Study of the Influence of Nitrogen Organic Matter in the formation of Trihalomethane in one drinking water plant in Nicaragua

Espinoza, L.V.,[1] Barquero, F.,[1] García, I.A.[2]
[1]Facultad de Ciencia y Tecnología del Ambiente, Universidad Centroamericana, UCA.
[2]Facultad de Ingeniería Química, Universidad Nacional de Ingeniería, UNI.
e-mail autor principal:laura17489@yahoo.com

1. Introduction

Mostly of the drinking water research focus in natural organic matter (NOM) use parameters as dissolved organic carbon (DOC), total organic carbon (TOC), ultraviolet absorbance at 254 nm (UV_{254}), colour, and specific ultraviolet absorbance (SUVA) to characterize the organic matter present in the water. In less extension, the presence of dissolved organic nitrogen (DON) had been monitored, even when the nitrogen compounds concentration had increases worldwide due to human activities. However, studies about dissolved inorganic nitrogen (DIN) formed by NO_3^-, NO_2^- and NH_4^+ species had been reported. The sum of DON and DIN quantify the total dissolved nitrogen (TDN) present in natural waters.

The importance to measure DON lays on the formation of nitrosamines, halonitromethanes, cyanogens halides, haloacetroniles and other compounds which are nitrogen disinfection by-products formed when organic matter is not removed properly in the potabilization treatment before the disinfection step with chlorine or chloramines. These nitrogen by-products (N-DBPs) had been linked with carcinogenic and mutagenic problems, even more strongly than other regulated DBPs.[1]

The presence of DON had not been measured in any of the drinking water plants in Nicaragua, only parameters as DOC, TOC, colour, SUVA had been determined giving high values in rainy season and low in dry season. Many of these plants can not achieve high NOM removal with only conventional coagulation treatment and therefore concentrations of trihalomethanes higher of 80 μg/L had been found.

The aim of this study is to determine the reduction of DOC, DON and DIN and its behavior by using chitosan as coagulant in raw water fractionated. Comparison with aluminium sulphate coagulant will be done. In addition, the formation of trihalomethanes is analyzed as well.

2. Results and Discussions

Juigalpa raw water presents low values of NOM (UV_{254}, DOC), DON and DIN. This source is a mixture of hydrophobic and hydrophilic fractions due the VHA fraction that characterize the hydrophobicity of the NOM in the water representing 57.1% and the hydrophilic fractions (SHA+ CHA + NEU) constitute 42.9% respectively. The higher percentages of hydrophobic fraction which can point out the presence of terrestrial organic matters of high molecular weight and allochthonous origin which can be reduced easily by coagulation process.[2] Also the higher colour and DOC/DON ratio in Juigalpa are indicative of allochthonous organic matter. Can be seen that the fractions have the same trend VHA>SHA>CHA>NEU for UV_{254}, DOC and colour. But for DON and DIN the tendency changes to SHA>VHA>CHA>NEU which indicate that the hydrophilic acid

part has more nitrogen content (SHA) than the very hydrophobic (VHA). The relation DOC/DON determines the trend to form N-DBPs in the disinfection step.[2] That makes up that Juigalpa source with a high DOC/DON value has much less tendencies to form N-DBPs. Specific colour have the same behaviour of SUVA to decrease from hydrophobic to hydrophilic fraction.

Table 1. Juigalpa water source fractionated and non fractionated.

Sample	UV_{254} (1/cm)	DOC (mg/L)	DON (mg/L)	Colour (mg/L)	DIN (mg/L)	DIN/TDN (mg/mg)	DOC/DON (mg C/mg N)	SUVA (L/mg-m)	Specific Colour
Whole NOM	0.126	4.7	0.214	35.2	0.141	0.40	22.0	2.7	7.5
VHA	0.062	2.8	0.057	21.6	0.025	0.30	49.1	2.2	7.7
SHA	0.027	1.1	0.121	6.5	0.073	0.38	9.1	2.5	5.9
CHA	0.014	0.6	0.027	2.8	0.038	0.58	22.2	2.3	4.7
NEU	0.007	0.4	0.016	1.2	0.019	0.54	25.0	1.8	3.0
Total Fractions	**0.110**	**4.9**	**0.221**	**32.1**	**0.155**	**0.41**	**22.2**	**2.2**	**6.6**

Table 2 shows the results after to treat the whole water and the fractionated water with alum or chitosan. UV_{254}, DON and Colour reduction were higher with alum; however, DOC and DIN achieved higher removal with chitosan. Also SUVA and specific colour which are indicator of the formation of THMs shows that with alum the formation is lower because the organic matter remaining is less reactive with chlorine. Similarly, the relation DOC/DON is higher with alum which pointed out than lower nitrogen disinfection by-products are formed in the disinfection step.

Table 2. Juigalpa coagulated water treated with alum or chitosan.

Water Treated with Alum									
Sample	UV_{254} (1/cm)	DOC (mg/L)	DON (mg/L)	Colour (mg/L)	DIN (mg/L)	DIN/TDN (mg/mg)	DOC/DON (mg C/mg N)	SUVA (L/mg-m)	Specific Colour
Whole NOM	0.037	1.9	0.073	6.0	0.053	0.42	26.0	1.9	3.2
Total Fractions	0.041	2.2	0.077	4.7	0.057	0.43	28.6	1.9	2.1
Water Treated with Chitosan									
Whole NOM	0.040	1.4	0.085	7.0	0.049	0.366	16.5	2.9	5.0
Total Fractions	0.045	2.1	0.087	7.4	0.058	0.400	24.1	2.1	3.5

3. Conclusion

Juigalpa water treated by alum achieves higher organic matter reduction as carbon and nitrogen compounds. The fraction that presents highest NOM removal with alum or chitosan is hydrophobic (VHA), followed by hydrophilic (SHA); the charged (CHA) and the lower is the neutral (NEU) fraction. This behaviour is because hydrophobic fraction is less soluble in water and more easily to coagulate in comparison with hydrophilic which is soluble. CHA and NEU fractions are recalcitrant and therefore hard to be removed by coagulation with both coagulants. Low formation of THMs was found in the fractions and the whole water.

4. Reference

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