SEj
Vol. 2, N° 1, 2018

Journal of Sciences and Engineering

A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-9503

Evaluation of free and residual chlorine in drinking water of the district of Pativilca - Barranca

Ronald Rodríguez Espinoza[a], Nicodemo Jamanca Gonzáles[a], Johnny Gomero Mancesidor [a], Héctor Castro Bartolomé [a], Santos Celis Rojas [a]

[a]Universidad Nacional de Barranca.
rrodriguez@unab.edu.pe

Resumen

Se tomaron muestras durante un mes en 12 zonas del distrito de Pativilca. Se realizaron análisis fisicoquímicos por los métodos fotometría de cloro libre y cloro combinado. Los resultados muestran que el cloro libre y total, presentan valores por debajo de los límites máximos permisibles, encontrándose que el 66.7 % de los puntos de muestreo en el distrito de Pativilca, no cumplen con el requerimiento mínimo de cloro dados por la Dirección General de Salud Ambiental del Ministerio de Salud. La calidad química del agua potable del distrito de Pativilca, en promedio, no está dentro de los estándares asignados para el cloro libre.

Palabras clave: Calidad del agua, agua potable, cloro libre, cloro total

Abstract

Samples were taken during one month in 12 areas of the district of Pativilca. Physicochemical analyses were performed by free chlorine and combined chlorine photometry methods. The results show that free and total chlorine have values below the maximum permissible limits, finding that 66.7% of the sampling points in the district of Pativilca do not comply with the minimum requirement of chlorine given by the General Directorate of Environmental Health of the Ministry of Health. The chemical quality of drinking water in the district of Pativilca, on average, is not within the standards assigned for free chlorine.

Keywords: Water quality, drinking water, free chlorine, total chlorine

1. Introduction

Consumption of water without prior disinfection treatment can transmit diseases such as diarrhoea, cholera, dysentery, typhoid fever and polio. According to WHO (2018), drinking water contamination is estimated to cause more than 502 000 deaths from diarrhoea each year.
The lack of adequate treatment, especially free chlorine, directly affects the health of the population, especially the most vulnerable such as children. According to the study carried out by Miranda, Aramburu, Junco and Campos (2010) estimated that the national proportion of children under the age of five who live in households with an adequate supply of water with free chlorine only reaches 19.5%, located mainly in the cities of the rural highlands and jungle of Peru, this situation represents a serious problem for the control of diarrheal diseases and child malnutrition. The progressive increase of the population, with the consequent increase of the pollution that this generates (urban and industrial wastes, miners, agricultural and cattle production, etc.) supposes a worsening of the quality of the waters, reason why its treatment becomes even more necessary to guarantee its quality and absence of risk of epidemics.
Currently, most drinking water treatment plants use chlorine, in its various forms, as a disinfectant agent (eliminates pathogenic bacteria, hummingbirds and drastically reduces the amount of other types of bacteria) (Fernández, 2014).

Please cite this article as: Rodriguez R, et al; Evaluation of free and residual chlorine in drinking water of the district of Pativilca - Barranca, Journal of Sciences and Engineering, vol. 2, no 1, 2018, pp. 16-20.

SEj
Vol. 2, N° 1, 2018
Journal of Sciences and Engineering
A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-9503

Chlorine is commonly used in industrial and domestic environments as a notable disinfectant and as bleach. In particular, it is used in the treatment of drinking water. Chlorine reacts with water forming hypochlorous acid and hypochlorites. Its reference value is 5 mg/L and it is present in most disinfected drinking water at levels of 0.2 - 1.0 mg/L (WHO, 2006). However, their use is being questioned due to disinfection by-products that originate when reacting with certain aquatic organic substances present in the water, a particular problem in some areas where nitrate pollution is high, are cause for concern in drinking water because they cause damage to health. In the study developed by Salazar and Peñuela (2016), they determined the effect of pre-oxidation with ClO2 in a conventional laboratory scale process on the formation of DBPs: trihalomethanes (THMs) and haloacetic acids (HAAs).

In addition, it is relevant to evaluate the microbial action of the disinfectant, as well in the work developed by Kunigk L, Gedraite R., Jurkiewics C. (2018) evaluated the action of chlorine dioxide (ClO2) and sodium hypochlorite (NaOCl) in reducing the number of mesophilic aerobes, as well as the decrease in chlorine demand in the water used. The results showed that chlorine dioxide is less affected by water pollutants when compared to sodium hypochlorite; a 3 log cycle reduction in the number of mesophilic aerobics was obtained through the use of ClO2 with residual concentration of 0.2 mg/L and a residual chlorine, NaOCl, of 0.8 mg/L. The results showed that chlorine dioxide is less affected by water pollutants when compared to sodium hypochlorite; a 3 log cycle reduction in the number of mesophilic aerobics was obtained through the use of ClO2 with residual concentration of 0.2 mg/L and a residual chlorine, NaOCl, of 0.8 mg/L. To obtain these concentrations, it is necessary to dose 5.0 mg/L of ClO2 and 15.5 mg/L of NaOCl in water. As mentioned, the quality of drinking water in all populations has a strong impact on public health (Angeles, 2000), so its quality control is an important factor in disease prevention, hence it is important to periodically sample and analyze the physical, chemical and microbiological characteristics supplied to the general population.

The drinking water supply service in the district of Pativilca is in charge of a Municipal Company whose supply comes from groundwater and rivers, which are subsequently disinfected with chlorine, but there are limitations on access to reports on its control and measurement in the water that reaches homes.

2. Materials and Methods

It is a quantitative, observational, descriptive and cross-sectional study.

Area of study

Drinking water supply comes from treatment plants administered by the municipality of Pativilca through EMAPAT SAC. (Empresa Municipal de Agua Potable de Pativilca SAC).

The study area included the urban area of the district of Pativilca, belonging to the province of Barranca.

Water sampling

Sampling was carried out in 12 random and representative zones of the district of Pativilca, which was carried out during the month of June 2018.

Physical-chemical analysis

Water samples were taken from each point in 250 ml sterile glass jars filled to a volume of 150 ml for chemical analysis.

Measurements were made using a PF12 compact photometer with colorimeter test kit for Chlorine 2 (0.1 - 0.2 mg/L).

(a) Determination of free chlorine

The ortoluidine in hydrochloric medium and in the presence of free chlorine oxidizes, giving a compound of yellow color. As the intensity of the coloration increases by increasing concentrations of free chlorine, it can be determined by colorimetry, using a series of known concentration patterns.

b) Combined Chlorine

Combined chlorine is obtained by the difference between total chlorine and free chlorine.

SEj
Vol. 2, N° 1, 2018
Journal of Sciences and Engineering
A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-9503

(c) Total chlorine

The amount of total chlorine in drinking water is equal to the amount of free chlorine plus the amount of combined chlorine. In a given water supply that portion of the "free" total residual chlorine serves as a measure of the ability to "oxidize" organic matter. When practicing free residual chlorination, it is recommended that at least 85 % of the total residual chlorine remains in the free state. Chlorination is also a relatively efficient method as a corrective treatment, if applied in appropriate quantities, in addition to those required for disinfection purposes.
Sometimes such large concentrations of chlorine are required that later dechlorination is required so that no chlorine flavours or odours are present in the water. A relatively recent chlorination technique includes the use of sodium chloride along with ordinary chlorination. Chlorine dioxide is produced in this reaction. It will be determined by photometry.

3. Results

The results of the determination of free, combined and total chlorine in drinking water carried out in the district of Pativilca are shown in table 1 and are represented in the figure.

Table 1. Concentrations of free, combined and total chlorine in the drinking water of the district of Pativilca

Sampling points	Free chlorine (ppm)	Combined chlorine (ppm)	Total chlorine (ppm)
Urbanización Buenos Aires - Point 1	0.25	0.13	0.38
Urbanización Buenos Aires - Point 2	0.23	0.19	0.42
Urbanización Nueva Victoria - Point 1	0.37	0.12	0.49
Urbanización Nueva Victoria - Point 2	0.35	0.11	0.46
Av. Juan Velasco Alvarado - Point 1	0.34	0.13	0.47
Av. Juan Velasco Alvarado - Point 2	0.28	0.07	0.35
Av. Ramón Castilla - Point 1	0.33	0.10	0.43
Av. Ramón Castilla - Point 2	0.11	0.12	0.23
Av. Francisco Bolognesi - Point 1	0.27	0.11	0.38
Av. Francisco Bolognesi - Point 2	0.29	0.15	0.44
Av. Cuzco - Point 1	0.09	0.10	0.19
Av. Cuzco - Point 2	0.18	0.12	0.30
Mean	0.26	0.12	0.38
maximum value	0.37	0.19	0.49
minimum value.	0.09	0.07	0.19

SEj
Vol. 2, N° 1, 2018
Journal of Sciences and Engineering
A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-9503

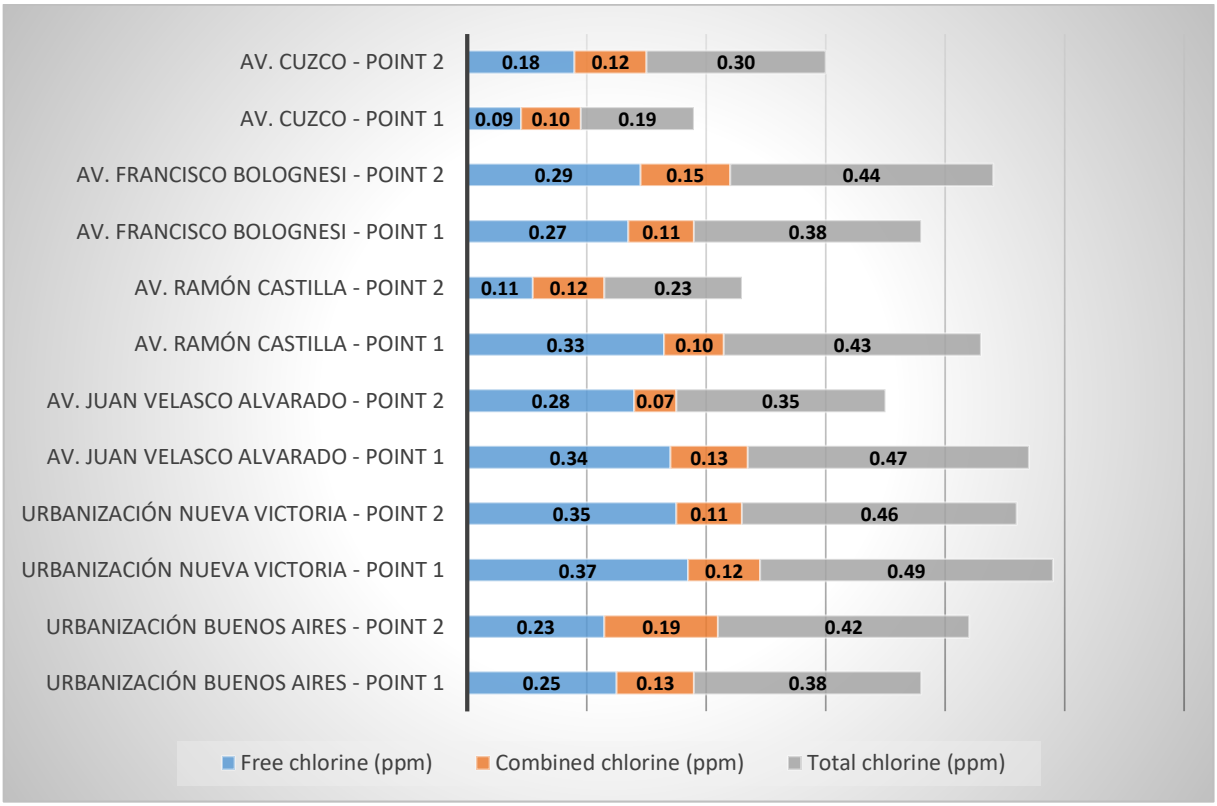

Figure 1. Average concentration of free, combined and total chlorine in the drinking water of the district of Pativilca.

4. Discussion and Conclusions

With respect to free chlorine or residual chlorine, 0.09 ppm and 0.37 ppm correspond to the minimum and maximum concentrations respectively, with an average value of 0.26 ppm.
All values are below 0.5 g/L (0.5 ppm), which is recommended by the Regulation on Water Quality for Human Consumption, according to D.S. No. 031-2010-SA of the General Directorate of Environmental Health, Ministry of Health (2010), which establishes a maximum permissible limit of 5 mg/L (5 ppm) and that 90% of samples should not fall below 0.5 mg/L (0.5 ppm) at any point in the distribution network and in the remaining 10%, none must contain less than 0.3 mg/L (0.3 ppm), finding 8 points that are below this limit. However, the WHO (2006) establishes that chlorine reacts with water forming hypochlorous acid and hypochlorites whose presence in disinfected drinking water varies in concentrations of 0.2 - 1 mg/L, but for disinfection to be effective it must contain ≥ 0.5 mg/L, after a contact time of at least 30 min at pH < 8.0.
In addition, for combined chlorine, there is a minimum value of 0.07 ppm and a maximum value of 0.19 ppm, with an average value of 0.12 ppm. It should be noted that combined chlorine is the result of the reaction between the chlorine added for disinfection and the organic material present in drinking wáter.

The free or residual chlorine for the 12 samples taken contains less than 0.5 ppm. 66.7 % of the sampling points in the city of Pativilca do not comply with the minimum chlorine requirement (not less than 0.3 ppm), being above the 10 % established by the D.S. norm N° 031-2010-SA of the General Directorate of Environmental Health of the Ministry of Health in its article 66°

SEj
Vol. 2, N° 1, 2018
Journal of Sciences and Engineering
A publication of
CINCADER
Centre of Research and Training for Regional Development
Online at www.journals.cincader.org

ISSN 2523-9503

References

Ángeles, C. J. 2000. Evaluación de la Calidad Bacteriológica del Agua Potable de la Ciudad de Iquitos. (Trabajo de grado). Universidad Nacional de la Amazonía Peruana. Iquitos – Perú.

Fernández M. 2014. Problemas de calidad del agua potable producidos por los subproductos del proceso de tratamiento. [Entrada de blog]. Available in: https://www.eoi.es/blogs/mariajesusfernandezmiguelez/2014/02/17/problemas-de-calidad-del-agua-potable-producidos-por-los-subproductos-del-proceso-de-tratamiento/

Kunigk, L.; Gedraite, R. y Jurkiewicz K., C. 2018. Efficacy of Chlorine Dioxide and Sodium Hypochlorite in Reuse Water Disinfection. Environmental Engineering and Management Journal. March 2018, Vol.17, No. 3, 711-720. Available in: http://www.eemj.icpm.tuiasi.ro/; http://www.eemj.eu

Ministry of Health. 2016. Reglamento de la Calidad del Agua para Consumo Humano. Decreto Supremo N° 031-2010-SA. Available in: http://www.digesa.minsa.gob.pe/publicaciones/descargas/Reglamento_Calidad_Agua.pdf

Miranda, M., Aramburú, A., Junco J. y Campos, M. 2010. Situación de la calidad de agua para consumo en hogares de niños menores de 5 años en Perú, 2007-2010. Revista Peruana de Medicina Experimental y Salud Pública. Vol. 27 Issue 4, p506-511. 6p. Available in: http://web.a.ebscohost.com/ehost/detail/detail?vid=3&sid=3e2f071d-3ee8-45c2-a10b-0c1d0d5c362f%40sessionmgr4009&bdata=Jmxhbmc9ZXMmc2l0ZT1laG9zdC1saXZl#AN=67402207&db=aph

Salazar S., Peñuela G. 2016. Effect of Pre-Oxidation with Chlorine Dioxide on the Formation of Trihalomethanes and Haloacetic Acids in a Drinking Water System. Revista Politécnica ISSN 1900-2351 (Impreso), ISSN 2256-5353 (En línea), Año 12, Número 22, páginas 9-20.

WHO. 2018. Available in: http://www.who.int/es/news-room/fact-sheets/detail/drinking-water

WHO. 2006. Guías para la calidad del agua potable. Primer apéndice a la tercera edición. Volumen 1. Available in: http://www.who.int/water_sanitation_health/dwq/gdwq3_es_fulll_lowsres.pdf