]: Since this is the report of your findings, I think you don't need to reference it.

Comment [D3]: What do you mean by the control unit having the greatest Reduction?
The highest concentration of 25.0mg/l actually has the greatest reduction.

220 pollution because the healthy water value of DO should be within the range of 5-14.6mg/l. Any
221 water body with less than 5 or greater than 14.6 indicates the impairment of the water which is a
222 problem for an aquatic body.

223 The pH values varied and ranged from 5.9 to 6.8. the highest value was observed in the
224 controlled unit (6.8 ± 0.03 ml/l) while the lowest value (5.9 ± 0.0 ml/l) was reported in the highest
225 concentration tank indicating a slight variation from alkaline to a slightly acidic state. The pH
226 value was lower than the permissible limits of [33] and [34] of (6.5-8.5). This could be based on
227 the effect of the increased effluent concentrations as a further decrease in the pH of the various
228 tanks led to more slight acidity which will become harmful to the test organism as time goes by.
229 However, the different concentrations in the tanks were not significant at $p < 0.05$ with
230 permissible limits of [33] and [34]. The pH of most natural water, according to Almeida *et al.*
231 (1982), ranges from 6.5 to 8.5, which is a divergence from the neutral 7.0 value due to the
232 CO/bicarbonate balance.

Comment [D4]: Not in reference.

233 The Total Dissolved Solids (TDS) value range between 180 to 373.2ppm across the test medium.
234 The level of total dissolved solids varied significantly ($P < 0.05$) as the test contraptions increased
235 the values were within the recommended range of 500-1000 by [34]. TDS may affect the
236 aesthetic quality of water, interfering with other chemical parameters[36]. [33] recommends that
237 water containing more than 1000 mg L^{-1} of dissolved solids is not be used if other less
238 mineralized supplies are available.

239 The electrical conductivity of water is a metric for ion concentration. The environment, mobility,
240 and water sources all have an impact on ion concentrations. The bulk of soluble ions in surface
241 water comes from rock mineral dissolution [37]. The conductivity increased from 2670.43 to
242 4530.01 S/cm, with the maximum value found at 25ml/l concentration. This value is higher

Comment [D5]: These values needs to be correctly written. They are 267 and 453S/cm respectively.

243 than[34] drinking permitted limit of 400 S/cm. As a result of the chemical reaction with
244 experimental water, the test water obtains a large amount of dissolved inorganic compounds in
245 ionised form. This assertion agrees [33] stated with the conductivity of water depends upon
246 the concentration of ions and its nutrient status and variation in dissolved solid content. The
247 chemical conductivity of water shows that it receives a large number of dissolved inorganic
248 compounds in the ionised form [38]. The limited diluting impact of the higher concentration of
249 the chemical utilised could explain the rise in conductivity seen in the research area[39].

250 **4.2. Mortality**

251 The acute toxicity results for *Tilapia guineensis* Juveniles Exposed to Methanol for 96 hours giving
252 an LC₅₀ value of 3.750ml/l with a concentration range from 2.5ml/l to 25ml/l. There was a
253 significant increase in the numbers recorded with an increase in the concentrations of the test
254 chemical from 24 to 96 hours of exposure. The number of mortalities in *T. guineensis* increased as
255 the concentration increased. There was an increase in percentage of mortality with an increased
256 concentration. There was no mortality recorded in the control tank from 24 to 96 hours.
257 Meanwhile, there were significant variations in the numbers of mortality across the different test
258 concentrations of 2.5ml/l to 25ml/l after 96 hours. The high number of mortalities could be
259 attributed to the obstruction of the respiratory structures of the test organism which is caused by
260 the increasing concentrations [40]. The high number of mortalities could also be attributed to the
261 assertion that the exposed test fish may have suffered from oxygen reduction brought by the
262 organic compounds in the test chemicals [41]. The values fall within the range of methanol toxicity
263 reported for other species as reported (Reyes- [42]). A comparison of methanol toxicity for other
264 aquatic species as reported by Helmstetter *et al.* (1996 [43] shows that *Nitocraspinipes*, *Mytilus*
265 *edulis*, and *Alburnasalburnas*, which are all brackish/marine had an LC₅₀ value of 15,900 mg/L as

266 determined in this study. It's worth noting that they only tested for 24 hours and didn't double-
267 check the methanol content. In our study, *T. guineensis* in the 25ml/l concentration did not survive
268 beyond 72 hours and were dead at 96 hours.

269 [44] reported that after 96 hours of exposure to SWFs of diesel and gasoline on marine
270 pejerrey *Odontesthes argentinensis*, the median lethal concentration after 96 hours (LC50) was
271 13.46% and 5.48%, compared to 15% in our current study. [45] investigated a 96 hrs. static acute
272 toxicity test on the juveniles *C. gariepinus* (African catfish) and *C. anguillaris* (mudfish) on
273 exposure to different concentrations of crude oil-polluted water and reported an LC₅₀ value of
274 while that of *C. gariepinus* was 0.000219% of the highest exposed concentration. The variation in
275 the numbers of mortality observed between *T. guineensis* and *O. niloticus* exposed to the same
276 concentrations of Methanol for 96 hours was significant and could be attributed to the selective
277 toxicity of Methanol to species of cichlid fish from both marine and freshwater aquatic bodies and
278 then 95% confidence intervals at 24 and 48 h of exposure [46].

279 5. CONCLUSION

280 In the present study, the LC₅₀ values showed that Methanol was toxic to the *Tilapia guineensis*
281 juvenile. The number of mortalities increased with increase in concentrations. Hence, it is
282 recommended that there is a need for proper handling and discharges this chemical into the aquatic
283 environment, to manage the potential toxicity associated with its interaction with the aquatic life
284 therein. Therefore, the discharge of methanol in the aquatic environment may result in the death of
285 non-targeted aquatic organisms and edible species which in turn affect human health.

286

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Comment [D6]: Kindly complete this report. LC₅₀ value of one of the experimental animal was not given.

Comment [D7]: Kindly change this to "in discharging".

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