Journal of Applied Pharmacy
ISSN: 1920-4159

Sunjida et al., J App Pharm 2016, 8:3
DOI: 10.21065/1920-4159.1000224

Research Article Open Access

Assessing the Quality of Household and Drinking Water in Tongi Industrial Zone of Bangladesh and Its Toxicological Impact on Healthy Sprague Dawley Rats

Sauda Binte Sunjida[1], Saquiba Yesmine[2], Imon Rahman[1]* and Ridwan Islam[1]

[1]*Department of Pharmacy, BRAC University, Dhaka 1000, Bangladesh*
[2]*Department of Pharmacy, Jahangirnagar University, Bangladesh*

Abstract

Rapid industrialization, deteriorating the quality of water leads towards disastrous health effects among the inhabitants of the areas with numerous industries. This study is a brief reflection of the toxicological effects of industrialization on water resources, as well as the pharmacological effects of contaminated household and drinking water on animal model of an industrialized area in a developing country. The obtained results of this study showed high concentration of some heavy metals in the water used in industrial area, than the maximum permissible limit that can be present in water according to the WHO guidelines of water which might cause anomaly in blood composition, severe effect on vital organs such as kidneys and livers. Successively, significant abnormalities were observed in the organs of the tested rat models drinking the water. Therefore, the findings of this study can be used to implement the long term study by broadening the sampling areas and to further elucidate the molecular mechanisms and public health impact associated with human exposure to water contaminated in the industrial areas.

Keywords: Industrialization; Household; Drinking water; Heavy metals; Sprague dawley rats, Liver, Kidney impairment

Abbreviations: DoE: Department of Environment; ETP: Effluent treatment system; WHO: World Health Organization; DWASA: Dhaka water supply and sewerage authority; USEPA: United states Environmental Protection Agency; EPA: Environmental protection Agency; EU: European Commission; TDS: Total Dissolved solids; DO: Dissolved oxygen

COD: Chemical oxygen Demand; BOD: Biological oxygen Demand; TSH: Thyroid Stimulating Hormone; CIOMS: The Council for International Organizations of Medical Sciences; EDTA: Ethylene diamine tetra acetic acid; WBC: White blood cell; RBC: Red blood cell; PLT: Platelets; HCT: Hematocrit; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration; WIC: WBC Impedance Count; WOC: WBC Optical Count; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; MP: Melting point; AAS: Atomic Absorption Spectrophotometer; H&E: Hematoxylin and Eosin; ROS: Reactive oxygen species; SOD: Superoxide dismutase

Introduction

Water can be used as a synonym of life because the existence of all types of living organisms on the earth is intimately connected to the quality of water available on earth. The existence of human life or any other living organism is greatly influenced by this vital element [1]. Therefore, adequate supply of safe water and access to safe drinking water is the prerequisite for a healthy life as access to safe drinking water lessens the risk of several health diseases and ensures a high standard of living. However, considering the present scenario, the condition of safe drinking and household water is in a real vulnerable situation due to manmade cause. One of easiest way that pollutes the ground and surface water is several types of toxic chemicals and heavy metals that are produced by various types of natural and human activities such as disposal of industrial effluents into the water bodies, enormous use of fertilizers and pesticides [2]. Rapid urbanization and industrialization have always been considered as one of the main source of water contamination, in spite of playing major role in the alleviation of poverty and also for the economic growth in many developing countries. Even though the implementation of modern technologies in the growth of industries is occurring but, unfortunately, environmental consideration is not properly integrated with the design of industrial processes mainly in the developing countries. As a result, though industries are providing basic economic growth for a developing country but, in the long run, it is making the survival more difficult by polluting its surrounding environment [3]. This condition is applicable for Bangladesh to a great extent. Every single industrial group in Bangladesh has increased production substantially due to its high demand from national and international arena. As a result of the haphazard growth of the industries, the number of unregistered small-scale industries is also increasing in number and most of those industries do not have any treatment plan and facilities since the cost is beyond the capacity of small scale industries [4]. Moreover, some industries do not have the provision of ETP (Effluent treatment system) and even though some of them have the provision of ETP but they are not operated due to the high operation cost and due to the lack of monitoring and effective policies discharge or dumping of those untreated wastage directly or indirectly into the river or nearby lakes has become a very common phenomena. These industrial pollutants very easily mix up with the water bodies and cause the pollution of water sources. Therefore, the growth of industry, mining and manufacturing has been paralleled by the development of occupational diseases. Considering the health benefits in a recent report, it was estimated that up to 10% of end stage renal disease and many liver diseases could be attributed to industrial exposures [4]. It is also predicted from study

***Corresponding author:** Imon Rahman, Department of Pharmacy, BRAC University, Dhaka 1000, Bangladesh, Tel: 8801711079808; E-mail: imon9585@gmail.com

Received: May 28, 2016; **Accepted:** June 17, 2016; **Published**: June 22, 2016

Citation: Sunjida SB, Yesmine S, Rahman I, Islam R (2016) Assessing the Quality of Household and Drinking Water in Tongi Industrial Zone of Bangladesh and Its Toxicological Impact on Healthy Sprague Dawley Rats. J App Pharm 8: 224. doi: 10.21065/1920-4159.1000224

that function of two-thirds of the nephrons of both kidneys may be lost before renal damage is clinically evident. However, in industries and the adjacent areas, poisoning with metals usually takes chronic form and results from the intake of small amounts of them over long periods of time. Acute poisoning may also occur from the accidental intake of large doses of toxic compounds like arsenicals, chromium, cadmium, zinc, manganese, lead etc. [4]. Nevertheless, these metals and their compounds with most physical hazards may also gain access into the body through drinking water.

In Bangladesh, the industries that are located near the water bodies not only use the water of the sources for industrial purposes but also play a major role in polluting those sources. The water that has been discharged into the water bodies without proper treatment by the industries, have been found to be ten times more polluted [1]. The uncontrolled dumping of immense industrial wastes of point and non-point sources is even to a great degree unsafe when the toxins are heavy metals and cannot be treated simply by conventional ways. The most common heavy metal pollutants are arsenic, cadmium, chromium, copper, nickel, lead and mercury. For the protection of human health, the maximum permissible concentrations for metals in natural waters that are recommended by the Environmental Protection Agency (EPA) (Table 1).

The presence of toxic heavy metals has made the problem of water pollution worse to a great extent. Trace amounts of metals enter water supplies naturally as rain percolates through rock; dissolving minute quantities into the water. This water enters larger water bodies which then are also used as resources for drinking water. Contamination of water resources by poisonous metals occurs largely due to human activity. These activities include industrial processes, such as electronics and mining, agricultural activities, and discarding of wastes in landfills. The most common metal pollution in freshwater comes from mining companies. They usually use an acid mine drainage system to release heavy metals from ores, because metals are very soluble in an acid solution. After the drainage process, they disperse the acid solution in the groundwater, containing high levels of metals [5]. Metals are considered as toxins and once they enter the body in more than the prescribed limit, they begin inflicting harm. Untreated or purportedly treated industrial effluents and sewage water contain variable amounts of heavy metals, for example, arsenic, lead, nickel, cadmium, copper, mercury, zinc, and chromium [6] which is broadly studied and their consequences for human wellbeing are routinely evaluated by international bodies such as the WHO. In the result of trace metals, the permissible limit of the content of arsenic, lead and manganese in the surface water samples was found to be <0.05 mg/L whereas the WHO permissible limit of cadmium is 0.005 mg/L [7].

Metal	Chemical Symbol	mgm^{-3}
Mercury	Hg	0.144
Lead	Pb	5
Cadmium	Cd	10
Selenium	Se	10
Thallium	Tl	13
Nickel	Ni	13.4
Silver	Ag	50
Manganese	Mn	50
Chromium	Cr	50
Iron	Fe	300
Barium	Ba	1000

Table 1: Maximum Permissible Concentrations (mpc) of various metals in water for the protection of human health [5].

An appreciable number of serious health concerns may happen as a consequence of the chemical contamination of water [8]. Especially, the poisonous impact of several hazardous metals on health through the drinking water has become a major cause of concern in most of the metropolitan city like Dhaka because heavy metals are very harmful, dangerous and toxic even in ppb (parts per billion) range [9]. Upon several analysis it has been found that the metals- lead, cadmium, chromium, arsenic may not have any significant advantages on the body but they do have a direct adverse impact on liver and kidney and they are significantly nephrotoxic and hepatotoxic even at normal levels [10]. Arsenic is a heavy metal which is very poisonous even in a very little amount and in Bangladesh natural level of Arsenic in groundwater has been found to be causing harmful effects on the population [11]. Similarly, cadmium is considered as one of the major pollutant of concern for many researchers, since it is found to be toxic in a very trace amount and has been also found to induce the oxidative stress by reducing the antioxidant and thus follows up with several organ dysfunctions [12]. As long term exposure to cadmium actuates renal and liver damage, cadmium is considered as one of the prior contaminants and observing in most of the countries and international organizations [12]. The most ubiquitous of toxic metals in drinking water is lead. Lead and copper both can leach from water pipes and soldered joints which deliver water to tap. This is especially a problem in older homes. The toxic effects of lead can lead to nerve and brain damage. It also causes general metabolic toxicity and enzyme inhibition [13]. Likewise, zinc is an essential trace elements for human body but in higher doses it causes renal damage, muscle cramps etc. Analogously, manganese toxicity can result in a permanent neurological disorder known as manganism with symptoms that include tremors, difficulty walking, and facial muscle spasms. These symptoms are often preceded by other lesser symptoms, including irritability, aggressiveness, and hallucinations. Therefore, it is certain that the contamination of water is directly associated with the industrial pollution thus, the persistent evaluation of the standard of ground and surface water source in the industrial areas is important [1].

In Bangladesh, the rivers Buriganga, Turag, Balu, Shitalakhya have been turned into the most polluted and poisonous river because of the adjacent industries [14]. The water of these rivers are continuously being polluted by untreated or partially treated sewage effluents, sewage polluted surface run off, untreated industrial effluent from nearby residential and industrial area, various industrial wastage, domestic wastage and indiscriminate discharge of pathological and commercial wastage. Among these rivers Turag River is the most adjacent one to the biggest industrial area of Bangladesh Tongi [15]. Gazipur, Tongi is considered as an industrial hub in the country and thousands of industries are situated there that includes metal industries, garments, textile, paper and pulps, jute, pharmaceuticals, food manufacturing factories and so on, which do not have any effluent treatment plant (ETP) and thus contaminates land, water bodies, sediments and air in the encompassing zones. This mechanical toxic water flows down through drains and finally mix up with Turag river, Tongi khal and others and thus significantly polluting these waters sources [15] and inflicting hazardous biological effects due to the use of water of industrial area for drinking and household purposes. A considerable number of reports are available regarding water pollution and their reduction, but no detail study on the quality of drinking or household water of highly industrialized Tongi area along with the pharmacological study on animal model has been done before. In the past years studies have been conducted to assess physical parameters, major ionic constituents and trace metals content of surface and ground water of tongi area in Bangladesh. Another study claimed that Buriganga, Balu, Shitalakhya, Turag and Tongi canal around Dhaka city got huge amount of untreated sewage, industrial liquid and city waste which prompts serious surface water contamination as the study concentrated on the presence of heavy metals in those rivers and canals [16]. Moreover, researches have been conducted on the concentration of heavy metals in drinking water, their effect on human health and also to assess the status of overall drinking water quality in the urban areas. Beside the review papers and toxicological studies, some researches have been conducted on the assessment of the harmful impacts of heavy metals in animal body. Therefore this study will be one of the first attempts to determine the quality effect of the industrial area water for household use and drinking along with the evaluation on animal model in Bangladesh (Table 2).

Objectives

On the basis of existing tendency of rapid industrialization and urbanization along with its associated hazards and the work of various researchers on this issue, the preliminary study was undertaken to examine the quality of household water in Tongi industrial area. This concurrent study is therefore aimed to-evaluate the household water quality of Tongi Industrial area, Dhaka analyze the presence of heavy metals in drinking water of this area nearer residential zone assess the health consequences of the dwellers who consumed this water in Tongi area by assaying hematological parameters and histopathology of liver, heart, kidney, Spleen, Brain and Lungs in rat models and,

Contribute to the existing knowledge of understanding relating to contamination of household and drinking water in the industrial zone of a developing country.

Methodology

The water sample was collected randomly from Kathaldia village, located in sub-locality of Tongi, Gazipur district, Dhaka, Bangladesh where the dominant source of water used for drinking and household purposes is from tube wells and springs installed in the households of these villages. Water samples were taken from chlorine treated ground water sources and taps and collected in double capped polyethylene bottles which had been prewashed with detergent, dilute HNO3 and doubly de-ionized distilled water respectively [13]. For this study, 18 healthy 8 weeks old male albino Sprague dawley rats weighed about 160 ± 25g were randomly divided into three groups of six rats each. Thus, six rats were taken for both control and experimental groups and they were acclimatized for a period of one week to adjust with the gradual change of the environment. The rats were divided into Group A, and B of six rats in each. Group A served as Control of the study and Group B was served as the experimental groups. The experimental study was conducted for 8 weeks (56 days). The control group A and B were given ad libitum access to mineral water in 100 ml bottle/day and sample tap water in 100 ml bottle/day respectively [17].

All of the rats were kept in plastic cages having dimensions of 30 x 20 × 13 cm and soft wood shavings were employed as bedding in the cages. Environmental condition was monitored strictly to maintain the temperature at 25°C and at 60% of relative humidity (according to BCSIR, Dhaka). The body weight of each rat in the treatment and control group was measured in the beginning of the experiment and twice weekly during the exposure period by using an electronic analytical weight balance. Blood was collected from each of the rat through cardiac puncture by using 25G needle with 5ml syringe. After the collection, blood samples were immediately transferred to ethylene diamine tetra-acetic acid (EDTA) anticoagulant tubes (8.5%) was quickly returned by mixing with anticoagulant in the tube. The hearts, kidneys, lungs, livers, and spleens of all rats were surgically removed by using sharp blade and scissors, rinsed with physiological saline, blotted dried and then weight of individual organ was measured. After obtaining the fresh organs weight of heart, kidney, lungs, liver, and spleen of each rat, the organs was preserved in 10% formaldehyde (pH 7.2 to 7.4) and sections of tissues were cut for histological procedures [18,19].

Organ	Group 1 (Control)	Group 2 (Tap water)
Heart	0.63 ± 0.03	0.60 ± 0.03
Kidney	0.71 ± 0.04	0.66 ± 0.03
Lungs	0.97 ± 0.05	1.04 ± 0.07
Liver	6.45 ± 0.29	6.01 ± 0.18
Spleen	0.49 ± 0.01	0.56 ± 0.02

All values are expressed in Mean ± SE; *Value (P= 0.005) is significantly different from the control group (P<0.05)

Table 2: Individual Organ weight of Rat (n=6) after 8 weeks of experiment.

Hematological parameters that were analyzed includes, white blood cell count (WBC), red blood cells (RBC), hemoglobin concentration (HGB), haematocrit (HCT), mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), platelet count (PLT). All hematological parameters were analyzed in the medical laboratory by using the automated method with the automatic analyzer "Hematology auto analyzer Sysmex XN 1000 System" [20].

In order to study the serum biochemistry, blood samples were taken in a lithium coated serum separator tubes and centrifuged at 4000 rpm for 10 m to separate the serum (supernatant) and the serum obtained (± 2 ml/rat) was stored in closed test tubes inside a freezer at (-20°C) prior to bio-chemical analysis within 48 hours. The stored serum samples were used to determine the biochemical parameters like creatinine, urea, and total proteins which were measured as functional marker for nephro-toxicity; and aspartate aminotransferase (AST), alanine aminotransferase (ALT) as marker for hepatotoxicity. This was done by using automated Biochemistry analyzer "Dimension RxL Max integrated Chemistry system".

Histopathology is an important medical tool for the microscopic study of diseased tissue. It is performed by examining a thin tissue section under light microscopes. It consists of a number of procedures that allow visualization of tissue and cell microscopic features and recognize specific microscopic structural changes of disease [21]. After obtaining the fresh organs weight of heart, kidney, lungs, liver, and spleen of each rat, the organs was preserved in 10% formaldehyde (pH 7.2 to 7.4) and sections of tissues were cut for histological procedures [21].

Statistical analysis was performed on a PC using SPSS, V.22. Results are expressed as Mean ± SE of n experiments (where n represents the number of animals used). The differences between the treated and control rats were evaluated using the Students t-test p (T > t) = 0.05. The differences were statistically significant if the value of p was less than 0.05 and not significant if the value of p was greater than 0.05 [10].

Since the level of toxic and heavy metals in Tongi areas drinking water has not been investigated yet, therefore the concentration of heavy metals in the water resources of Kathaldia village of Tongi, Gazipur district was measured which will be a great concern for proper assessment of drinking water quality and possible hazards to public health. The concentration of Heavy metals that were determined in this study includes cadmium, selenium, and arsenic by using an atomic absorption spectrophotometer (AAS). The concentrations of resulting heavy metals were then compared with the national and International organization.

Results and Discussion

All the animals found to be increased in body weight after 56 days relative to their initial weight at the beginning of the experiment. But statistically no significant differences in body weight of the animals in each group were observed ($p > 0.05$) relative to one another and relative to the control (Figure 1). This observation revealed that polluted water supported growth in rats.

The result showed small decrease in the weight of liver in the experimental group treated with normal tap water. The decrease of liver weight might occur due to the presence of free radicals which interfere with the development and growth of hepatocytes and causes destruction of already formed parenchymal tissue. Free radical are cytotoxic and acts as a mediator of tissue injury by causing direct damage of the tissue or by initiating additional immunological reactions that results in damage. Thus, in this study in order to have a conspicous idea the histological observation of liver tissue need to be considered.

Hematological results of this study are as presented in table 3. It was observed that hematological parameters, Hemoglobin, HCT, MCV, MCHC, ESR, WBC, and RBC in both control and experimental group showed no significant difference ($p>0.05$) after the period of 56 days experiment. The value of platelets were found to decrease significantly ($p<0.05$) in the experimental group exposed with normal tap water as compared with the control. (Table 3). In the statistical analysis of hematological parameters, no significant changes was observed in case of Hemoglobin, HCT, MCV, MCHC, ESR, WBC and RBC in the experimental group as compared to their control. But the values of platelets were found to decrease significantly in the experimental group exposed with normal tap water as compared with the control. Platelets are considered as the smallest formed element of blood which plays a vital role in maintaining the hemostasis. To be more specific, they form a plug at the sites of endothelial cell injury. Moreover, it also plays a role as mediators of inflammation and helps in coagulation. In many studies, it has been observed that the decrease of platelets may occur due to some reasons such as entrapment of platelets in an enlarged spleen, endothelial injury of hepatocytes, sevaral autoimmune diseases (which causes Immune thrombocytopenia), presence of bacteria in blood, viral infections of hepatocytes, and in some types of anemia. Since in this study, no significant changes in red blood cell (RBC), and in mean corpuscular volume (MCV) as compared to control was observed, thus presence of anemia cannot be considered as a reason behind the decrease of platelets (Figure 2).

WBC, White blood cells (X103/µL); MCV, mean corpuscular volume (fL); RBC, red blood cells (X106/µL);MCH, mean corpuscular hemoglobin (pg); HGB. hemoglobin (g/dL); PLT, platelets (X103/µL); HCT, hematocrit (%); MCHC, mean corpuscular hemoglobin concentration (g/dL). *Value (P=0.035) is significantly different from the control group ($P<0.05$).

Estimation of activities of various enzymes in tissues and body fluids is a critical and well known aid in disease investigation and identification [22]. Such estimation will give an understanding to the site of cellular damage as an after effect of strike by medication or other chemicals. The estimation of enzyme activity is especially imperative since it sums up the catalytic impact of different variables such as inhibitors and activators during such pathological conditions. The specific activity of aspartate amino transferase (AST) has found to decrease in the experimental group but showed no significant difference ($P>0.05$) in comparison with the control group. The activity of alanine amino transferase (ALT) showed significant decrease ($P<0.05$) in the experimental group in comparison with the control group. The level of Urea (mg/dl), creatinine (µg/mL) and total Bilirubin (µg/mL) showed no significant changes in the activity in comparison with the control group. All values and changes are presented in figure 3.

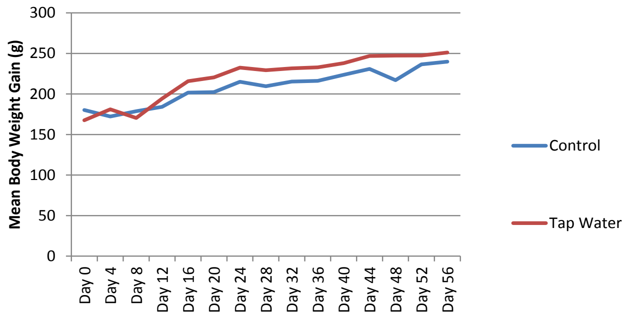

Figure 1: Growth response curve of male rat orally exposed to sample water. Results were expressed as mean body weight of rats after 56 days of experiment and changes are statistically non-significant when compared with control rats (P>0.05). All the values are Mean ± SE; n= 6.

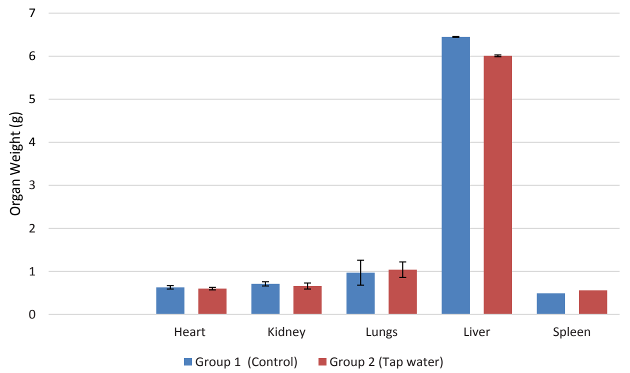

Figure 2: Individual Organ weight of Rat (n=6) after 8 weeks of experiment. Results were expressed as mean SEM (n = 6) of rats after 56 days of experiment. Tap water (Normal) exposed group showed non-significant changes as compared with control group (p>0.05). Means of 6 rats only.

Parameters	Group 1 (Control)	Group 2 (Tap water)
Hemoglobin	13.75 ± 0.30	13.75 ± 0.29
HCT/PCV	10.03 ± 9.57	0.46 ± 0.01
MCV	58.22 ± 0.53	50.75 ± 6.77
MCH	17.18 ± 0.16	16.95 ± 0.13
MCHC	29.5 ± 0.16	29.58 ± 0.20
ESR	6.17 ± 0.48	6.83 ± 1.07
WBC	4616.66 ± 913.39	4433.33 ± 202.76
RBC	7966.66 ± 223.11	8033.33 ± 170.62
Platelet	838700 ± 28406.50	418350 ± 151163.89*

Table 3: Hematological Values (Mean ± SE) of Wister Rats (n=6) after 8 weeks of experiment.

Serum alanine aminotransferase (ALT) and aspartate aminotransferase are considered as well-known biomarkers to predict the liver condition. ALT is usually considered as more sensitive indicator of hepatocellular injury than AST. In the statistical analysis of the biochemical enzymes, the level of ALT was found to decrease significantly in the group treated with normal tap water as compared with the control which demonstrates that the decrease of ALT and AST might indicate liver dysfunction, liver injury or presence of any viral infection of hepatocytes. It also proposed that the significant decrease of ALT and AST might indicate the exposure to free radicals by inducing

Citation: Sunjida SB, Yesmine S, Rahman I, Islam R (2016) Assessing the Quality of Household and Drinking Water in Tongi Industrial Zone of Bangladesh and Its Toxicological Impact on Healthy Sprague Dawley Rats. J App Pharm 8: 224. doi: 10.21065/1920-4159.1000224

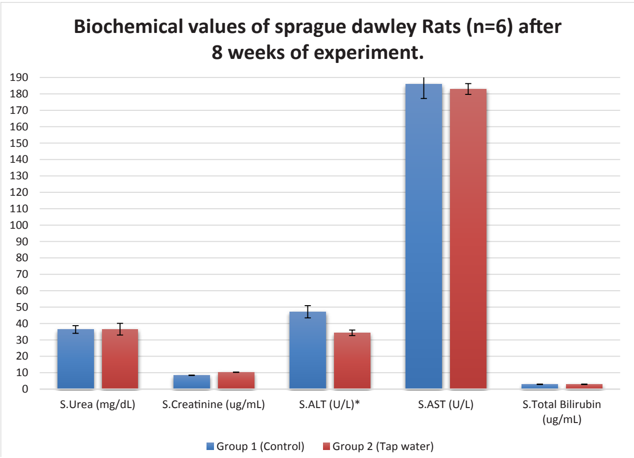

Figure 3: Biochemical values (Mean ± SE) of sprague dawley Rats (n=6) after 8 weeks of experiment. *value (P=0.045) is significantly different from the control group (p <0.05);(n=6).

oxidative stress which is again linked to organ damage. The decrease of biochemical enzymes might occur due to the induced of oxidative stress that is linked with the oxidative damage of the organ by the exposure of radiation or free radicals [23]. Therefore, it can be predicted that, in the experimental water there might have some chemicals or compounds present which is somehow directly or indirectly involved in inducing oxidative stress.

The result of the histopathological responses of the brain, heart, kidney, lungs, liver and spleen after the period of 8 weeks study are presented in figures 4 (1-6). By using light microscopy (x100 magnifications), the histopathological changes especially prominent lesions and observed recoveries were photographed.

Through the microscopic histological observation of the tissue the presence of any lesions, inflammation, swelling, damage or any alteration in the tissue due to the presence of some disease or exposure of the organ to any pernicious compound can easily be determined. Even though the 8 weeks of study is too early to create any conspicuous alteration in the histology of the organs but in some sections few alteration of the tissue has been observed as compared with the control. The histopathological observation of heart showed normal distribution of cardiac muscle along with the normal appearance of cardiac tissue. Even though in the experimental group irregular distribution of cardiac tissue has been observed but no distinct alteration has been observed as compared to the control to justify the reason.

The histopathological observation of kidney in the experimental group menifested severe congestion at the renal cortex, intact glomerulus and tubules as compared to the histopathology of control group. Therefore it might predict that due to the short term of study distinct alteration of the kidney tissue doesnot occur but this mild alteration might validate the presence of kidney dysfunction at an initial stage [24].

In the histopathological section of the liver of the experimental group few alterations has been noticed as compared to the control, which might indicate the presence of mild liver dysfunction to corroborate the previous observation of biochemical enzymes. In comparison with the control mild sinusoidal dilution along with cytoplasmic vacuolation and presence of hepatocytes bilucleation along with hydropic degeneration has been observed [25]. The histopathological observation of spleen showed the presence of mild white pulp hyperplasia as compared with the control which again somehow validates the decrease of platelets due to the enlarged spleen but to have a distinct result long term study is needed [26]. The histopathological study of study of brain and lungs showed no obvious changes as compared to the control group.

Concentration of Heavy Metals

The concentration of heavy metals found in the normal sample tap water with the help of Atomic Absorption Spectroscopy are given in table 4. The obtained result shows the concentration of Manganase (Mn), Arsenic (As), and Cadmium (Cd) high than the maximum recommended limits of WHO (2011) guideline of drinking water quality (Table 4).

In this study the observation of the heavy metals showed high concentration of Manganese (Mn), Arsenic (As) and Cadmium (Cd) than the maximum permissible limit need to be present in drinking water according to the WHO guidelines of water [7].

The concentration of manganese in the sample tap water was found 0.1249 mg/l which is very high than the maximum permissible limit

Metals	Concentration Found by AAS (ppm)	WHO (2011) Maximum admissible limits (mg/l)
Cr	0.0074	0.05
Mn	0.1249	0.05
Ni	0.0211	0.07
Cu	0.05	1.0
Zn	0.33	5.0
As	0.89	0.05
Se	0.544	0.01
Pb	0.037	0.05
Cd	0.013	0.005

Table 4: Concentration of Heavy Metals found in the sample Tap water of Kathaldia Village and maximum admissible limit set by WHO (2011).

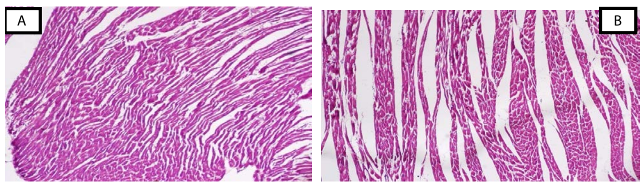

Figure 4.1: A: Histological section of Heart of the control rat (H&E x100): Section showing well developed and normal distribution of cardiac muscle fibers; normal apperance of cardiac tissue.
B: Histological section of Heart of the rat treated with Normal Tap water (H&E x100): showing somewhat normal appearance of collagen fibers in the cardiac muscle fibers. Showing irregular distribution of nuclei of myocytes of cardiac tissue

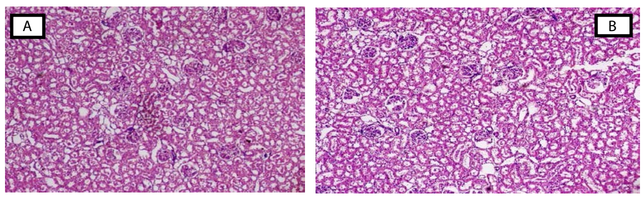

Figure 4.2: A: Histological section of kidney of control rat (H&E x100): Section showing normal histological features including glomerulus and tubules. Glomeruli are normal and tightly filing the Bowman's corpuscle. Renal tubules are lined with typical thick cubic epithelium.
B: Histological section of Kidney of the rat treated with normal Tap water (H&E x100): section showing mild interstitial hemorrhage and tubular necrosis at the renal cortex.

Citation: Sunjida SB, Yesmine S, Rahman I, Islam R (2016) Assessing the Quality of Household and Drinking Water in Tongi Industrial Zone of Bangladesh and Its Toxicological Impact on Healthy Sprague Dawley Rats. J App Pharm 8: 224. doi: 10.21065/1920-4159.1000224

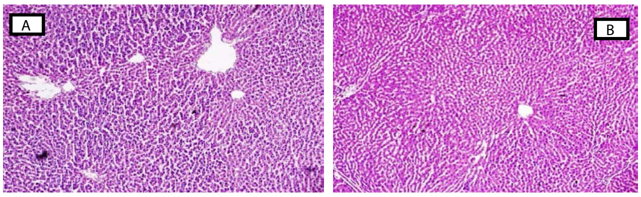

Figure 4.3: A: Histological section of Liver of control rat (H&E x100): Section showing normal hepatocytes and red cell stasis within the central vein and sinusoids.
B: Histological section of Liver of the rat treated with normal Tap water (H&E x100): section showing mild sinusoidal dilation.

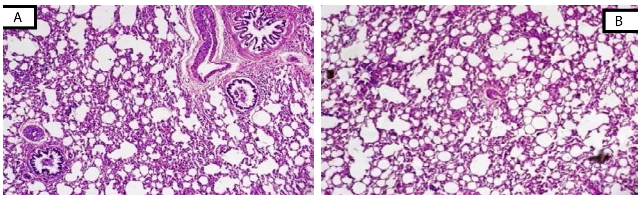

Figure 4.4: A: Histological section of Spleen of control rat (H&E x100): Section showing normal histology of spleen, Region of the periarterial lymphoid sheath.
B: Histological section of Spleen of the rat treated with normal Tap water (H&E x100): section showing the presence of mild white pulp hyperplasia.

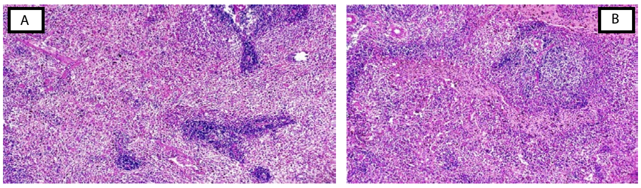

Figure 4.5: A: Histological section of lungs of control rat; **B:** Histological section of lungs of the rat treated with normal Tap water, In section B, alveolar fibrosis is observable in contrast to the well-stained branching alveolar in the group A and no significant change is found.

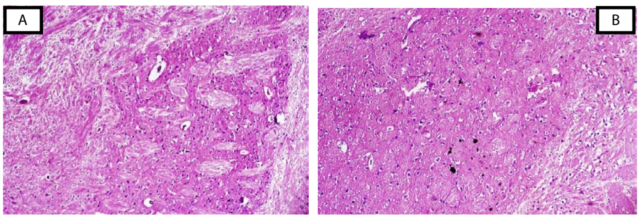

Figure 4.6: Histological section of brain: The cortical layers, neuronal cells and blood vessels are well delineated in the control group (A). No ovbious changes were noted in the treated group (B) as compared to the control group.

(0.05 mg/l) of WHO (2011). Manganese is an essential trace element which is found to produce some toxic effect upon the long term exposure. It has been reported that chronic exposure to manganese causes serious liver function and kidney damage [27]. Arsenic and cadmium are the metals which are found to be toxic at a very trace level. The concentration of Arsenic found in the sample water was 0.89 ppm which is much higher than the (0.05 mg/l) WHO permissible limit. On the other hand the concentration of cadmium also found in a higher concentration (0.013 mg/l) whereas the maximum permissible limit of Cadmium is 0.005 mg/l. The cadmium has always been considered as one of the most toxic metal since it produces toxic effect even at a very low concentration and can easily bio-accumulate in the body. Therefore, it has always been considered as one of the major pollutants in the water by several reasearchers [28].

In sevaral studies it has been observed that the presence of arsenic, cadmium and lead greatly damage the immune responses of the body which in turn effect the hematology of the body by decreasing the platelets. The known deadly impact due to these heavy metals toxicity in drinking water incorporates damaged or diminished mental and central nervous function and lower energy level. They likewise cause an anomaly in blood composition, severe effect on vital organs such as kidneys and liver [28]. Moreover, the presence of arsenic alone in a higher amount has been found to alter the biochemical enzymes and usually reduces the level of AST [29]. These findings somehow corroborate the previous observation to justify the reason behind the decrease platelet and AST value in the experimental rat of this study.

Again in several studies it has been observed that, cadmium in a trace amount instigate oxidative stress in several organs especially in the liver cells. Because cadmium has high affinity for sulfhydral (-SH) groups, disabling numerous enzymatic reactions, amino acids, sulfur containing antioxidants that includes N-acetylcysteine, glutathione and alpha-lipoic acid which in turn follows up with subsequent decrease of antioxidants and thus increases oxidative stress. In case of long term of exposure cadmium increases the production of reactive oxygen species (ROS) such as superoxide radical, peroxide, hydroxyl radical, thus inhibits the serum superoxide dismutase (SOD) enzyme which act against free radicals. Thus it ends up with causing platelet aggregation, oxidative damage of the liver, kidney and testis [30]. Moreover, in some studies it was demonstrated that oxidative stress decrease the liver weight along with the decrease of serum ALT and AST and also interferes with the body's normal immune response [31-41].

Therefore, from overall discussion it can be predicted that the presence of some toxic heavy metals in the sample water in a high amount might have created some negative effect on the experimental Sprague-Dawley rat. Somehow those effect is linked with the oxidative damage of some of the organs to some extent due to the instigate of oxidative stress by some toxic metals. Even though eight weeks of study is a very short period to develop distinct damage in the organs and to know the effect of some heavy metals in the drinking water, but the outcomes of this study can be used as an important tool for assesing the possible health consequences in the long term of study.

Conclusion

In the recent years there has been increasing awareness and concern about water pollution all over the world and new approaches towards achieving sustainable exploitation of water resources have been developed internationally but the inhabitants of the developing countries of the world are still at risk of being the prey of hazardous water pollution and its perilous impacts. The co-exposure of metal/metalloid mixtures of heavy metals in household and drinking water produce severe effects at both relatively high and low dose levels [31,41-46]. This study is a brief reflection of the toxicological effects of industrialization on water resources, as well as the pharmacological effects of contaminated household and drinking water on animal model of an industrialized area in a developing country. From the findings of this study it can interpreted that since, Tongi is considered as an industrial hub, the impact of those industries has been seen to affect the standard of water and the inhabitants of the study area are at high risk of renal or hepatic abnormaities and other helth issues as their drinking and household water contains some heavy metals more than the permissible limit of WHO. However, it may be concluded the water quality of the Turag River is beyond acceptable limit that is unfavorable for all aquatic lives and human beings due to discharging of untreated industrial effluents into the river water. For the detailed analysis of water quality and to reach into a conspicuous conclusion, this study demands for a longer period of study to confirm the study reliablity. Therefore, the observations of this study can be used to implement the long term study by broadening the sampling areas and to further elucidate the molecular mechanisms and public health impact associated with human exposure to water contaminated with mixtures of toxic metals.

Acknowledgement

The authors acknowledge all of officials and laboratory staffs of the animal laboratory of Jahangirnagar University, Wazed Miah Science Research Center in Jahangirnagar University, Novelta bestway Pharmaceuticals for their best co-operation and laboratory supports during the research work.

References

1. Halder JN, Islam MN (2015) Water Pollution and its Impact on the Human, Journal of Environment and Human 2: 36-38.
2. Ammann AA (2002) Speciation of heavy metals in environmental water by ion chromatography coupled to ICP-MS. Anal Bioanal Chem 372: 448-452.
3. Jolly YN, Islam A, Akter S (2013) Characterization of Some Industrial Effluents of Dhaka. Bangladesh Journal of Physics 1-7.
4. Tasnim F, Rahman I, Rahman MS, Islam R (2016) A Review on Occupational Health Safety in Bangladesh with Respect to Asian Continent. International Journal of Public Health & Safety 1: 102.
5. EPA (1991) Federal Registration 110, EPA, USA.
6. Singare PU, Lokhande RS, Naik KU (2010) A Case Study of Some Lakes Located at and Around Thane City of Maharashtra, India, with Special Reference to Physico-Chemical Properties and Heavy Metal content of Lake Water. Interdisciplinary Environmental Review 11: 90-107.
7. Ojekunle OZ, Ojekunle OV, Adeyemi AA, Taiwo AG, Sangowusi OR, et al. (2016) Evaluation of surface water quality indices and ecological risk assessment for heavy metals in scrap yard neighbourhood. Springerplus 5: 560.
8. Begum DA, Ahmmed KM (2010) Water Quality Aspects in and around Dhaka City. Proceedings of International Conference on Environmental Aspects of Bangladesh.
9. Gebrekidan M, Zerabruk S (2011) Concentration of Heavy Metals in Drinking Water from Urban Areas of the Tigray Region, Northern Ehiopia. CNCS, Mekelle University 3: 105-121.
10. Sabath E, Robles-Osorio ML (2012) Renal health and the environment: heavy metal nephrotoxicity, Nefrologia 32: 279-286.
11. Smith AH, Lingas EO, Rahman M (2000) Contamination of drinking-water by arsenic in Bangladesh: a public health emergency. Bull World Health Organ 78: 1093-1103.
12. Patra RC, Rautray AK, Swarup D (2011) Oxidative stress in lead and cadmium toxicity and its amelioration. Vet Med Int 2011: 457327.
13. Islam MS (2011) Legal Issues of River Pollution through Industrial Effluents. Eastern University Journal, 3: 88-99.
14. Mobin MN, Islam MS, Bakali B (2014) Analysis of Physicochemical Properties of the Turag River Water, Tongi, Gazipur in Bangladesh, Journal of Environmental Science and Natural Resources 7: 27-33.
15. Rahman S, Khan MT, Akib S, Biswas SK (2013) Investigation of Heavy Metal Pollution in Peripheral River Water around Dhaka City. Pensee Journal 75: 421-435.
16. CIOMS (2012) International guiding principles for biomedical research involving animals.
17. Parasuraman S, Raveendran R, Kesavan R (2010) Blood sample collection in small laboratory animals. J Pharmacol Pharmacother 1: 87-93.
18. Alimba CG, Bakare AA, Aina OO (2012) Liver and Kidney Dysfunction in Wistar Rats Exposed to Municipal Landfill Leachate. Resources and Environment 2: 150-163.
19. Hounkpatin ASY, Johnson RC, Guedenon P, Domingo E, Alimba C, et al. (2012) Protective Effects of Vitamin C on Haematological Parameters in Intoxicated Wistar Rats with Cadmium, Mercury and Combined Cadmium and Mercury. International Research Journal of Biological Sciences 1: 76-81.
20. Slaoui M, Fiette L (2011) Histopathology Procedures: From Tissue Sampling to Histopathological Evaluation. Drug safety Evaluation 691: 69-82.
21. Malomo SO (2000) Toxicological implications of ceftriaxone administration in rats. NJBMB 15: 33-38.
22. Abdelhalim MA, Moussa SA (2013) The biochemical changes in rats' blood serum levels exposed to different gamma radiation doses. African Journal of Pharmacy and Pharmacology 7: 785-792.
23. Awe EO, Banjoko SO (2013) Biochemical and haematological assessment of toxic effects of the leaf ethanol extract of Petroselinum crispum (Mill) Nyman ex A.W. Hill (Parsley) in rats. The official journal of the International Society for Complementary Medicine Research 13: 75.
24. Onyeama H, Ebong P, Eteng M, Igile G, Ibekwe H, et al. (2012) Histopathological Responses of the Heart, Liver and Kidney to Calliandra Portoricensis Extracts in Wistar Rats Challenged with Venom of Echis Ocellatus. Journal of Applied Pharmaceutical Science 2: 164-171.
25. Elmore SA1 (2006) Enhanced histopathology of the spleen. Toxicol Pathol 34: 648-655.
26. Indravathi G, Devi CB (2014) Manganese Induced Hematological Alterations in Albino Rats: Reversal Effect of Alpha-Tocopherol. International Journal of Innovative Research in Science, Engineering and Technology 3: 14988-14996.
27. Mohod CV, Dhote J (2013) Review of Heavy Metals in Drinking water and their effect on human health. International Journal of Innovative Research in Science, Engineering and Technology 2: 2992-2996.
28. Islam MT, Parvin S, Pervin M, Bari AS, Khan MA (2011) Effects of Chronic Arsenic Toxicity on The Haematology and Histoarchitecture of Female Reproductive System of Black Bengal Goat. Bangladesh Journal of Veterinary Medicine 9: 59-66.
29. Fahim MA, Nemmar A, Dhanasekaran S, Singh S, Shafiullah M, et al. (2012) Acute cadmium exposure causes systemic and thromboembolic events in mice. Physiol Res 61: 73-80.
30. Wang G, Fowler BA (2008) Roles of biomarkers in evaluating interactions among mixtures of lead, cadmium and arsenic. Toxicol Appl Pharmacol 233: 92-99.
31. Green N, Bjerkeng B, Hylland K, Ruus A, Rygg B, et al. (2003) Hazardous substances in the European marine environment: Trends in metal and persistent organic pollutants.
32. Ehi-Eromosele CO, Okiei WO (2013) Resources and Environment 2: 82-86.
33. US Department of Health and Human Services (2012) Toxicological Profile for Manganese, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.
34. Zakir HM, Sharmin S, Shikazono N (2006) Heavy metal pollution assessment in water and sediments of Turag River at Tongi area in Bangladesh. International Journal of Lakes and Rivers 1: 85-96.
35. Banu Z, Chowdhury MS, Hossain MD, Nakagami K (2013) Contamination and ecological risk assessment of heavy metal in the sediments of Turag River, Bangladesh: an index analysis approach. Journal of Water Resource and Protection 5: 239-248.
36. Bakali B, Younus M, Zakir HM (2014) Water quality evaluation of tong area in Bangladesh: an impact of industrialization. Journal of Chemical, Biological and Physical Sciences 4: 1735-1752.
37. Razzak NH, Praveena SM, Zaharin A, Hashim Z (2015) Drinking water studies: A review on heavy metal, application of biomarker and health risk assessment. Journal of Epidemiology and Global Health 5: 297– 310.
38. Rahmanian N, Ali SH, Homayoonfard M, Ali NJ, Rehan M, et al. (2015) Analysis of Physiochemical Parameters to Evaluate the Drinking Water Quality in the State of Perak, Malaysia. Journal of Chemistry.
39. Ocheri M, Ogwuche J (2012) Lead in rural groundwater of Benue state, Nigeria. Journal of Environmental Science and Water Resources 1: 115-119.
40. Salem HM, Eweida EA, Farag A (2000) Heavy Metals In Drinking Water And Their Environmental Impact on Human Health.

41. Siglin JC, Mattie DR, Dodd DE, Hildebrandt PK, Baker WH (2000) A 90-day drinking water toxicity study in rats of the environmental contaminant ammonium perchlorate. Toxicol Sci 57: 61-74.

42. Oloyede OB, Sunmonu TO (2008) Decrease in Activities of Selected Rat Liver Enzymes following Consumption of Chemical Effluent. Journal of Applied Science Environment Management 12: 95-100.

43. Latinwo LM, Badisa VL, Ikediobi CO, Odewumi CO, Lambert AT, et al. (2006) Effect of cadmium-induced oxidative stress on antioxidative enzymes in mitochondria and cytoplasm of CRL-1439 rat liver cells. Int J Mol Med 18: 477-481.

44. Kheradmand A, Alirezaei M, Dezfoulian O (2013) Cadmium-Induced Oxidative Stress in the Rat Testes: Protective Effects of Betaine. International Journal of Peptide Research and Therapeutics 19: 337-344.

45. Saoudi M, Abdelmouleh A, Jamoussi K, El Feki A (2009) Oxidative Stress and Hepatotoxicity in Rats Induced by Poisonous Pufferfish (Lagocephalus lagocephalus) MEAT. J Venom Anim Toxins incl Trop Dis 15: 424-443.

46. Nordberg GF, Jin T, Hong F, Zhang A, Buchet JP, et al. (2005) Biomarkers of cadmium and arsenic interactions. Toxicol Appl Pharmacol 206: 191-197.