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Original Research Article

Abattoir Waste-Induced Microbial Loads on the Water and Fish Samples of Kara Cow Market of Ogun River, Nigeria

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ABSTRACT

Abattoir wastes discharged untreated into water bodies has caused significant damages to the aquatic ecosystem. A kilometer distance of Ogun River by Kara cow market was sampled within the area of high slaughtering of animals and discharge. A total of 110 respondents were selected for the administration of questionnaire using purposive sampling method. Fish samples were obtained from fishermen landed catches and preserved on an ice box while water samples were collected in one litre bottles from the sampling points for laboratory analysis for wet and dry seasons. The results showed that untreated abattoir wastes were discharged into the river. The abattoir waste has 97.3% direct effects on the river with 99% chances of polluting the surface water. There were significant ($p<0.05$) differences in the concentration of the microbial organisms at the different sampling points with regards to their occurrence and distribution. The observed bacteria include Pseudomonas spp., Bacillus spp., Escherichia coli, Klebsiella spp. and Staphylococcus aureus. In summary, it will be logical to say that the abattoir wastes discharged into the water body has contaminated it due to the presence fecal indicator microbials capable of causing sickness to humans and affecting the health conditions of fishes in the water body.

1. INTRODUCTION

Human activities have greatly affected and disrupted the natural environment leading to instability, disorder, harm, and discomfort to both the physical systems and living organisms inhabiting the ecosystems. Livestock production business is a source of livelihood and considered a potential food for the world's needy people.

The challenge of managing its wastes calls for urgent attention as it has become a major source of pollutant in the country site and cities, especially when discharged into rivers and waterways UNEP (2009) in (Ferronato and Torretta, 2019). In most of the cases, the discharged effluents/wastes end up introducing enteric pathogens and excess nutrients into surface waters (Alonge, 1991).

Many towns in the rural and urban cities of Nigeria have a slaughterhouse or slaughter slab provided for them by government. This act is believed to offer benefits and drawbacks in such designated settings (Magaji and Chup, 2012). Wastes generated from abattoir operations are usually separated into three categories (solid, liquid, and fats). The solid part of the wastes consists of condensed meat, undigested ingest, bones, hairs, and aborted foetuses. The liquid aspect on the other hand consists of dissolved solids,blood, guts contents, urine, and water, while fat waste consists of fat and oil. Magaji and Chup (2012) reported that a slaughtered cow can produce 328.4 kg of waste in form of dung, bone, blood, horn, and hoof. According to Forster (2005), the disposal of abattoir waste products is a problem that has always dominated slaughtering business, and on an average, 45 percent of each live cow animal, 53 percent of each sheep, and 34 percent of each pig consist of non-meat substances.

The pollution of water resources often results in the destruction of primary producers, which in turn leads to an immediate diminishing impact on fish yields, with the resultant consequence of the decrease in diet (Aina and Adedipe, 1991). The characteristic of slaughterhouse wastes, and effluents vary from day to day depending on the number, types of stock being processed, and the processing method (Bustillo-Lecompte and Mehrvar, 2015).

Liew *et* al. (2020) reported that animal wastes can affect water, land, or air quality if proper practices of management are not adhered to. The same wastes, however, can be valuable for crops but can also cause water quality impairment. It also contains organic solids, trace heavy metals, salts, bacteria, viruses, other microorganisms, and sediment. The waste from animals can also be washed into streams if not protected and reduces oxygen in water, thereby endangering aquatic life. Furthermore, Smith *et al.* (2015) recounted that improper animal waste disposal can lead to animal diseases being transmitted to humans through contact with animal feces. Abattoir wastes reaching water bodies contribute significant levels of nitrogen, phosphorous and biochemical oxygen demand, as well as other nutrients, resulting in stream pollution and eutrophication (Omole and Longe, 2008; Raheem and Morenikeji, 2008). In addition, abattoir wastes can alter ground water significantly in its located vicinity through seepage of abattoir effluents (Sangodoyin and Agbawhe., 1992).

This present study is intended to have a closer look at the activities of butchers and the generated wastes in Kara cow market of Ogun state and its environs and the impacts on the receiving Ogun River.

2. MATERIALS AND METHODS

2.1. Study Area

The Ogun River basin is in the southern part of Nigeria with latitudes $6^{o}26$'N and $9^{o}10$'N and longitudes $2^{o}28$'E and $4^{o}8$'E (Figure 1). About 2% of the basin area fell outside Nigeria in the Benin Republic with land area of about 23,000km^2. The river flows southwards over about 480km before it discharges into the Lagos Lagoon (Bhattacharya and Bolaji, 2010). At Isheri-Olofin, the Lower Ogun River receives effluents from 'Kara' Abattoir which was established in 1984. The abattoir itself is extremely important to the locals of the area as well as those of Lagos' metropolitan mega city. There are observed artisanal fisheries activities going on in the river and the study population consists of the fishermen and the `butchers in Kara market.

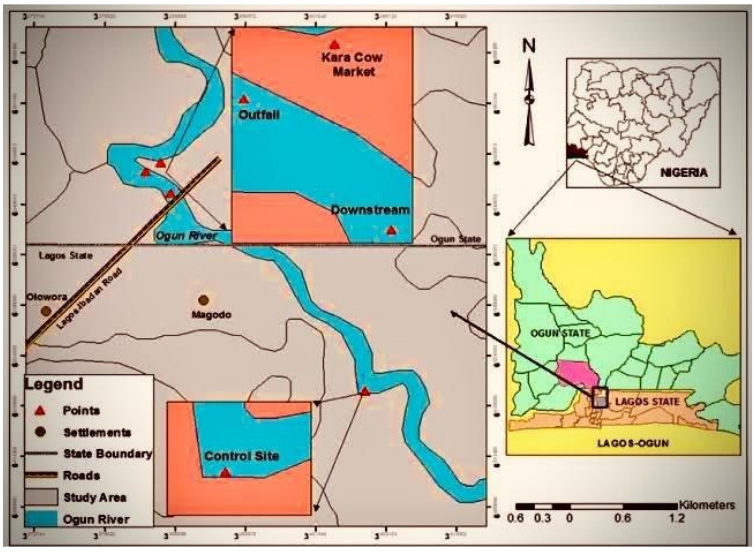

Figure 1: Map of study area

2.2. Sampling Size and Techniques

Two methods of data collection were used for studying the human activities impact and their livelihood: Self-reporting or participant direct observation method to ensure that only first-hand information is observed and recorded by the researcher. Secondly, purposive sampling method was used to select 110 respondents for the administration of questionnaire. However, study of the microbial loads involved obtaining water sample and fish caught by fishermen for both wet and dry seasons.

2.3. Sampling Location

The field survey was carried out over a kilometer distance of the Ogun River from Opic to Kara Abattoir. Four sampling points were randomly selected as activity point along the river. Samples were taken between the hours of 6 am – 9 am butchers peak activities period of slaughtering. The sampling points were selected over 100 m from the discharge point into the Ogun River as:

Sample point 1: This point is located upstream from the point source (a hundred meters from the point source). It was taken as the control sample used to reflect the ambient state of the water body.

Sample point 2: This is the actual point where the effluent from the abattoir discharges into the river body. It is a direct effluent filled with blood, feces, urine, and hair from the slaughtered animals. The water had a murky appearance.

Sample point 3: This is located 20 meters downstream from the point source of the discharged effluent. The water was quite clear but with observed particles.

Sample point 4: This is located 40 meters downstream from the point source of the discharged effluent. At this point, the water had clearer appearance but not without particles.

2.4. Microbial loads and analytical methods

A total of four water samples were collected from the four differentpoints and labeled appropriately. More so, following the method of Olawusi-Peters *et al.* (2015), fish samples were systematically collected randomly from fishermen landed catch and were identified using fish guide by Olaosebikan and Raji, (2004) before counting in the sampling points. The samples were preserved in ice chest at 4 ºC before being taken to College of Veterinary Medicine laboratory of the Department of Parasitology and microbiology, Federal University of Agriculture, Abeokuta for analysis. The laboratory procedures for total bacteria count, occurrence and distribution were conducted using selective culture media on serially diluted (Nutrient and MacConkey) Agar after standard pour plate method and incubated at 35℃ between 24 and 48hrs according to the notes of

bacteriological analysis for water and food samples (Orji *et a*l., 2005; Fagade, 2008; FAO, 2011; WHO, 2015). Furthermore, biochemical tests for microorganism isolation and identification were performed in accordance with ISO 6887-3: (2017) recommendation for microbiological samples. Finally, bacteria load was assessed using the standard plate count method while colonies were counted using a digital colony counter for each plate and expressed as colony-forming units of the suspension.

2.5. Statistical Analysis

The data from the structured questionnaire was subjected to descriptive statistics while the data from TBC on the water and fish samples were determined by inferential statistics with the means being further separated using Analysis of Variance for statistical package for social sciences (SPSS) version 21. Finally, Duncan Multiple Range Test was used to separate the means at $p<0.05$.

3. RESULTS AND DISCUSSION

3.1. Socio-demographic Data of the Respondents

The socio-demographic data of the respondents in the market showed that majority of the respondents were males 85.5% with fewer number of females 14.5% within age 31-50 (Table 1). The respondents age précised middle age classes and indicated that greater percentage of the total population were in an active stage of life for their daily activities.

Table 1: Socio-demographic characteristics of the respondent

Variable	Frequency	Percentage	Mean ± SD
Age			
< 30	23	20.9	37.39± 8.33
31 – 40	54	49.1	
41 – 50	27	24.5	
51 – 60	3	2.7	
> 60	3	2.7	
Sex			
Male			
Female	16	14.5	
Marital status			
Single	16	14.5	
Married	87	79.1	
Divorced	7	6.4	
Household size			
1 – 5	92	83.6	
6 – 10	16	14.5	
> 10	2	1.8	
Tribe			
Igbo	20	18.2	
Yoruba	78	70.9	
Hausa	12	10.9	
Level of education			
No formal	3	2.7	
Primary	20	18.2	
Secondary	22	20.0	
Tertiary	65	59.1	
Religion			
Christianity	75	68.2	
Islam	31	28.2	
Traditional	4	3.6	

This age bracket is common because of the high energy needed to carry out day to day activities such as trading, cow businesses and fishing. The result further revealed that 14.5% of the respondents were single, 79.1% were married and 6.4% were divorced. More so, the household size ranged between 83.6-1.8% within the numbers of 1-10. The implication of more men to women in this study is due to men's ability and strength to efficiently bear stressful nature of the activities more than the females who are mostly their wives (William, 2006; Idowu *et al.*, 2018). Furthermore, their marital status made it a family business for meeting their daily needs. According to Olaoye *et al.* (2012) most subsistence and small-scale businesses including artisanal fishing activities is mostly family business carried out by them for sustaining their household. Furthermore, other occupations practised by the respondents other than fishing, include trading, (25%), barber, cow selling and other businesses in other to sustain the family effectively (Figure 2).

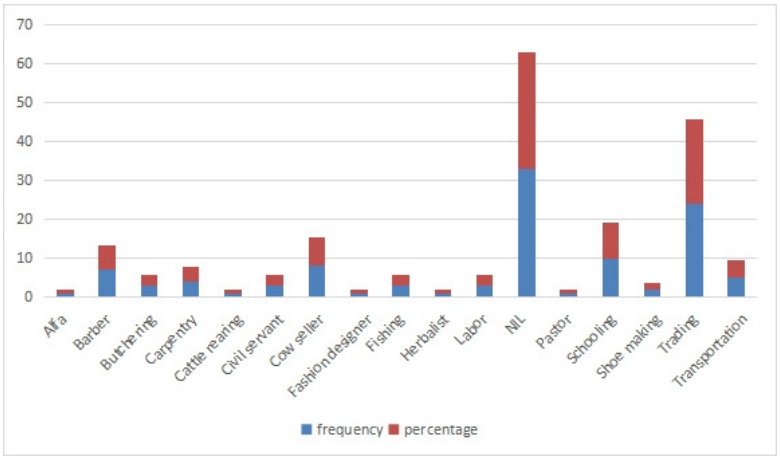

Figure 2: Occupations of respondents

3.2. Fishing Characteristics

The days of fishing per week and the type of boat used in Kara River is presented in Table 2. The results showed 52.7% use boat without engine while 47.3% use boat with engine signifying financial capacity and catch availability. The years of experience entails progression of learning and mastering in fishing (10 - 43.6% within the numbers of 6 - 15). According to Rougoor *et al.* (1998) years of experience will impact positively on the fishers catch efficiency due to practical resource allocation, as he must have acquired everyday an understanding through trial and error over time. In summary, the economic postulate is that the more experienced a fisherman, the better he is to utilize the available resources judiciously (Nwankwo, 2004). The result from fishing characteristics showed that silver catfish is dominant by 69.1% in the study area with greater number of the fishermen 64.5% engaging in self-labour. The abundance of silver catfish in the water body can be attributed to the slow flowing of the waterbody and the abounding shallow swamps with vegetation that supports their (Zengeya, 2016; Diouf *et al.*, 2020). The available fish species caught in the water body with reference to their abundance were *Chrysichthys nigrodigitatus* (69.1%) and *Hydrocynus forskalli (*10.9%).

3.3. Human Activities Around the Water Body

The various human activities around Kara River and its environs as identified during the study period showed that 91.8% of the respondents' bath in the water (Table 3). The result also indicated washing of clothes and plates around the water body. Cases of open defecation by majority of the respondents (98.2%), dumping of abattoir wastes (89.1%) and oil spillage (84.5%) into the river were recorded. These actions are detrimental to the aquatic fauna and flora composition of the waterbody. In developing and under-developed countries, these trends are common human behavior around waterbody and is not specific to Kara River. Olawusi-Peters (2010) recorded that resident around Ogun River dumped their waste directly into the water body because it is convenient and free, and, in most cases, they argue that it is not harmful to their health as they do not suffer any disease or infection outbreak (Idowu *et al.,* 2018). According to Oladeji and Adelowo (2016), the continuous deposition of human wastes into water bodies increases the chances of contracting diseases from them.

Table 2: Fishing characteristics

Variable	Frequency	Percentage
Days of fishing		
	2	8
	3	32
	4	37
	5	29
	6	3
	7	1
Types of boat		
Boats without engine	58	52.7
Boats with engine	52	47.3
Fishing experience		
1 – 5	15	13.6
6 – 10	48	43.6
11 – 15	36	32.7
> 15	11	10.0
Use of canoe		
Yes	53	48.2
No	57	51.8
Types of canoe		
Wooden	85	77.3
Dug-out canoe	25	22.7
Source of labour		
Self	71	64.5
Family members	21	19.1
Hired labor	18	16.4
Fish species		
Hydrocynus forskalli (Akoko)	12	10.9
Oreochromis niloticus (Epia)	22	20.0
Chrysichthys nigrodigitatus (Silver catfish)	76	69.1
Output		
< 10	89	80.9
11 – 20	20	18.2
> 20	1	.9

3.4. Different Components of Abattoir Wastes and its Effects on the Water

The result of the effects of the various abattoir wastes in Kara cow market indicated that 53.6% of the abattoir wastes are deposited in the water body. The deposited wastes in the river with regards to their quantity include blood (33.6%), gut contents (20.0%), bones (18.2%), undigested ingesta (12.7%), urine (8.2%) and hairs (7.3%) Table 4. The different abattoir wastes going into the waterbody have 97.3% direct effects on it with 99% chances of polluting the surface water, hence, leading to fish death and extinction. This result agrees with the findings of Woke *et al.* (2013) who observed that the extinction of some fish species in water body is due to large waste dumps. In addition, some hazardous substance may undergo biological amplification in food chains, causing serious damage to organisms at high trophic levels (Tse *et al.*, 2007). Also, Miller and Tyler (1990) reported that heavy water pollution can kill or damage benthic organisms and adversely affect food webs.

Table 3: Human activities in and around the water body

Variable	Frequency	Percentage
Bathing		
Yes	101	91.8
No	9	8.2
Washing of plates		
Yes	96	87.3
No	14	12.7
Washing of clothes		
Yes	92	83.6
No	18	16.4
Dumping of refuse		
yes	107	97.3
No	3	2.7
Defecating		
Yes	108	98.2
No	2	1.8
Urinating		
Yes	109	99.1
No	1	0.9
Dumping of abattoir waste		
Yes	98	89.1
No	12	10.9
Burning of bushes		
Yes	58	52.7
No	52	47.3
Burning of refuse		
Yes	69	62.7
No	41	37.3
Use of chemicals for weed control		
Yes	50	45.5
No	60	54.5
Oil spillage		
Yes	93	84.5
No	17	15.5
Dumping of plastic materials		
Yes	86	78.2
No	24	21.8
Dumping of unwanted materials		
Yes	89	80.9
No	21	19.1

3.5. Microbial Loads Study

3.5.1. Total bacteria count (TBC) in water

The total bacteria count for wet and dry seasons showed that the highest TBC was recorded in sample point 1 with the values 1.60 x 10^6 ±0.05 and 1.44 x 10^6±0.11 CFU/mL respectively. The result can be attributed to the settled nature of the water with high vegetation cover in the upstream. This result is quite similar with those of Nafarnda *et al.* (2012) report of varied total bacteria values between the upstream and downstream of water bodies in Abuja. Additionally, they were no significant difference ($p<0.05$) between points 1 and 2 during the dry season in the collected water samples. The lowest total bacterial count was on the other hand found at sample point 4 for both dry and wet seasons as shown in Table 5.

Table 4: Different component of abattoir wastes and its effects

Variable	Frequency	Percentage
Abattoir waste disposed in water		
Always	39	35.5
Sometimes	59	53.6
Rarely	12	10.9
Types of abattoir waste		
Bones	20	18.2
Blood	37	33.6
Hair	8	7.3
Undigested ingesta	14	12.7
Urine	9	8.2
Gut content	22	20.0
Effects of abattoir waste		
Yes	107	97.3
No	3	2.7
Death of fish		
Yes	108	99.1
No	2	0.9
Pollution of surface water		
Yes	109	99.1
No	1	0.9
Pollution of ground water		
Yes	50	45.5
No	60	54.5
Poisoning		
Yes	105	95.4
No	5	4.5
Decrease air quality		
Yes	103	93.6
No	7	6.4
Poor water quality		
Yes	105	95.5
No	5	4.5
Water pollution		
Yes	105	95.5
No	5	4.5
Extinction		
Yes	108	98.2
No	2	1.8
Poor fish growth		
Yes	100	90.9
No	10	9.1
Poor fish quality		
Yes	99	90.0
No	11	10
Migration		
Yes	102	92.7
No	8	7.3
Quality fish seed		
Yes	27	24.5
No	83	75.4

The observed low TBC at the sample point 4 can likely be credited to self-purification and dilution effects of the river systems but still poses a potential health hazard to the public and the ecosystem. Furthermore, the impacts according to the result introduced microbial pathogens due to accumulated effects even at the lowest level when compared with the Federal Environmental Protection Agency (FEPA) and WHO threshold. (FEPA, 1991; WHO, 2015). It is important to note that microbial loads in water according to WHO (2013), causes diseases such as acute gastroenteritis, hepatitis, typhoid, and cholera in relation to their pathogens. This can be through human exposure, direct contact, or ingestion of contaminated fish. The present study is supported by the findings of Benka-Coker and Ohimian (1995) as reported by Idowu *et al.* (2018) that the continuous discharge and influx of human wastes into water bodies can result to an increased organic matter loads on such water body.

Table 5: Total Bacteria count in water during dry and wet seasons

Sample points	Wet season (cfu/ml)	Dry season (cfu/ml)
1	1.60±0.05a	1.44±0.11^{a}
2	1.40±0.08^{ab}	1.40±0.15^{a}
3	1.55±0.05^{a}	1.10±0.00^{b}
4	1.23±0.08 ^{b}	1.00±0.00^{b}

Means with different superscripts along same column are significantly different ($p<0.05$)

3.5.2. Occurrence and distribution pattern of isolated bacterial organisms in the water samples

There was presence of four (4) out five of (5) bacteria organisms isolated in the water samples collected from sample point 2 during the wet season (Table 6). This result is anticipated as it is the point of activities and discharge of the abattoir wastes into the water body. Furthermore, two bacteria species, *Pseudomonas* and *E. coli* were observed to be present in all the sampled points during wet and dry respectively. This signifies resilience for survival and adaptability to the water conditions among the other bacteria species present in the water body in the varying seasons as recorded in (Coker *et al.*, 2001) study.

Table 6: Occurrence and distribution pattern of isolated bacterial organisms in the water samples

Sample points	*Pseudomonas spp.*	*Bacillus spp.*	*Escherichia coli*	*Klebsiella spp.*	*Staphylococcus aureus*
Dry season					
1	+	-	-	+	-
2	+	+	-	+	+
3	+	-	-	+	-
4	+	-	+	_	+
Wet season					
1	-	+	+	+	-
2	+	-	+	-	-
3	-	+	+	+	+
4	-	+	+	+	+

+ = Present, - = Absent

3.5.3. Fish samples identification

Four different fish species were identified in the water body during the study period (Table 7). The result indicated that *Chrysicthys auratus* of the family Bagridae was available all season (dry and wet seasons) and the most abundant. *C. auratus* are hardy and can survive harsh environmental conditions, which is partly why they are the most abundant.

3.5.4. Total bacteria count and distribution pattern of isolated bacterial organisms in fish samples

The total bacteria count in the fish samples showed no significant difference ($p<0.05$) during dry season across the sampling points as seen in Table 8. *O. niloticus* recorded the highest load of bacteria (1.70±0.40^{a} and 1.57±0.06^{a}) during both seasons. This result agreed with the previous studies of Mitiku *et al.* (2023) and Hanson *et al.* (2008) on high infection rate in plankton feeders such as the cichlids than the benthic feeders. Additionally, the presence of more bacteria species during the dry season in the fish sample's skin and intestine

than in the wet season can be due to reduced vegetation and water level in the water body (Table 9). The result collaborates with the findings of Idowu *et al.* (2018) that high densities of fecal indicator organisms such as *Pseudomonas fluorescens*, *Escherichia coli* and *Staphylococcus aureus* in fish samples indicates the severity of the microbial accumulation and contamination.

Table 7: Fish species found in Kara River during the study period

Family	Scientific name	Number of samples	Local name	Availability	
				Dry	Wet
Bagridae	*Chrysicthys auratus*	25	Obokun	++	++
Cichlidae	*Oreochromis niloticus*	19	Epeya	++	±
Mugilidae	*Mugil cephalus*	7	Atoko	±	-
Schilbeidae	*Parailia pellucida*	17	African glasscatfish	+	±

± = Present but not all the time; + = Present; - = Absent; ++ = Present all the time

Table 8: Total Bacteria count in fish samples during wet and dry seasons

Fish species	Wet season (cfu/ml)	Dry season (cfu/ml)
Chrysithysis auratus	1.601 ± 0.29^{c}	1.49 ± 0.06^{a}
Parailia pellucida	1.65 ± 0.32^{a}	1.53 ± 0.06^{a}
Mugill cephalus	1.56 ± 0.25^{b}	1.44 ± 0.06^{a}
Oreochromis niloticus	1.70 ± 0.40^{a}	1.57 ± 0.06^{a}

Means with same superscript in a column are not significantly different ($p>0.05$)

Table 9: Occurrence and distribution pattern of isolated bacterial organisms on the fishsamples during the seasons

Sample	*Pseudomonas spp.*	*Bacillus spp.*	*Escherichia coli*	*Klebsiella spp.*	*Staphylococcus aureus*
Dry season					
CA (Skin)	+	+	+	+	+
CA (Intestine)	+	-	+	-	+
MC (Skin)	+	+	+	-	+
MC (Intestine)	-	+	+	-	+
PP (Skin)	+	+	-	+	-
PP (Intestine)	+	+	+	+	+
ON (Skin)	-	+	-	+	-
ON (Intestine)	+	-	+	-	+
Wet season					
ON (Skin)	+	+	-	+	+
ON (Intestine)	+	-	+	-	-
CA (Skin)	+	+	-	+	+
CA (Intestine)	+	+	+	+	-
MC (Skin)	-	+	+	-	+
MC (Intestine)	+	+	+	-	-

+ = Present, - = Absent, CA = *Chrysicthys auratus*, ON = *Oreochromis niloticus*, MC =*Mugil cephalus*, PP = *Parailia pellucida*

4. CONCLUSION

This study reports the socio-demographic and livelihood characteristics of the respondents in Kara market, the impacts of their daily activities on the aquatic ecosystem fauna and flora. From the results obtained in the present study, Kara cow market has provided families with a lot of opportunities for meeting their daily needs however, their actions have brought uneasiness to the surroundings including the adjoining river. This situation is evident in the loads of wastes and effluents coming from the abattoir and discharged into the river untreated thus, resulting into increased total bacteria counts on both the water and fish samples with the observed presence of fecal indicator microbials such as *P. fluorescens* and *S. saprophyticus*. It is important to state that the

indiscriminate disposal of pollutants without pre-treatment should be discouraged in the market in order to recover the river. Conclusively, a further study on the various levels of each of the identified bacteria is recommended so as to know the level of contamination.

5. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

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