# ESTIMATION OF ORGANIC MATTER CONTENT IN DRINKING WATER SOURCES; ASSUMING HUMIC ACID AS THE PREDOMINANT SPECIES OF ORGANIC MATTER IN WATER

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**Abstract** - Natural Organic matter (NOM) is a complex matrix of organic compounds present in natural surface water sources (Mahvi et al., 2009). Humic substances (HS) are the predominant type of natural organic matter (Richard et. al., 2009). Not only HS affect the odour, colour and taste of water but also affects several processes in drinking water treatment as such as biofouling, increasing chlorine demand etc. (Aoustin et al., 2001). Halogenated HS during water treatment are collectively referred to as disinfection by products (Kurt et al, 2013). HS cause formation of disinfection by products (DBPs) such as chloroform, bromo-dichloromethane, etc., which are suspected carcinogenic compounds (Yildiz, et al., 2008). For this reason, the USEPA currently regulates two classes of DBPs commonly found on drinking water – trihalomethanes (THMs) and halo acetic acids (USEPA, 2009). As the HS predominates in NOM, HS can be used to determine the concentrations of NOM. Still, National Water Supply and Drainage Board does not have a reliable method to measure the concentrations of NOM in water, in its regional laboratories. Therefore, the amount of organic matter entering the drinking water treatment plant is unrevealed. The objective of this study is to quantify the NOM in natural drinking water sources, using available laboratory facilities. Standard solutions of HS were prepared using the commercially available Humic acid powder (Sigma Aldridge brand). A graph was obtained by scanning the samples, against series of wave lengths from 990 to 1100 nm, Using the DR 5000 spectrophotometer. Then the wave length range was filtered to 230 nm to 630 nm, as the absorbance at the other wave lengths were not given considerable variations. The results obtained were used to construct a graph of Absorbance Vs Wave length and it was used to estimate the concentrations of HS in unknown samples.
The highest concentration of HS sample has widest absorbance range, while the least concentration has the narrowest curve. Using the results obtained from graph of absorbance Vs Wave length the concentration of HS in the Doluwa water could be estimated. The graph of absorbance Vs Wave length can be used as a reliable method to estimate the Organic matter content in water samples. All the raw water samples measured during the three months period of time (from August to October – 2018), collected from 13 locations of Kandy South region (39 samples), contained organic matter content of less than 0.1 mg/L, which means water sources are less contaminated and still far away from the danger of DBPs.

**Keywords** - Natural Organic matter, Humic acid, Disinfection by products

## I. BACKGROUND/ OBJECTIVES AND GOALS

### Background

Natural Organic matter (NOM) is a complex matrix of organic compounds present in natural surface water sources (Mahvi et al., 2009). Not only it does affect the odour, colour and taste of water but it also affects several processes in drinking water treatment (Aoustin et al., 2001). The presence of natural organic matter in water has been identified as one of the main contributors to the problems associated with the supply of potable drinking water (Parkinson et al., 2001).

Humic substances (HS) are the predominant type of natural organic matter present in ground and surface waters (Richard et. al., 2009). On the basis of their solubility in water and as a function of pH, humic substances are generally classified into humic acids (HA), fulvic acids (FA) and humin (Uyguner and Bekbolet, 2005).

Humic substances cause formation of disinfection by products (DBPs) such as chloroform, bromo-dichloromethane, etc., which are suspected carcinogenic compounds (Yildiz, et al., 2008). Chlorine as a disinfectant, although essential for pathogen control, leads to the halogenation of organic matter present in source water (Croue' et al 1999). Halogenated (Chlorine and Bromine) containing compounds form from dissolved and particulate organic carbon during water treatment and are collectively referred to as disinfection by products (Kurt et al, 2013). Although only a small fraction of the organic carbon present in source water reacts to form Disinfection by products (DBPs) several DBPs have been identified as mutagenic and carcinogenic (Krasner et al, 2006). For this reason, the USEPA currently regulates two classes of DBPs commonly found on drinking water – trihalomethanes (THMs) and halo acetic acids (USEPA, 2009). In addition to being a source of DBPs, organic carbon contributes to biofouling, increases chlorine demand, and can affect aesthetic qualities of water such as taste, odour, and colour (Cooke and Kennedy, 2001).

The humic substances are also responsible of the formation of water-soluble complexes of humic substances with metal ions is of particular interest, because complexing can increase concentrations of these ions in natural waters far above the concentrations that could be expected based on the solubilities of inorganic species (Boggs et. al., 1985).

The measurement of ultraviolet absorbance at 254 nm (UVA254) has been used by the drinking water

industry as a proxy for DOC concentration for several decades (Edzwald et al., 1985). Dissolved Organic carbon or DOC is a measurement of the amount of organic matter in water that can be passed through a filter, commonly 0.45 µm. In addition to providing information about DOC concentration, absorbance data can provide insight into the chemical makeup of the DOM pool (Rathban, 1996).

**Research Goals**

NOM can be defined as a mixture of complex organic compounds that universally present in natural waters. High NOM content in water strongly impact the water quality and treatment in several ways. Besides that, NOM also acts as the main precursor to disinfectant by products produce from the reaction of NOM and disinfectant during water treatment. DBPs are known to be carcinogenic to human and animals. In addition, NOM are capable of complexing with metal ions and bringing them to the water sources.

As the HS predominates in NOM, HS can be used to determine the concentrations of NOM. Because when the NOM concentration is higher, the defective outcomes will be higher due to them. Still, National Water Supply and Drainage Board does not have a reliable method to measure the concentrations of NOM in water, in its regional laboratories. Therefore, the amount of organic matter entering the drinking water treatment plant is unrevealed.With the available laboratory facilities in regional levels, National Water Supply and Drainage Board of Sri Lanka has to find a method to estimate the amount of organic matter content in water that is entering the treatment plant.

**Objectives**

The objective of this study is to realize a reliable method using available laboratory facilities, to quantify the NOM in natural water sources, which are used by the National Water Supply and Drainage Board as drinking water origin.

## II. METHODS

Standard solutions of HS were prepared using the commercially available Humic acid powder (Sigma Aldridge brand). A graph was obtained by scanning the different standard samples, against series of wave lengths from 990 to 1100 nm, Using the DR 5000 spectrophotometer. Then the wave length range was filtered to 230 nm to 630 nm, as the absorbance at the other wave lengths were not given considerable variations. Then the results obtained from the standard graph was compared with the unknown samples, the concentration of the organic matter in the sample can be estimated.

## III. RESULTS

Figure 1 shows the absorbance patterns of different concentrations of organic matter samples. The highest concentration of organic matter sample has wider absorbance range, while the least concentration has the narrow absorbance range.

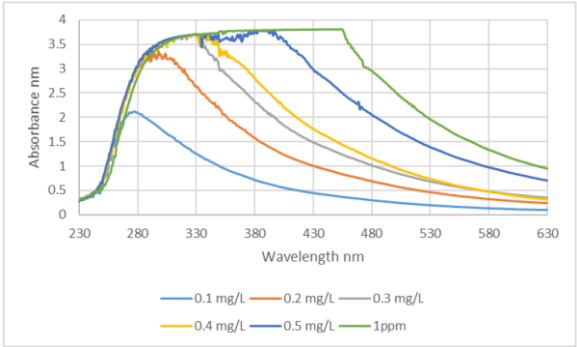



**Figure 1: absorbance patterns of different concentrations of organic matter**

The results stipulated in Figure 1 were used to estimate the concentrations of organic matter content in naturally occurring water samples collected from various locations.

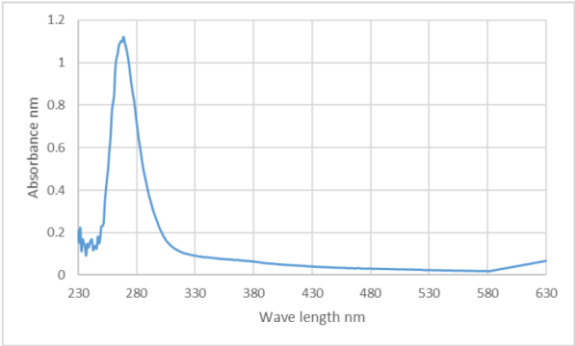



**Figure 2: Graph of Absorbance Vs Wave length for Doluwa WSS**

When the results obtained from the Figure 1 graph is used, the concentration of organic matter content in the water sample collected from Doluwa can be estimated.

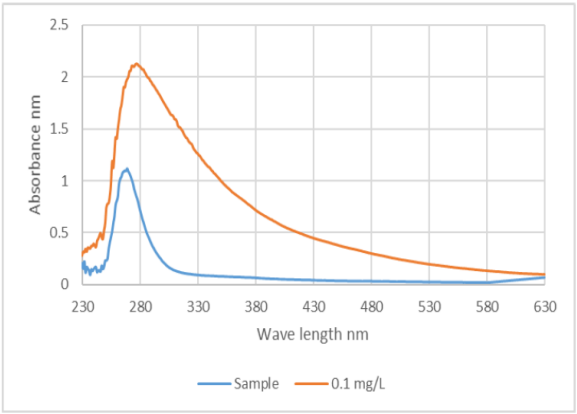



**Figure 3: Comparison of absorbance of the Doluwa sample and 0.1 mg/L HS standard sample**

According to the Figure 3, sample contains organic matter content of less than 0.1 mg/L.

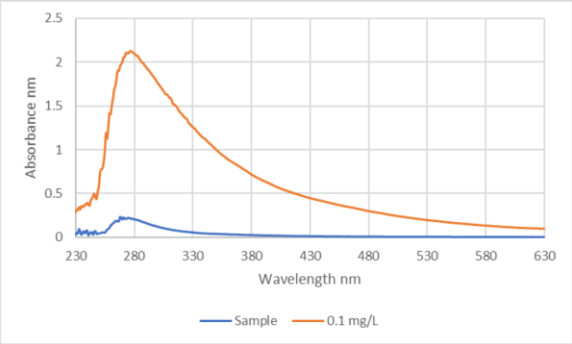



**Figure 4. Comparison of absorbance of the Nawalapitoya sample and 0.1 mg/L HS standard sample**

## IV. CONCLUSIONS

The graph shown in the figure 1 can be used as a reliable method to estimate the Organic matter content in water samples. All the raw water samples measured during the three months period of time (from August to October – 2018), collected from 13 locations of Kandy South region (39 samples), contained organic matter content of less than 0.1 mg/L, which means water sources are less contaminated and still far away from the danger of DBPs.

## REFERENCES

[1] Croue', J.P., DeBroux , J.F., Amy, G.L., Aiken, G.R., Leenheer, J.A. (1999). Natural Organic matter – Structural characteristics and reactive properties. Formation and control of disinfection by products in drinking water. American Water Works Association.

[2] Kurt, D.C., Tamara, E.C.K., Jami, H.G., John, F.S., Bryan D.D., Brian A.B. (2013). Sources and characteristics of Organic matter in the clackmas River, Oregon, Related to the formation of disinfection by products in treated drinking water. Scientific investigations rofeport. U.S. Department of the interior survey. U.S. Geological Survey.

[3] Krasner, S.W., Weinberg, H.S., Richardson, S.D., Pastor S.J., Chinn, R., Sclimenti, M.J., Onstad, G.D., Thurston, A.D. (2006). Occurrence of a new generation of disinfection byproducts: Environmental Science and technology. Vol. 40, N0. 23. Pp 7175-7185

[4] United States Environmental Protection Agency (USEPA). 2009. National primary drinking water regulations – Minor correction to stage 2 disinfectants and disinfection byproducts rule and changes in reference to analytical methods : Federal Register, June 29, 2009. Vol 74, No. 123.

[5] Cooke, G.D., Kennedy, R.H. (2001). Managing Drinking water supplies. Journal of Lake and Reservoir management. Vol. 17. No. 3.

[6] Edzwald, J.K., Becker, W.C., Wattier, K.L. (1985). Surrogate parameters for monitoring organic matter and THM precursors: Journal of American Water Works Association. Vol. 77. No. 4.

[7] Rathban, R.E. (1996). Trihalomethane and non-purgeable total organic halide formation potentials of the Missisipi River: Archives of Environmental contamination and Toxicology. Vol. 30. No.2.

[8] Weishaar, J.L., Aiken, G.R., Bergamaschi, B.A., Fram, M.S., Fujii, Roger, Mopper, Kenneth. (2003). Evaluation of specific ultraviolet absorbance as an indicator of the chemical composition and reactivity of dissolved organic carbon. Environmental science and Technology. Vol. 37. No.20.

[9] Helms, J.R., Stubbins, Aron, Ritchie, J.D., Minor, E.C., Kieber, D.J., Mopper, Kenneth. (2008). Absorption spectral. Slopes and slope ratios as indicators of molecular weight, source, and photobleaching of chromophoric dissolved organic matter. Limnology and Oceanography, Vol. 53. No. 3.

[10] Spencer, R.G.M., Stubbins, Aron, Hernrs, P.J., Baker, Andy, Mopper, Kenneth, Aufdenkampe, A.K., Dyda, R.Y., Mwamba, V.L., Mangangu, A.M., Wabakanghazi, J.N., Six, Johan. (2009). Photochemical degradation of dissolved organic matter and dissolved lignin phenols from the Congo River. Journal of Geographical Research – Biogeosciences. Vol. 114.

[11] Mahvi, A.H., Maleki, A., Rezaee, R., Safari, M. (2009). Reduction of Humic substances in water by application of ultrasound waves and ultraviolet irradiation. Iran Joural of Environmental Health Science Engineering. Vol.6. No. 4.

[12] Aoustin, E., Schafer, A.I., Fane, A.G., Waite, T.D. (2001). Ultrafiltration of natural organic matter. Sep. Purification Technology.

[13] Parkinson, A., Barry, M.J., Roddick, F.A., Hobday, M.D. (2001). Preliminary toxicity assessment of water after treatment with UV-IR radiation and UVc/H2O2. Water research. Vol. 35

[14] Richard, T.L., Karen, H.T. (2009). Critical comparison of Humic acids test methods. Communications in soil science and plant analysis. ISSN 0010-3624

[15] Uyguner, C.S., Bekbolet, M. (2005). A comparative study on the photocatalytic degradation of humic substances of various origins. Desalination. Vol. 176.

[16] Boggs, S., Livemore, D., Seltz, M.G. (1985). Humic Substances in natural waters and their complexation with trace metals and radionuclides : A review. Argonne National Laboratory, 9700 South Case Avenue, Argonne, Illinois, 60439.

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