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Study of Physico-chemical Properties and Heavy Metals Status in Relation to Aluminium Phosphide (AlP) and Rotenone on Water in Ponds at Taherpur Municipality of Rajshahi District, Bangladesh

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ABSTRACT

The present research was carried out to determine the impacts of physico-chemical properties and heavy metal status against the fish killer chemicals, aluminum phosphide (AlP) and rotenone on water in selected 10 fish ponds at Taherpur Municipality under Bagmara Upazila of Rajshahi District in Bangladesh. The fish killer chemicals, AlP and rotenone are generally used in water to start-up a pond for removing all kinds of fish species before restocking. The observed physico-chemical properties like temperature, pH, electric conductivity (EC), dissolved oxygen (DO) and total dissolved solids(TDS) were found in water within the range of Bangladesh and WHO standard values. The mean values of water temperature, pH, EC, DO and TDS were 23.73±0.13^{o}C, 7.59±0.08, 230.83±1.78 µS/cm, 4.33±0.11 mg/L and 211.59±2.62mg/LforAlPand23.80±0.20^{o}C,7.58±0.08,232.00± 1.63µS/cm,4.28±0.08 mg/L and 212.60±2.55 mg/L for rotenone respectively. The student's t-test was used for comparison of mean values of control and treatment, and DO exhibit a highly significant difference at the level of $P< 0.001$ both for AlP and rotenone and EC at $P< 0.01$ only for rotenone. The ANOVA revealed that there was statistically highly significant difference ($P< 0.001$) between treatments (AlP and rotenone) and fish ponds. The level of heavy metal concentrations in the two treatments did not exceed the WHO maximum recommended limit except Cr and Pb. The descending order of heavy metal concentrations for AlP and rotenone were Cr > Pb > Fe > Mn > Zn and Cr > Pb > Mn > Fe > Zn respectively. These results suggested reducing the unnecessary use of AlP and rotenone in ponds because these two chemicals increase the level of Cr and Pbin water. The present investigation was the first report on this topic that proposes future research on the soil as well as fisheries species to understand the total environmental impacts of ponds concerning AlP and rotenone.

1. Introduction

Bangladeshis encompassed by rivers and different types of water bodies like ponds, bills, haors- baors, lakes, weight land, etc. Freshwater resources play an important role in food security and socio-economic development in Bangladesh (Nabi, 1982; BBS, 2002).Fish culture and harvesting in Bangladesh is a traditional occupation, it is changing day by day in accordance with demand of the consumer (Hussain and Mazid, 1997; Hussain, 2005). It is reported that more than 12% of populations are directly or indirectly involved in many activities under fisheries sector for their livelihood (BBS, 2016). According to the yearbook of fisheries statistics of Bangladesh 2018-2019, the number of the total fish ponds in Bangladesh

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was 2480,883, and the annual production of fish was 1974,632 metric tons (DoF, 2019). The total pond area in Bangladesh was 397,775 hectares in which Rajshahi district covers 12,426 hectares that produce 57,132metrictonsofthetotalfish production (DoF, 2019).Rajshahi district also contributes 3.12% of the total area of ponds in the country which contributes 3% of the total production (DoF, 2019).

In the context of climates, water availability and quality of Bangladesh mostly cultured common fishes are shrimp, prawn, carp, catfishes, pangas, thai koi (Ali, 1991). Bangladesh enriches with aquatic diversity containing 260 species of fresh water fish species (Rahman, 2005). In fish culture, supplementary foods *viz*. rice bran, oilcake, wheat, maize, soyabean cake, dry fish, fish meal, ready feed are used generally (Mamun-Ur-Rashid *et al.*,2013). The fishfarmer used different types of fertilizer, vitamin-mineral premix, calcium, phosphorus in their ponds for the growth of fish (Zaher and Mazid, 1993). Some common pesticides, insecticides, rodenticides like aluminium phosphide (AlP), rotenone, amamectinebenzoyde, quinulfus, malatheone, etc., are used in fish culture. Among them, AlP and rotenone are mostly used as fish killer chemicals in Bangladesh. These fish killer chemicals have applied in water to start-up a pond for removing all kinds of fish species from ponds before restocking. It is reported that only fish toxicants *e.g.*, chlorine, rotenone and antimycin A are currently approved by the U.S. Environmental Protection Agency (EPA) (Wynne and Masser, 2010).

AlP is a highly toxic, cheap, effective and commonly used inorganic pesticide. Generally, AlP is used to kill small crawling mammals such as moles and rodents, and it is practiced as a rodenticide, insecticide and fumigant (Corbridge, 2013). It is available in our country under some trade name*s e. g.*, Padmatox, Greenfume, Saratox, Quicktox and Mimtox. Although AlP is suitable for killing small mammals, however, unfortunately, at present it is widely used as a fish killer chemical. It is now one of the most common causes of poisoning among agricultural pesticides (Gurjar*etal.*, 2011).A previous study about the mechanism of toxicity of AlP has shown that AlP liberates phosphine gas in water and in the stomach in the presence of HCl (Gurjar *et al.*, 2011). After that, AlP is quickly absorbed through the gastrointestinal tract, then attacks the gills, heart, lung, kidney, liver and other major organs of the body (Gurjar *et al.*, 2011; Nourbakhsh *et al.*, 2019).

Rotenone is used to remove unwanted species from freshwater systems for centuries by fishermen to harvest fish (*Sackett, 2012*). Rotenone is derived naturally from the seeds, roots and stems of several plants. The mode of action of rotenone is suffocation by inhibiting cellular respiration and preventing the ability to use dissolved oxygen (Wynne and Masser, 2010). It also affects most aquatic gill-breathing animals such as fish, amphibians and insects. The physico- chemical conditions *i.e.*, temperature, pH, electric conductivity (EC), dissolved oxygen (DO) and total dissolved solids (TDS) of water in fish ponds are major elements for fish growth rates and development (Jhingran, 1991). It is well known that the good quality of water in fish ponds is essential for the survival and adequate growth of fish (Burford, 2008). A considerable amount of work on the physico-chemical characters of ponds water has been carried out by various researchers *viz*. Hossain *et al.* (2013), Khatun *et al.* (2018), Bhatnagar and Devi (2019).

The term heavy metals imply any metallic chemical element that is toxic or poisonous at low concentrations, and it includes lead (Pb), cadmium (Cd), zinc (Zn), mercury (Hg), arsenic (As), silver (Ag) chromium (Cr), copper (Cu) iron (Fe) and thallium (Tl) (Duffus, 2002; Govind and Madhuri, 2014). Heavy metals are considered highly toxic to the aquatic environment as well as harmful to living organisms (Duffus, 2002). These are threats to human health, and contaminated food causes several health risks such as skin lesions, gastrointestinal diseases, damage to the nervous system, kidney disease, heart disease, diminished intellectual capacity, bone fracture, cancer, and death (Järup, 2003, Jaishankar *et al.*, 2014). It is also documented that heavy metals are contaminated the food chain in water (Islam *et al.*, 2018).The toxicity of heavy metals can cause great harm to the fish species in the aquatic environment (Jothi*et al.*, 2018).

Taherpur Municipality under Bagmara Upazila can be counted as one of the principles fish production areas in the northwest region of Bangladesh. Nearly all fishermen are used AlP and rotenone in water as fish killer chemicals to start-up their fish ponds. In this context, it is necessary to find out the impact due to applying such kinds of fish killer chemicals in fish culture. Although some works on AlP and rotenone have been done all over the world, but little or no work has been done on the AlP and Rotenone in relation to physico-chemical conditions and heavy metals status on water in fish ponds of Rajshahi, Bangladesh. Therefore, the present study has an aim to the assessment of physico- chemical conditions and heavy metals status against fish killer chemicals, aluminium phosphide (AlP) and rotenone on water in fish ponds at Taherpur Municipality of Rajshahi District in Bangladesh.

2. Materials and Methods

2.1. Study Area

The study area was selected at Taherpur Municipality in Bagmara Upazila under Rajshahi District which is an area of the North-western part of Bangladesh **(Fig. 1)**. The land area of Taherpur Municipality is 363.3 sq km,

located in between 24°30'and 24°41' north latitudes and in between 88°41' and 88°58' east longitudes. It is bounded by Manda and Atrai Upazila on the north; Durgapur, Puthia and Natore Sadar Upazila on the east and Mohonpur Upazila is on the west. Taherpur Municipality is 30 km far away from Rajshahi city and 10 km far away from Bagmara Upazila.

2.2. Climate of Study Area

The climate of Rajshahi is usually tropical monsoon characterized by high temperature, heavy rainfall and often disproportionate humidity (Islam and Neelim, 2010). It has four distinct seasons from the climatic point of view: the summer pre-monsoon (PM) season from March to May; the rainy monsoon season

(M) from June to September; the autumn post-monsoon (PoM) season which lasts from October to November; and the winter

(W) season from December to February (Shahid, 2010; Khatun *et. al.*, 2016).

2.3. Sampling Ponds and Collection Period

Taherpur Municipality consists of 9 wards, and 10 sampling ponds were selected from each ward except ward 5 (two ponds from this ward) for study **(Fig. 2**). Pond sizes of the study area varied from 33 decimal (1 bigha) to above 330 decimal (10 bigha) of which the total area of ponds was 2079 decimal (63 bigha). The sample were collected season-wise i.e., monsoon, pre-monsoon, post-monsoon and winter during July 2016 to June 2017.

2.4. Doses Preparation

Two fish killer chemicals such as aluminium phosphide (AlP) and rotenone were used throughout the experiments. For AlP treatment, 330 tablets (3g each) were used for 33 decimal (1 bigha) water areas with an average 5 feet water depth which is commonly used by fish farmers.In this study, rotenone was appliedat 2kg/1 bigha/5 feet water depth to keep the similarity with the fish farmers. The detailed procedure of dose preparation was followed by Kumar *et al.*, 1992.

2.5. Determination of Physico-chemical Parameters

Physico-chemical data were collected season-wise on five parameters *viz.* temperature, pH, electric conductivity (EC), dissolved oxygen (DO) and total dissolved solids (TDS) from 10 ponds. Data were collected three times from each pond in every season for control and treatment (treatment with AlP and rotenone). The temperature of the water was recorded directly in ponds by using an alcohol thermometer. Then water samples were carried out immediately in a plastic bottles and transfer to the Water Lab, Institute of Environmental Science, University of Rajshahi for determining pH, EC, DO and TDS. The pH, EC, DO and TDS of water were measured by pH meter, EC meter, DO meter and digital TDS meter respectively (HANNA instrument, Romania).

2.6. Heavy Metal Analysis

A total of 66 water samples were collected for laboratory investigation from the 10 study ponds at three times for control and treatment (treatment with AlP and rotenone) separately. Analytical works were done in the Central Science Laboratory, University of Rajshahi.

2.7. Statistical Analysis

All data were calculated using Microsoft Office Excel (version 2016). Student t-test and two-way analysis of variance (ANOVA) were performed. $P< 0.05$ (*) was considered statistically significant.

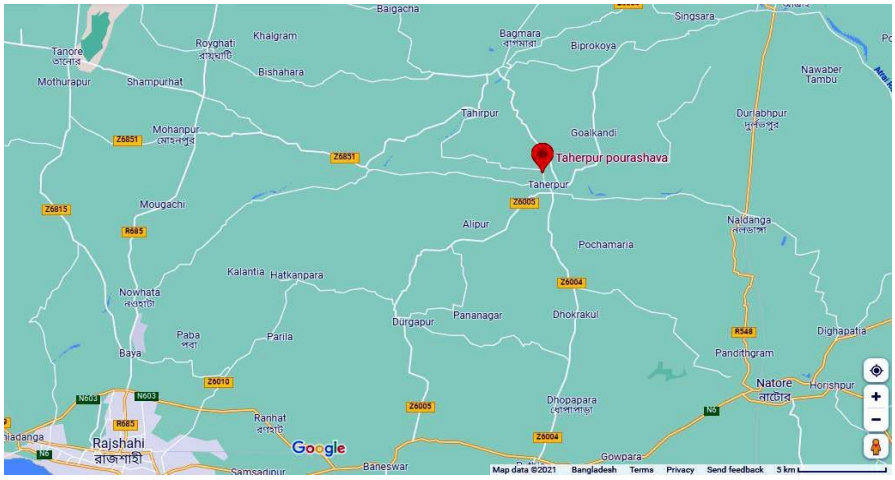

Figure 1. Map of study area at Taherpur Municipality (Pourashava).

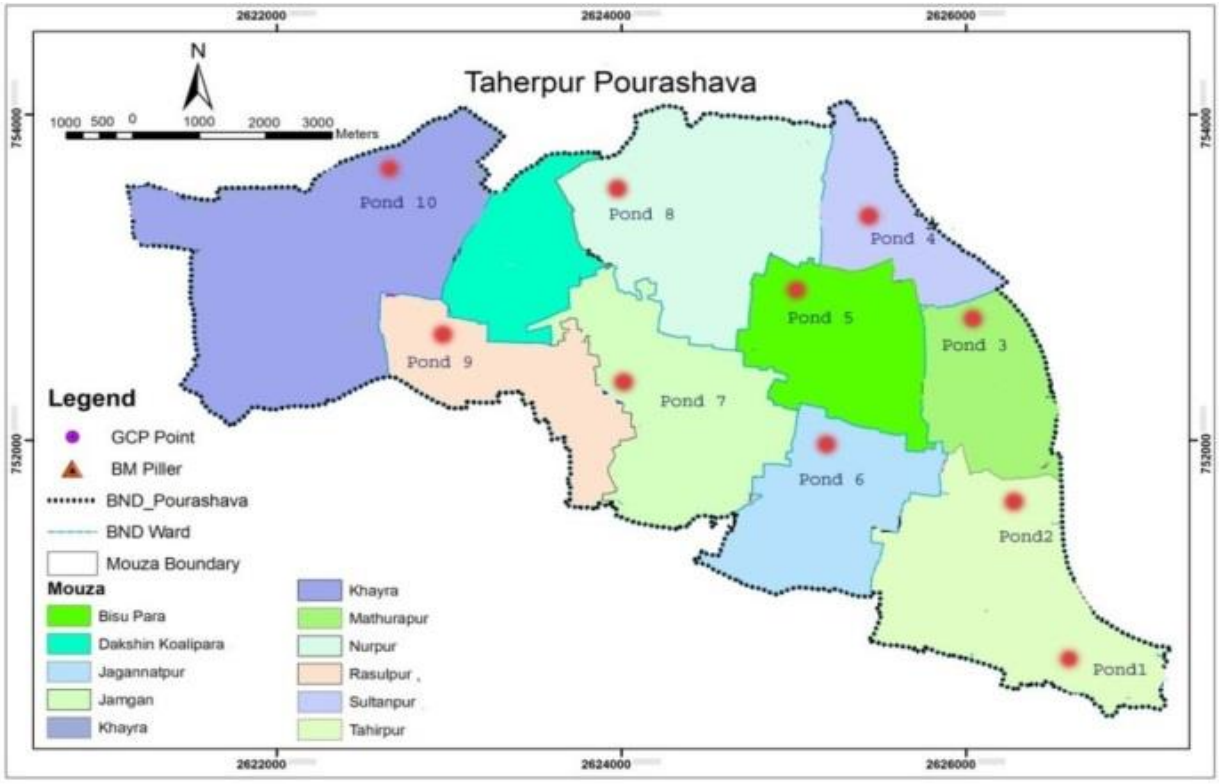

Figure 2. Map of sampling ponds at Taherpur Municipality (Pourashava). Red circles show the pond location.

3. Results and Discussion

The physico-chemcal parameters of the water in fish ponds such as temperature, pH, EC, DO and TDS are presented in **Table 1-5**. The heavy metals statuses show in **Table 6**.

3.1. Physico-chemical Conditions against AlP and Rotenone

3.1.1. Temperature

The highest value of water temperature was recorded at 28.93°C and the lowest value was 17.47°C for AlP **(Table 1)**. For rotenone, the maximum value of water temperature was recorded at 29.17°C and the minimum value was 17.47°C **(Table2)**. The mean value was noted against AlP and rotenone at 23.73°C and 23.80°C respectively **(Table 3)**. The temperature is one of the major factors which affect the aquatic ecology (Huet, 1986). The recorded temperature range was supported by another study that showed temperature fluctuation from 17.09º C to 31.66º C (Bhuiyan *et al.*, 2008a). According to Bangladesh Environmental Quality Standard (BEQS), the typical limit of surface water temperature is 20°-30°C, and below or above these temperature range affect the aquatic organisms (DoE, 1997).

3.1.2. pH

The highest value of water pH was recorded at 7.87and the lowest value was7.27 for AlP **(Table 1)**. For rotenone, the maximum value of water pH was recorded at 8.07 and the minimum value was 7.33 **(Table 2)**. The mean value was documented against AlP and rotenone at 7.59 and 7.58 respectively **(Table 3)**. The pH is very essential parameter because it`s have a significant effect on the water quality. Our result indicates that the water of the pond is slightly alkaline in nature. The acceptable range of pH for fish culture is 6.5 to 8.5 according to Bangladesh standards, FAO standards and Bangladesh Environment Conservation Rule (ADB, 1994; ECR, 1997). More or less similar findings were observed by Bhuiyan *et al*. (2008b) in a fish pond in Rajshahi.

3.1.3. Electric Conductivity (EC)

The highest value of electric conductivity (EC) of water was recorded at 253.33 micro Siemens per cm (µS/cm) and the lowest value was 208.33µS/cm. For rotenone, the maximum value of EC water was recorded at 255µS/cm and the minimum value was 210µS/cm **(Table2)**. The mean value was noted against AlP and rotenone at 230.83 and 232.00µS/cm respectively **(Table 3)**. Meghla *et al.*, (2013) stated that the EC

values of Turag River were ranged from 691to 822,618 to 1334 and 155 to 276 µS/cm in post monsoon, premonsoon and monsoon season respectively. A previous study from the adjacent area of present study field, Mohanpur Upazila of Rajshahi District showed that the EC of surface water was 233 to 645 µS/cm (Salam *et al.*, 2012).In this study, the range of EC was 208.33 to 255 µS/cm which is considered as a desirable range.

Table 1. Season-wise average of physico-chemical conditions against aluminium phosphide (AlP) on ten ponds at Taherpur Municipality of Rajshahi District in Bangladesh. P: Pond; PM: Pre-Monsoon; M: Monsoon, PoM: Post-Monsoon; W: Winter.

Parameters	**Season**	**Sampling sites/ Pond water**									
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Temperature (^oC)	PM	26.27	26.43	26.23	26.23	25.57	26.03	26.53	25.57	26.4	26.43
	M	28.63	28.57	28.9	28.87	28.83	28.93	28.53	28.9	28.8	28.9
	PoM	22.47	22.73	21.6	22.33	21.53	22.83	22.33	22.23	21.87	22.7
	W	18.03	17.5	17.77	17.73	17.87	17.6	17.5	17.9	17.63	17.47
pH	PM	7.57	7.53	7.47	7.43	7.4	7.63	7.63	7.87	7.7	7.83
	M	7.27	7.47	7.47	7.47	7.33	7.63	7.47	7.63	7.4	7.23
	PoM	7.33	7.37	7.53	7.47	7.83	7.77	7.77	7.6	7.7	7.73
	W	7.77	7.5	7.6	7.73	7.8	7.63	7.8	7.55	7.77	7.83
EC (µS/cm)	PM	210	208.33	210	213.33	210	206.67	208.33	210	208.33	206.67
	M	243.33	253.33	246.67	248.33	245	245	251.67	250	245	251.67
	PoM	225	221.67	228.33	233.33	230	221.67	223.33	228.33	220	220
	W	240	240	236.67	240	243.33	238.33	243.33	243.33	245	240
DO (mg/L)	PM	4.93	4.53	4.73	4.57	4.4	4.63	5	4.67	4.8	4.5
	M	3.53	3.7	3.5	3.57	3.2	3.87	3.87	3.7	3.83	3.77
	PoM	4.9	4.8	4.8	4.87	4.67	4.8	5.07	4.8	4.77	4.63
	W	4.3	4.23	4.2	4.3	4.13	4.1	4.17	4.1	4.1	4.13
TDS (mg/L)	PM	225.4	228.8	220	228.63	225.77	227.3	223.83	228.33	226.67	223.47
	M	140.8	153.63	162.23	149.13	161.9	154.17	162.23	152.5	145.4	145.57
	PoM	253.97	253.93	257.2	262.23	248.7	255.77	262.17	267.27	260.53	270.3
	W	203.73	209.07	199	212.3	203.93	212.23	208.93	208.8	210.67	217.27

Table 2. Season-wise average of physico-chemical conditions against rotenone on ten ponds at Taherpur Municipality of Rajshahi District in Bangladesh. P: Pond; PM: Pre- Monsoon; M: Monsoon, PoM: Post-Monsoon; W: Winter.

Parameters	Season	Sampling sites/ Pond water									
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Temperature (^oC)	PM	26.27	25.6	26.63	26.03	26.4	26.13	26.37	26.9	26.07	26.6
	M	28.5	28.87	28.93	28.4	28.93	29.03	28.87	29.17	28.77	29.17
	PoM	22.77	22	22.57	22.27	22.83	22.93	22.3	21.93	21.6	22.5
	W	17.63	17.9	17.7	17.5	17.47	17.8	17.67	17.57	17.53	17.97
pH	PM	7.67	7.5	7.63	7.6	7.4	7.6	7.43	7.73	7.63	7.87
	M	7.37	7.33	7.33	7.47	7.43	7.7	7.47	7.5	7.37	7.37
	PoM	8.07	7.53	7.77	7.43	7.7	7.63	7.43	7.5	7.6	7.5
	W	7.93	7.6	7.6	7.63	7.33	7.6	7.87	7.77	7.63	7.67
EC (µS/cm)	PM	210	208.33	215	211.67	210	210	210	210	213.33	206.67
	M	251.67	251.67	250	251.67	246.67	246.67	255	248.33	246.67	250
	PoM	221.67	226.67	230	233.33	223.33	223.33	223.33	230	226.67	226.67
	W	238.33	240	241.67	243.33	241.67	240	241.67	241.67	241.67	241.67
DO (mg/L)	PM	4.6	4.5	4.63	4.53	4.53	4.57	4.93	4.63	4.57	4.47
	M	3.43	3.33	3.43	3.37	3.4	3.83	3.57	3.73	3.53	3.63
	PoM	4.93	4.77	4.77	4.77	4.57	4.77	4.97	4.77	4.77	4.3
	W	4.13	4.1	4.27	4.37	4.33	4.23	4.3	4.23	4.13	4.53
TDS (mg/L)	PM	225.13	228.43	226.97	235.23	225.7	228.87	223.7	235.3	228.8	233.63
	M	148.9	155.47	159	150.87	157.33	152.33	159.17	151.83	145.4	145.27
	PoM	257.17	254	257.1	262.4	248.97	255.7	260.73	267.2	260.67	268.73
	W	205.47	208.87	205.53	212.3	203.83	212.3	208.93	208.93	210.6	217.33

Table 3. Composition of physico-chemical parameters (mean) recorded against AlP and rotenone on ponds (N= 10) at Taherpur Municipality of Rajshahi District in Bangladesh (BD standard and WHO limit referred by DoPHE, 2021).

Parameters	Units	Control (Mean±SD)	Treatment with ALP (Mean±SD)	Treatment with Rotenone (Mean±SD)	BD standard	WHO
Temperature	^{o}C	23.71±0.16	23.73±0.13	23.80±0.20	20-30	≤ 40
pH	--	7.63±0.12	7.59±0.08	7.58±0.08	6.5-8.5	6.5-8.5
EC	(µS/cm)	229.62±1.32	230.83±1.78	232.00±1.63	500	750
DO	mg/L	4.51±0.07	4.33±0.11	4.28±0.08	≤ 5	6.5-8.5
TDS	mg/L	210.69±2.87	211.59±2.62	212.60±2.55	1000	500

3.1.4. Dissolved Oxygen (DO)

The highest value of dissolved oxygen (DO) of water was recorded at 5.07 mg/L and the lowest value was 3.20mg/L **(Table 1)**. For rotenone, the maximum value of DO of water was recorded at 4.93 mg/L and the minimum value was 3.33 mg/L **(Table2)**. The mean value was documented against AlP and rotenone at 4.33 and 4.28 mg/L respectively **(Table 3)**. Dissolved oxygen levels in water less than 1: death of fish, less than 5: fish survive but grow slowly and put under stress, 5 and above: desirable (Bhatnagar and Devi, 2019). Dissolved oxygen content in all the study ponds varied from 3.20 to 5.07 mg/L. Khatun *et al.* (2018) found dissolved oxygen range between 3.52±0.25 to 4.79±0.59 in some ponds which is much closer to the present study. A previous study also showed that the dissolved oxygen range between 3.35 to 4.77 mg/L in some fish ponds which is similarly supported the current study (Bhuiyan *et al.*, 2008a).

3.1.5. Total Dissolved Solids (TDS)

The highest value of total dissolved solids (TDS) of water was recorded at 270.30 mg/L and the lowest value was140.80 mg/L **Table 1)**.For rotenone, the maximum value of TDS of water was recordedat268.73mg/ Land the minimum value was145.27 mg/L **(Table2)**. The mean value was noted against AlP and rotenone at 211.59 and 212.60 mg/L **(Table 3**). It is well known that TDS is a vital chemical parameter for water assessment (Kabir *et al*., 2002). According to DB standard and WHO, the maximum permissible limit of TDS for drinking water is given in **Table3** (DoPHE, 2021). James (2000) stated that the maximum TDS value of 400 mg/L is permissible in fish culture. The highest and lowest TDS values of pond water of Tangail District were recorded as TDS 85-164 mg/L respectively which is supported by this study (Munni*et al.*, 2013). It can be said that the TDS values of the present study were very low than the standard value.

3.2. Student's T-test among Mean Values

The student's t-test was done among the mean values of the control and treatments (AlP and rotenone) of 10 ponds separately **(Table 4)**. In the case of AlP treatments, temperature, pH, EC and TDS were not shown any significant differences between control and treatments. Interestingly, DO was showed highly significant (P<0.001) differences between control and treatments, and T and P values were 4.446 and 0.0003 correspondingly (**Table 4)**. On the other hand, temperature, pH and TDS were not exposed to any significant differences between control and treatments. Remarkably, the T values were 3.581 and 7.229 for EC and P values were 0.0021 and 0.0001 for DO respectively.EC and DO were considered as moderate and highly significant at the level of P<0.01 and P<0.001 respectively **(Table 4)**.The present study did not show any significant difference between the pH for control and treatments. However, Leščešen *et al.*, (2015) revealed the values of pH are statistically significant at the level p<0.01 between warmer and colder periods. A recent study showed that t-test of physical parameters of water *viz.* EC, turbidity, TDS were significant at the level of P<0.001(Sakthi vadivela *et al.*, 2020).

Table 4. Statistical analysis of physico-chemical conditions of mean values of control and treatment of 10 ponds using student's t-test for AlP and rotenone at Taherpur Municipality of Rajshahi District in Bangladesh.

Parameters	**Treatment with AlP**			**Treatment with rotenone**		
	T value	Pvalue	Level	T value	Pvalue	Level
Temperature	0.2782	0.7840	NS	1.001	0.3303	NS
pH	1.009	0.3264	NS	1.199	0.2459	NS

EC	1.725	0.1017	NS	3.581	0.0021	**
DO	4.446	0.0003	***	7.229	0.0001	***
TDS	0.7324	0.4734	NS	1.572	0.1334	NS

**, P <0.01; ***, P<001; NS, not significant

3.3. ANOVA analysis

A two-way analysis of variance (ANOVA) was conducted to evaluate the relationship of treatments (AlP and rotenone) and water quality in different ponds (N= 10). The ANOVA analysis was exposed that there were highly significant differences ($P< 0.001$) among different treatments in all physico-chemical parameters, while among the study ponds only EC and DO were shown as significant at the level of $P< 0.05$ and $P< 0.01$ respectively **(Table 5)**. Jannat *et al.,* (2019) reported that the ANOVA analysis did not expose any significant difference ($P> 0.05$) in physico-chemical water quality parameters in different study points of the Mokesh beel, Gazipur which did not support the present study. The study was supported by a current study that ANOVA showed a highly significant difference ($P< 0.001$)among physical parameters of water *viz.* EC, turbidity, TDS (Sakthivadivela *et al.*, 2020).

Table 5. Two-way analysis of variance (ANOVA) that examined the effect of treatments (AlP and rotenone) and ponds (N= 10) at Taherpur Municipality of Rajshahi District in Bangladesh.

Parameters	*SourceofVariation*	*SS*	*DF*	*MS*	*F*	*P-value*	*F crit*	Level
Temperature	Treatments	1415.052	7	202.1503	2017.967	1.48E-71	2.158829	***
	WaterPonds	0.955731	9	0.106192	1.060066	0.404316	2.032242	NS
	Error	6.311039	63	0.100175				
	Total	1422.319	79					
pH	Treatments	0.660135	7	0.094305	4.143714	0.000834972	2.158828996	***
	WaterPonds	0.24475	9	0.027194	1.19491	0.314110962	2.032242211	NS
	Error	1.43379	63	0.022759				
	Total	2.338675	79					
EC	Treatments	17969.95	7	2567.136	329.5657	4.25828E-47	2.158828996	***
	WaterPonds	168.484	9	18.72044	2.403307	0.020632904	2.032242211	*
	Error	490.7354	63	7.789451				
	Total	18629.17	79					
DO	Treatments	17.17405	7	2.453436	124.6465	2E-34	2.158829	***
	WaterPonds	0.535511	9	0.059501	3.022953	0.004601	2.032242	**
	Error	1.240039	63	0.019683				
	Total	18.9496	79					
TDS	Treatments	120102.4	7	17157.49	654.1091	2.79913E-56	2.158828996	***
	WaterPonds	439.4615	9	48.82905	1.86155	0.074470959	2.032242211	NS
	Error	1652.51	63	26.23032				
	Total	122194.4	79					

*,P<0.05; **, P<0.01; ***, P<001; NS, not significant

3.4. Status of Heavy Metals Analysis

The results of heavy metal concentrations in ponds water (N=10) are shown in **Table 6**. The trace heavy metals were Iron (Fe), Chromium (Cr), Lead (Pb), Zinc (Zn) and Manganese (Mn). The mean values of heavy metal concentrations were found against AlP as Fe: 0.0240□0.0008 mg/L, Cr: 0.1063□0.0003 mg/L, Pb: 0.0723□0.0099mg/L,Zn:0.0052□0.0002mg/ LandMn: 0.0077□0.0003mg/ L **(Table 6)**. The concentrations of trace metals in water treated with AlP following the descending order of:

Cr>Pb>Fe >Mn >Zn

The mean values of heavy metal concentrations were found against rotenone as Fe:0.0191□0.0006 mg/L, Cr: 0.1189□0.0001mg/L,Pb:0.0811□0.0021

mg/L, Zn: 0.0095□0.0035 mg/L and Mn: 0.0307□0.0014 mg/L **(Table 6)**. In the case of rotenone, the rank of heavy metal concentrations in water was as:

Cr >Pb >Mn >Fe>Zn

The level of the metal's status for the Cr and Pb was exceeded against the two fish killer chemicals compared to the WHO maximum possible limit (DoPHE, 2021). The range of values of heavy metals of

Mn, Zn, Fe and Pb varied from 21.30±2.64to76.57±30.90mg/L,

0.08±0.02to1.25±0.79mg/L,0.75±0.10

to1.87±0.53mg/Land0.14±0.12 to 4.92±1.66 mg/L respectively, which was much higher than the present study (Flowra *et al*., 2012). Similar observation for Zn, Pb and Cr was reported by Sultana *et al*. (2017) in aquaculture ponds in Mymensingh which ranged over the following intervals: Zn: 0.01- .072 mg/L, Pb0.039–0.068mg/L, and Cr:0.123-0.23

mg/L. A recent study has been reported that the average concentration of Pb was 0.05±0.05 mg/L that supports the present study (Islam *et al.*, 2018). Many researchers also worked on heavy metals namely Beyene and Berhe (2015) and Jaishankar *et al.* (2014).

Table 6. Trace heavy metal concentrations (mg/L) in water samples from ponds (N= 10) and their WHO limits for AlP and rotenone (WHO limit referred by DoPHE, 2021)

Sl.No.	Name of heavy metal	Control (Mean±SD)	Treatment with ALP(Mean±SD)	Treatment With Rotenone (Mean±SD)	WHO limit mg/L
1	Iron(Fe)	0.0297±0.0017	0.0240□0.0008	0.0191□0.0006	0.3
2	Chromium (Cr)	0.1040±0.0014	0.1063□0.0003	0.1189□0.0001	0.05
3	Lead(Pb)	0.1418±0.0251	0.0723□0.0099	0.0811□0.0021	0.01
4	Zinc(Zn)	0.0084±0.0010	0.0052□0.0002	0.0095□0.0035	3.0
5	Manganese(Mn)	0.0243±0.0005	0.0077□0.0003	0.0307□0.0014	0.4/0.1

4. Conclusion

A comprehensive study was done first time in Bangladesh to find out the impact of aquatic environmental conditions (physico-chemical parameters and heavy metals status) in relation to fish killer chemicals, aluminum phosphide (AlP) and rotenone in ponds at Taherpur Municipality under Bagmara Upazila in Rajshahi District, Bangladesh. This study showed that some physico-chemical properties like temperature, pH, EC, DO and TDS met the standard permissible limit in Bangladesh while the student's t- test displayed significant difference in EC and DO when applied fish killer chemicals (AlP and rotenone).ANOV Aanalysis confirmed a highly significant relation between fish killer chemicals and different ponds. The results revealed that heavy metal concentrations of Fe, Zn and Mndid not exceed the recommended values provided by WHO except Cr and Pb. To understand the impact of the overall aquatic environment of ponds, only water is not enough but also soil and fisheries species are needed to study. Therefore, further research is suggested to evaluate the effects of AlP and rotenone on soil quality and fisheries species in the same study area.

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