Evaluation of surface water quality in East Timor using larval medaka *(Oryzias latipes)* acute toxicity assay

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1. Introduction

Water quality assessment is not only for suitability for human consumption but also in relation to its agricultural, industrial, recreational, commercial uses and its ability to sustain aquatic life. Water quality monitoring is therefore a fundamental tool in the management of freshwater resources. However, water pollution has become one of the most serious problems in many countries, especially in the developing countries (Hunter et al., 2009; Tsuzuki., 2008). In East Timor, 57% of the total population doesn't have access to improved sanitation system as the sewerage system is not yet developed properly (Ministry of Finance, 2009-10). In addition there is lack of solid waste management and their water sources are not well protected as well. As a result the surface water is polluted due to the various human activities. This research evaluates the surface water quality in Dili city, the capital of East Timor country, via exposing the eluted toxicants from two sampling techniques; Active and passive sampling techniques to acute toxicity assay using Larval Medaka fish *(Oryzias Latipes)* . In addition to identifying the sources of organic toxicants using GC/MS simultaneous analysis.

2. Methodology

There are four surface water streams running in Dili city as shown in Fig(1). Stream 1 and 2 have a relatively good flow rate along the year, Stream 3 is almost dry during dry season and stream 4 is running in the center of Dili city. Four grab water samples were collected from those streams during dry season in September 2015, in addition to the deployment of SDB-RPS passive sampler disks in stream 2 for a time series 1,2,3,7 and 10 days.

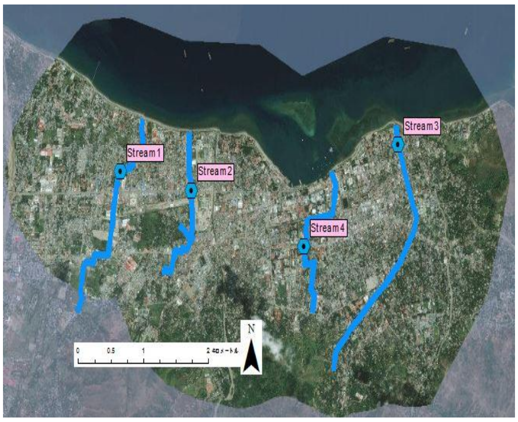

Fig: Water streams in Dili city

3. Result and Discussion

3.1 Acute toxicity assay results.

Yamashita et al., 2012, proposed a toxicity index which expressed using inverse of median lethal time (LT_{50}^{-1}) of 100-fold concentrated sample. But (LT_{50}^{-1}) cannot be handled as concentration. So, we expressed the toxicity as a lethal dilution rate (LDR_{50}). LDR_{50} is the inverse of lethal concentration rate (LCR_{50}) which proposed by Liu et al., 2006, and defined as the dilution ratio at which 50% of fish survive the acute toxicity test. Toxicity test results of eluted chemicals from active sampling were more clear and significant at different dilution ratio reaching to 20 and 10 folds in highly polluted streams 2 and 4 respectively. On the other hand , the eluted chemicals from passive sampling for 1, 2 and 3 days deployment events did not show any toxicity, only 100 fold of eluted chemicals from passive sampler disks that deployed for 7 and 10 days showed a little toxicity(LDR50 = 0.014) comparing to high toxicity (LDR50 = 0.071) of active sampling from stream 2. LDR50 toxicity index values were ; >0.2, 0.071, 0.033 and <0.01 for stream 4, Stream 2, stream 3 and stream1 respectively, as shown in the following Table combined with GC/MS analysis results

3.2 GC/MS analysis results

Table : GC/MS analysis results combined with toxicity results for eluted pollutants from Sep-Pak cartridges & passive sampler SDB-RPS disks during the dry season September 2015.

				Sep-pak cartridges				Passive sampler disks / Stream 2				
				Stream1	Stream2	Stream3	Stream4	1day	2days	3days	7days	10days
Organic compound	uses	CAS Number	LC50(mg/l) *	µg/l	µg/l	µg/l	µg/l	µg/3disks	µg/3disks	µg/3disks	µg/3disks	µg/3disks
1;1;0;n-C16H34	Gasoline, kerosene	629-78-7		0.31741	0.45977	0.0487	0.51518	0.004	0.00292			
1;1;0;n-C18H38	Heavy oil, asphalt	629-92-5		0.77444	0.69634	0.19478	0.80359	0.00205	0.00326	0.00179	0.0029	0.00212
1;1;0;n-C20H42	Heavy oil, asphalt	629-94-7		0.89704	0.87194	0.43502	0.90113	0.00265	0.0057	0.00536	0.00339	0.00173
1;1;0;n-C22H46	Heavy oil, asphalt	638-67-5		0.76275	0.73928	0.49981	0.76998		0.00054			
1;1;0;n-C24H50	Heavy oil, asphalt	629-99-2		0.40757	0.40235	0.33011	0.41547	0.00326	0.00548	0.00366	0.00651	0.00523
1;1;0;n-C26H54	Heavy oil, asphalt	593-49-7		0.25425	0.24124	0.22281	0.25619				0.00054	
1;2;0;Pentamethylbenzene	used in research	700-12-9			0.05831	0.04574	0.20129					
2;4;0;Bis(2-ethylhexyl)phthalate **	Plastic and Rubber Products, Paints, Adhesives	117-81-7	0.212	0.56059	0.63826	0.89039	1.03446	1.01431	0.6951	0.79566	1.24401	1.07555
2;4;0;Diethyl phthalate **	Plastic and Rubber Products, Paints, Adhesives	84-66-2		0.01649	0.36664	0.30554	0.5895	0.03139	0.03339	0.02857	0.06959	0.15851
2;4;0;Diisobutyl phthalate **	plasticizer, nail polish, cosmetics, lubricants	84-69-5	3.04	0.43666	2.37396	2.20565	1.99713	0.03934	0.04387	0.05415	0.12578	0.18711
2;4;0;Di-n-butyl phthalate **	plasticizer, nail polish, cosmetics, lubricants	84-74-2	2.75	0.17774	0.81252	0.51889	1.04208	0.08382	0.08113	0.14093	0.31233	0.39232
2;9;0;2-Ethyl-1-hexanol **	Paints and Coatings, Fuels	104-76-7		0.08377	0.27907	0.07452	3.84758	0.01912	0.00678	0.00595	0.01195	0.0081
2;9;0;alpha-Terpineol	Perfume, cosmetics, PCPs	98-55-5		0.02362	0.52431	0.45148	1.68585	0.00426				0.0087
2;9;0;Cholesterol	Cosmetics, pharmaceuticals	57-88-5			0.34751	1.1502	1.92957	0.14249	0.23172	0.33343	0.87026	0.51114
2;9;0;Coprostanol	Fecal contamination indicators	360-68-9			0.06412	0.33059	0.36916	0.04897	0.10685	0.17814	0.37975	0.23953
2;9;0;Di(2-ethylhexyl)adipate	Food Packaging, Fuel, Lubricants	103-23-1	50	0.02151	0.41961	0.00129	2.62118	0.00277	0.00301		0.00248	0.0005
3;3;1;4-Chloro-2-nitroaniline	pigments	89-63-4	17			0.24667						
3;9;0;Acetamide, N-(2-phenylethyl)-	Degradation products of pharmaceutical products	877-95-2			0.37341	0.0697	1.43431	0.02855	0.0276	0.03456	0.09447	0.12318
6;1;;Aspirin	pharmaceuticals	50-78-2			0.38736	0.29408	0.72343					
6;1;;Caffeine **	pharmacological agent	58-08-2		0.01101	1.68733	0.36175	0.57725	0.24787	0.2901	0.42921	0.64903	0.88071
6;1;;Diethyltoluamide	insect repellent agent	134-62-3	100	0.28374	2.57283	2.8293	2.32919	0.11853	0.14909	0.16074	0.33951	0.59554
6;1;;Ibuprofen	pharmaceuticals	15687-27-1			0.27195	0.68476	2.42546					
6;1;;L-Menthol	Toothpaste, breath fresheners, pharmaceuticals	2216-51-5		0.13419	1.084	0.67848	8.3199	0.011	0.00936	0.00476	0.01469	0.04834
7;1;;3-Hydroxycarbofuran 1	crop pesticides	16655-82-6				0.60392						
7;1;;Pyrethrin 3	insecticide	8003-34-7			0.08161	0.2829						
7;2;;Bensulide	herbicide	741-58-2			0.33306		0.57313					
7;3;;Triadimenol 2	fungicide	82200-72-4			0.20056		0.13268					
Number of all detected compounds				27	114	108	156	56	50	39	81	73
Sum of concentration of all compounds				**5.92**	**18.09**	**16.03**	42.05	**2.02**	**2.44**	**2.95**	**6.18**	**5.77**
LDR50				**<0.01**	**0.071**	**0.033**	>0.2	**<0.01**	**<0.01**	**<0.01**	**0.014**	**0.014**
$LT50^{-1}$				**<0.02**	>2	>2	>2	**<0.02**	**<0.02**	**<0.02**	**0.111**	**0.556**

Previous table shows only the compounds with high concentration (peak area ⩾75%) , it is noticed that straight-chain alkanes, plasticizers, pharmaceuticals and pesticides were the most detected compounds. Bis (2-ethylhexyl) phthalate, Di-isobutyl phthalate and Di-n-butyl phthalate are plasticizers and were detected in all Streams in a relatively high concentration, these compounds have a toxic effect on Medaka fish with LC50 values (0.212, 3.04, 2.75) respectively and also included among endocrine disrupting chemicals. According to the toxicity test and GC/MS analysis results, stream 4 showed the highest polluted stream followed by stream 2 and stream 3 even the total concentration of detected chemicals in stream 3 was higher than that in stream 2, this gives an indication that, not always high concentration shows high toxicity, where, we must consider about the synergism effect of chemicals ,also GC/MS analysis cannot detect all chemicals.

4. Conclusion

Active sampling using Sep-pak plus ps2 cartridges combined with acute toxicity assay using Larval Medaka fish *(Oryzias Latipes)* showed an efficient evaluation on the water quality safety in Dili water streams than passive sampling. Then it is a helpful tool to focus the environmental investigation and management efforts towards streams showing high toxicity levels. GC/MS simultaneous analysis showed the sources of organic toxicants which reflected the negative impacts of human activities and bad practices on surface water quality.

5. References

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