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EFFECT OF ABATTOIR EFFLUENT ON MACRO INVERTEBRATE ALONG UNGUWA UKU STREAM, GOMBE

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ABSTRACT

The physico-chemical parameters and macroinvertebrates in Anguwa-uku stream Gombe between the months of May through July 2021 within three sampling sites, each 10 m apart were selected along the stretch of the stream and studied to assess the impact of abattoir effluent on macro invertebrate samples. Physico-chemical parameters were within the allowable limits of United States Environmental Protection Agency (USEPA) for fresh water bodies. There were significant differences ($p<0.05$) in the mean values of Dissolved Oxygen(DO) (2.63) , Total Dissolved Solid TDS(58.00), transparency(68.05), nitrate(0.83) and phosphate(1.50) between the months and through the sampling stations. A total of fifteen genera of benthic macro-invertebrates belonging to five orders (Diptera(29), Decapoda(37), Coleoptera(52), Odonata(3), and Prosobranchia(2) were recorded in the three sampling sites of the stream during the study. Pollution tolerant species including *Coenagrionides*and *Chironomus sp*. Dominated the benthic macroinvertebrates with a total number and percentage abundance of 29(43.21%) and 20(31.25%), respectively. Anguwa uku stream is relatively under stress due to dominance of indicators of pollution.

Keyword: Physico-Chemical Parameters, Macroinvertebrates And Abattoir Effluent

INTRODUCTION

Macro invertebrates are a diverse array of animals without backbones operationally defined as those that are retained by a sieve or mesh with pores size of 0.2 to 0.5 mm, as used most frequently in stream sampling devices. Stream macro invertebrates include various groups of worm (flatworms, eelworms and segmented round-worms), mollusks (snails and bivalves), crustaceans (shrimps, crayfish and other shrimp-like groups), mites, and above all insects (Winterbourn, 1999). Most invertebrates are important components of stream ecosystems. They graze periphyton (and may prevent blooms in some areas), assist in the breakdown of organic matter and cycling of nutrients and, in turn, may become food for predators (e.g., fish) (Hynes, 2010; Jimoh *et al*., 2011; Uwem *et al*., 2011). Macro invertebrates are the organisms most commonly used for biological monitoring of freshwater ecosystems worldwide. This is because they are found in most habitats, have generally limited mobility, are quite easy to collect by way of well-established sampling techniques, and there is a diversity of forms that ensures a wide range of sensitivities to changes in both water quality (of virtually any nature) and habitats (Hellawell, 2000; Abel, 2019).

The invertebrates, which live on, in, or near the substratum of running water, include representatives of almost every taxonomical group that occurs in freshwater.Water is the most relevant natural resources to the existence of man. Without it nothing would survive on the earth. The volume of water which is available in portable forms is found in water from the ground, springs, rivers and lakes, the proportion of which is only about

3%.The available water is often inadequate to meet the needs of ever-growing population and industrial demands (Behailu*et al*,2017).It is a common situation in the African continent that majority of the people are living in environments where the available water resources do not meet global standard(Salami *et al,*2017). Groundwater is the commonest potable source around the world (Kanmani, 2013). The chemical composition of groundwater is an indicator of how suitable it is for the consumption, for human beings, animals and plants (Chakraborty, 2015). Water quality refers to the amount of physical impurities, dissolved gases, chemicals, and pathogen in a given sample of water (Wurbs, 2010) Human activities impact natural water sources, including groundwater. One of such activities is the indiscriminate location of abattoirs in residential areas in developing countries. However, the settlement of abattoir otherwise known as slaughtering house is not often monitored and regulated as expected. Most of the abattoirs in Nigeria are not well developed and facilities for the handling of abattoir solid waste and wastewater are absent. Water pollution caused from abattoir effluents leads to contamination of water bodies and could create significant hazards (Kawe*et al*, 2012).

The main abattoir activities include butchering, removal of the hide, intestine management, rendering, trimming, processing and cleaning activities. The wastes generated from abattoirs usually comprise blood, oil, mineral and organic solids, salts and chemicals added during handling operations. Abattoir wastewater could significantly intensify the amounts of nitrogen, phosphorus, and total solids in the receiving water body (Akange *et al*, 2016). Slaughtering houses are known globally to contaminate the environment either directly or indirectly from their several procedures. The situation is worsened when abattoirs are situated near residential areas and as such the abattoir wastes are disposed in gullies where runoff washes them downhill, thereby contaminating groundwater and nearby streams.The dynamics of stream macro-invertebrates is influenced, by a number of factors such as geomorphology, physicochemical and biological factors as well as the pollution status of the water (Batabyal *et al*., 2015). Anguwa-Uku stream, receives effluent from the abattoir in Gombe metropolitan town. The effluents pollute water channel to the extent that it becomes deleterious to aquatic animals. There is only few documented information on the pollution status of these effluents.The present study is therefore aimed to determine the status of abattoir effluents on the stream that carries the effluent and to assess the influence of these effluents on the abundance and distribution of macro invertebrates. The study aimed at investigating the effect of abattoir effluent on macro invertebrates at Anguwa-Uku stream fed with effluent from Gombe township abattoir

MATERIALS AND METHODS

Study Area

This research was conducted in Gombe township abattoir along the stream that carries the effluent. The abattoir lies between the latitude 10.17^0N and longitude 11.11^0E whereas Gombe lies between latitude 10.08^0N and 11.24^0E. Gombe is the capital city of Gombe State which is located in the center of the North eastern part of the country.

Anguwa uku stream lies between longitude 10^0,17.36^0N and latitude11^0 11.72^0E at an elevation of 419m. The stream was given birth as a result of convergence of multiple drainage sources emerging from within the metropolis surface runoff. In addition to the primary surface run off from the riparian communities, the stream is also fed from another arm which majorly delivers effluents from the Gombe township abattoir located a few meters away from the stream. The stream flows just outside the Gombe metropolis along the edge of Anguwa-uku passing through Wuro-Bello,Wuro-Jauroyya, the nearest villages and is likely emptied into the dam in Dadin kowa.

The stream substratum consists mainly of fine sand mixed with mud and occasionally with coarse sand and pebbles. Decaying macrophyte and debris also form part of the substratum. The wet season is from April to October and the dry season is from November to March.

Water Sampling Collection

Water samples were collected on a monthly basis between May and July, 2021 at three stations i.e. the upstream, midstream and downstream with an interval of 10m apart to ensure the homogeneity of the variables. Surface water temperatures were recorded with a thermometer. PH, Dissolved Oxygen (DO), transparency/Turbidity and Alkalinity were determined according to APHA (1998) method. Nitrate and Phosphate were measured spectrophotometrically after reduction with appropriate solutions APHA (1998).

Macro invertebrate Sampling

Macro-invertebrates were collected using the kick sampling method at each station (Emere, and Narisu, 2007). Samples for macro-invertebrates were collected into pre labelled collecting bottles containing 70% ethanol to preserve them. The bottles were taken to Biological Sciences Laboratory, Gombe State University. In the laboratory, samples were washed in a 500-mm mesh sieve to remove sand and macroinvertebrates were sorted using a stereoscopic microscope (magnification X10). All animals were separated and enumerated and identified under a binocular dissecting microscope. Macroinvertebrate species were identified using available keys (Day et al. 2002; de Moor et al. 2003; Arimoro and James 2008), and keys from elsewhere; Merritt and Cummins (1996) as well as assistance from macroinvertebrate specialists.

Data Analysis

All statistical analysis where appropriate were conducted using SPSS. The summary of Biological metrics, physical and chemical variables was compared using one-way Analysis of Variance (ANOVA) and the correlation coefficient was tested using Pearson Correlation.

RESULTS

The physico-chemical parameters of running waters could have been influenced by natural and anthropogenic activities around the sampling sites of this study as shown in Table 1 and 2.

Table 1: Variation of Physico-chemical Parameters for the three stations along Unguwa Uku stream (May-July, 2021).

Physicochemical Parameters	Upstream	Midstream	Downstream	P value
Temperature (°C)	33.19±0.85^b	22.20±0.85^b	29.00±0.7^a	0.001**
pH	7.33±0.29^a	7.22±0.27a	7.11±2.00a	0.451ns
Transparency (cm)	10.07±6.85a	14.70±4.44a	13.38±2.11a	0.267ns
Phosphate (mg/L)	2.12±0.45^a	1.80±53.53^b	1.2±2.2^b	0.202ns
Turbidity (mg/L)	77.40±5.83^a	71.10±84.39^a	87.61±1.80^a	0.40ns
Dissolved Oxygen (mg/L)	2.74±3.40^a	2.38±0.43^a	3.41±0.81^a	0.309ns
Nitrate (mg/L)	1.42±0.14^a	1.21±0.18^a	1.28±0.31^a	0.337ns
Total Dissolved Solid (ppm)	55.09±0.22^a	57±0.20^a	53±0.53^a	0.557ns

Means with different alphabet(s) along rows are significantly different

** Significant different at P≤0.01, ns – not significant at P≥0.05.

Table 2: Monthly Variation of Physico-chemical Parameters along Unguwa Uku stream, Gombe State (May-July, 2021).

cc	Temperature (°C)	pH	Transparency (cm)	Turbidity (mg/L)	Phosphate (mg/L)	TDS (ppm)	Nitrate	D.O(mg/L)
May	24.78 ± 0.38^{ab}	7.75 ± 0.45^{a}	63.38 ± 6.52^{a}	75.75 ± 1.96^{b}	1.50 ± 4.11^{ab}	58 ± 0.52	0.88 ± 0.26	2.15 ± 0.56^{a}
June	24.85 ± 0.45^{ab}	7.85 ± 0.46^{a}	48.50 ± 7.23^{a}	79.25 ± 5.69^{b}	2.50 ± 4.11^{ab}	60 ± 0.43	1.54 ± 0.71	2.63 ± 0.71^{a}
July	24.93 ± 0.57^{ab}	7.30 ± 0.13^{a}	68.00 ± 3.63^{a}	88.50±8.46a	2.75 ± 7.66^{a}	62 ± 0.34	1.33 ± 0.24	1.03 ± 0.43^{a}
P value	0.003**	0.440ns	0.506ns	0.001**	0.370ns	0.52ns	0.002ns	0.45ns

Means with different alphabet(s) along columns are not significantly different.
** significant at P≤0.01, ns – not significant at P≥0.05.

The benthic macro invertebrates' community composition of a particular habitat reflects the habitat characteristics. The presence of a particular population is governed by a specific set of ecological conditions prevailing at that period of times.The varieties found shows that the macro invertebrates are not sensitive species rather pollution tolerant species since they can thrive in a highly polluted water. Below is Table 3 showing the list of macro invertebrates found within the three selected stations of the stream.

Table 3: A checklist of macro invertebrates.

S/N	Phylum	Class	Order	Family	Genus	Species	Common names
1		Insecta	Diptera	Chironomidae	Cricotopus	*syvestris*	Non-biting midge
2		Insecta	Odonata	Gomphidae	Stylurus	*plagiatus*	Dragonfly
3		Insecta	Coleoptera	Psphenidae	Sapereda	*vestita*	Water penny larvae
4		Maxillopoda	Coleoptera	Euchaetidae	Pteroxena	*ischnochitonika*	Copepod
5		Insecta	Coleoptera	Eliminidae	Zaitzevia	*parucila*	Riffle beetle larvae
6		Insecta	Dipteral	Tabaidae	Tabanus	*sulcifrons*	Horsefly
7		Insecta	Coleoptera	Gyrinidae	Gyrinus	*marinus*	Whirligig beetle larvae
8		Insecta	Odonata	Coenagrionidae	Argis	*apicalis*	Damselfly
9		Insecta	Diptera	Ceratopogonidae	Leptoconops	*bezzianobilis*	Biting midge larvae
10		Insecta	Diptera	Syriphidae	Eristalis	*tenas*	Rat-tailed maggot larvae
11		Malacostraca	Decapoda	Atyidae	Gammanis	*tulas*	Freshwater shrimp
12	ARTHROPODA	Insecta	Coleoptera	Amphizoidae	Dysticus	*lastissimus*	Adult beetle
13		Gastropoda	Prosobranchia	Pleuroceridae	Hortia	*aruensis*	Gilled snail
14		Insecta	Odonata	Aeshnidae	Gynacantha	*vesiculata*	Aeshnid larvae
15		Insecta	Diptera	Bibionidae	Rhagoletis	*pomonella*	Marchfly larvae

Composition of macroinvertebrates is displayed in Table 4. In this present study, altogether 5 groups of benthic macro invertebrates were recorded, viz. Diptera, Odonata, Coleoptera, Decapoda, and Prosobranchia. The macro invertebrate abundance was found to vary in different months depending on the amount of discharge from rainfall. The macro invertebrate abundance was found to be more through the month of May when there was little or no rainfall and less abundance was recorded through the month of June and July where the rainy season set in.

Table 4: Composition of Macro-invertebrate along the three selected sample stations of Anguwa-uku stream.

MAY

S/N	Order	Upstream	Midstream	Downstream	Total Composition	Composition (%)
1	Diptera	4	7	9	20	31.25
2	Odonata	10	0	5	15	23.44
3	coleoptera	3	14	12	29	45.31

JUNE

S/N	Order	Upstream	Midstream	Downstream	Total Composition	Composition (%)
1	Diptera	3	2	0	5	16.13
2	Odonata	1	3	8	12	38.71
3	Coleoptera	3	5	1	9	29.03
4	Decapoda	0	0	3	3	9.68
5	Prosobranchia	0	0	2	2	6.45

JULY

S/N	Order	Upstream	Midstream	Downstream	Total Composition	Composition (%)
1	Diptera	3	1	0	4	14.29
2	Odonata	1	0	9	10	35.71
3	coleoptera	10	3	1	14	50.00

From the present study, the low number of benthicmacroinvertebrates encountered could be due tosome ecological imbalance arising from alterations ofsome important factors (including water quality, immediate substrates for occupation and foodavailability) governing the abundance anddistribution of the communities(Andem *et al*., 2012). Similar results were obtained by Ogbeibu andEgborge(1995) in water bodies in the Okomu forestreserve(sanctuary) in southern Nigeria and theystated that high biodiversity is expected inecosystems devoid of significant anthropogenicimpacts.

The occurrence and dominance of pollutiontolerant species (*Melanoides tuberculata andChironomus* larvae) in the study area suggestsdeterioration of water quality. *Chironomus* larvae areknown to thrive in polluted environment probablydue to possession of haemoglobin a pigment thattransport and store dissolved oxygen (Tyokumbur *etal*., 2002). The presence of these indicator speciessuggests organic pollution from anthropogenicsource. Hence, the abattoir effluent has effect on the macro invertebrates along anguwa uku stream.

The month of May recorded the highest abundance of macro invertebrate (64) and the month of July, recorded the least (28) the least. The benthic macroinvertebrates with the highest percentage abundance was Coleoptera in the first and third month (43.51%) and(50.00%)Diptera(31.25%) in May was> greater rhan that of July and Odonata lesser in May(23.44%) but highest in June(38.71%). Decapoda (9.68%) and Prosobranchia (6.45%) recorded the most minimal percentage composition.

DISCUSSION

The physicochemical qualities of water, immediate substrate of occupation, level of discharge and food availability are important factors affecting the abundance of macro invertebrates (Arimoro and Muller 2010). The physicochemical parameters of Anguwa-uku stream demonstrated a fair level of pollution. However, water conditions were better in the upstream station and further downstream than in the middle reaches. This may be as a result of the influx of the abattoir effluent hitting the stream at that particular point. Water temperature over the span of three months fluctuated with a minimal difference between the three stations where the temperature was recorded. At the upstream station, it was recorded at a minimum of 22.85^{0}C. The mid- and downstream recorded of non difference as the temperature rose to 24^{0}C. Generally, depth and flow velocity were considerably greater during the second and third month (June and July) as rainfall was more persistent than in may where there was little or no rainfall. Most of the chemical variables (Dissolved Oxygen, Phosphate and Nitrogen) showed a statistically significant difference from the month of May through July. Lesser values Dissolved Oxygen downstream might have been exherting respiratory stress for the aquatic fauna which is in agreement the findings of Nnaji *et al.* (2011) who mentioned comparable situation for the River Galma, Nigeria. Hydrogen ion concentration of the various sampling sites revealed that the stream is slightly acidic but differences among the sites were not statistically significant. pH being one of the most important water quality parameters has been found to have profound effect on the ecology of macro invertebrate in the aquatic system although, macro invertebrate sensitivity to pH varies (Yuan, 2004). Values below 5.0 and greater than 9.0 are considered harmful. Low pH values are associated with lower diversity of macro invertebrate.

It has been reported in a number of studies that intense human activities resulting from discharge of organic pollutants into streams lead to increase in nutrient levels and in biological oxygen demand which in turn affects the distribution and abundance of macro invertebrates (Masese *et al*. 2009; Gichana *et al*. 2015; Mwedzi *et al*. 2016).

The dominant macro invertebrates in Anguwa-uku were the aquatic insects. This observation is similar to the observation of Imoobe (2008) in Ologe Lagoon, Nigeria, and that of Arimoro et al. (2015), but differs from the dominance by mollusks reported in Lagos Lagoon and Porto Novo Creek (Ajao and Fagade 2002). These differences in the dominance of macro invertebrates are linked to the environmental conditions of the various water bodies. The abundance of Diptera, Coleoptera, and Odonata in all the stations is an indication that these sites are relatively polluted. It has been reported that the species of Coleoptera is found in mostly very clean waters (Andem *et al*. 2014).

The tolerant Dipterans were the most dominant order with a little of Odonatans. Sensitive taxa as coleoptera, prosobranchea and decapoda represented together only few portion of the observed numbers, whereas Plecoptera were totally lacking. The opportunistic pollution tolerant aquatic macro invertebrate taxa recorded at these stations are known to thrive in organically polluted areas of aquatic environments. Furthermore, the total number of orders observed in the present study was comparable with Wosinie and Wondie (2014) but was rather low compared with other studies in Ethiopia (Mehari *et al.,* 2014; Sitotaw, 2006) and in Africa (Kibichii *et al.,* 2007; Kasangaki *et al.,* 2008; Masese *et al.,* 2009).

CONCLUSION

The physico-chemical parameters of Anguwa-uku receiving effluents from Gombe main abattoir lies within the allowable limits of fresh water body. The dominant benthic macro-invertebrates fauna of the stream recorded were pollution tolerant species. The low number of benthic macro-invertebrates and the dominant species suggested that the stream is relatively under stress. It is relatively polluted with organic pollutants released by effluent from the abattoir.

A better drainage system or underground sewage should be constructed to avoid or minimize the rate at which effluents from abattoirs or their likes are deposited onto water bodies. Regular assessment should be conducted to checkmate the increasing pollution trend which does more harm to the aquatic fauna.

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