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An overview of water quality regulation or standards in swimming pools, drinking water, and hot springs in Germany, Canada, and Colombia

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Abstract

This article presents the regulations in the quality of water in swimming pools and drinking water in Germany, Canada, and Colombia, with a comparison to existing regulations and standards of quality of hot springs. Canada, Germany, and Colombia stipulate that drinking water must be free from unsafe levels of substances chemicals and pathogens, specifying guidelines for the microbiological and chemical parameters.

However, in the case of hot springs Canada and Germany do not possess specific regulations or standards, but apply the same microbial and chemical requirements for swimming pools according to Public Swimming Pools Regulation of Canada and the standard DIN 19643 as well as the Infection Protection Act of Germany.

Colombia does not have regulations or standards pertaining to the quality of hot springs, as established in article 6 of Decree 554 of 2015, and it does not apply the swimming pool regulations to hot springs.

Keywords: drinking water; hot springs; regulations; standards; swimming pool

Resumen

Este artículo presenta las regulaciones en la calidad del agua en piscinas y agua potable en Alemania, Canadá y Colombia, mediante una comparación con la regulación existente y los estándares de calidad de las aguas termales. Canadá, Alemania y Colombia estipulan que el agua potable debe estar libre de niveles inseguros de sustancias químicas y patógenas, especificando guías para los parámetros microbiológicos y químicos.

Sin embargo, en el caso de las aguas termales, Canadá y Alemania no poseen regulaciones o estándares específicos, pero aplican los mismos requisitos microbianos y químicos para piscinas, de acuerdo con el Reglamento de piscinas públicas de Canadá y la norma DIN 19643, tanto como la ley de protección contra infecciones de Alemania.

Colombia no cuenta con reglamentos o normas sobre la calidad de las aguas termales, tal como lo establece el artículo 6 del Decreto 554 de 2015 y no aplica la regulación de piscinas a aguas termales.

***Palabras clave**: agua potable; termales; reglamentos; normas; piscina*

1. Introduction

Hot springs are used for recreational, therapeutic and medicinal purposes (Sánchez and Cheu, 2019), and potentially benefit people's health by improving blood pressure and treating respiratory diseases, low-grade inflammation, stress-related pathologies, pain, rheumatoid arthritis, osteoarthritis of the knees and hips, psoriasis, and atopic dermatitis (Galvez et al., 2018), (Verhagen et al., 2007, 2015), (Fioravanti et al., 2012) and (Ronni et al., 2003).

According to the Center for Disease Control and Prevention (CDC) of EEUU, reducing Recreational Water Illnesses (RWI) requires vigilant monitoring of pool staff, swimmers, and health departments because it is a multifaceted issue. The poor maintenance of hot springs can result in low disinfectant levels that can allow the spread of a variety of microorganisms that cause health issues for swimmers. Therefore, the water in natural hot springs must have a satisfactory microbiological quality and must be properly managed to control the exposure of bathers and staff to infectious agents (Valeriane et al., 2018). Natural hot springs are left untreated to ensure the original properties of the sources waters and subsequent potential health benefits (Giampaoli et al., 2012). However, most hot springs have lost their natural properties due to the addition of chlorine and other disinfecting chemicals (Valeriane et al., 2018).

Therefore, the control of pathogens in recreational waters is achieved with adequate treatment and influenced by disinfection with chlorine or other disinfectants (WHO, 2006). However, protozoa and parasites may require further treatment, such as UV radiation, to be completely deactivated

(Ontario, 2019). Disinfection is mainly achieved using chlorine, ozone, or ultraviolet (UV) radiation (with ozone and UV being used in combination with chlorine or bromine) (Barrera et al., 2012; WHO, 2006). As a results, there are standards or regulations to guarantee the quality of the water.

2. Methodology

To research sources, various references were consulted, including international journals and official websites of organizations such as: World Health Organization, Health Ministers, Investigation Centers: i) regulation or standards in swimming pools and hot springs, ii) regulations or standards in drinking water, and iii) guidelines for drinking water and recreational water in Germany, Canada, and Colombia.

3. Water Quality Regulations or Standards in Swimming Pools, Drinking Water, and Hot Springs

The regulations or standards for drinking water in Germany, Canada, and Colombia stipulate that water must be free from unsafe levels of substances chemicals and pathogens, specifying the microbiological and chemical parameters that need to be followed. Each country establishes parameters according to the water sources, including Lake Ontario in the province of Ontario in Canada, underground sources, lakes and rivers in Germany, and rivers and underground sources in Colombia.

Germany, Canada, and Colombia establish that swimming pool water must be disinfected, and establish limit parameters for chlorine, bromine, and formation of chlorination and/or bromination by-products.

In Colombia, the regulations for hot springs are insufficient and do not have specific parameters for water quality. Article 6 of Decree 554 of 2015, of the Ministry of Health and Social Protection, establishes (Colombia, 2015) "*The general physical - chemical and microbiological parameters of the water will not be required of the ponds that store hot springs and therapeutic uses. The Ministry of Health and Social Protection will define these parameters.*"

However, in the case of hot springs where the bather is exposed to similar conditions to that of swimming pools, Canada and Germany do not possess specific regulations or standards for the quality of water from hot springs, but apply the same microbial and chemical requirements that exist for swimming pools with water circulation, filtration, and disinfection. In Germany, as in conventional swimming pools, the main focus of water treatment is filtration in order to minimize the use of disinfectants (Reuss, 2011). Hot springs in Colombia are not treated in this way, and frequent dilution and replacement of water is therefore carried out, which are often insufficient to guarantee a microbial quality of the water, representing a risk for bathers (Gere, et al., 2022; Sánchez & Cheu, 2019).

Tables 1 and 2 present regulations or standards of drinking water and swimming pools water with main microbiological, physical and chemical parameters in Germany, Canada, and Colombia. It

is observed that each country has different parameters and evaluation criteria to control water quality, but in the case of pathogenic organisms all regulations stipulate absence of such microorganisms.

In the comparison made between the regulation of drinking water and swimming pool water, it is observed that water for human consumption has greater control parameters with respect to swimming pool parameters, water that is required for the use of swimming pools. In the case of hot springs, for Canada and Germany the microbiological quality of the water is a priority regardless of its chemical quality, because it applies its swimming pool regulations to hot springs and in the case of Colombia the chemical quality is a priority over the bacteriological quality, because it is not regulated like swimming pool water.

Table 1. Main microbiological parameter

PARAMETER	UNIT	DRINKING WATER					SWIMMING POOL			
		CANADA			GERMANY	COLOMBIA	CANADA		GERMANY	COLOMBIA
		ONTARIO Reg. 169/03 (a)	GUIDELINE FOR ONTARIO (b)	GUIDELINES FOR CANADIAN (c)	BGBl. I 2016, 476 (d)	Resolution 2115/07 (e)	Alberta Reg. 204/2014 and Government (f)	Ontario Reg. 565/1990 (g)	DIN 19643 (h)	Resolution 1618/10 (i)
Total coliforms	MPN/ 100 mL	Not detectable			-	0 CFU	Not presence UFC/100 mL	Not presence	-	-
Coliformes fecales (Estericha Coli)	MPN/ 100 mL	Not detectable			0	0 CFU	Not presence	Not presence	0 CFU/ 100 mL	0 UFC / 100 cm^3
Heterotrophic	CFU/mL	-	-	-			100	-	100	-
Enterococci	MPN/ 100 mL	-	-	-	0	-	-	-	-	-
Legionella	MPN/ mL	-	-	-	-	-	-	-	0 CFU/ 100 mL	-
Pseudomona aeruginosa	MPN/ 100 mL	-	-	-	-	-	Not presence	Not presence	0 CFU/ 100 mL	0 UFC / 100 cm^3
mesophilic microorganisms	CFU/ 100mL	-	-	-	-	100	-	-	-	<200
Giardia	Cysts	-	Minimum removal or inactivation		-	0	-	-	-	0 Cyst/1000 cm^3
Cryptosporidium	Oocysts	-	Minimum removal or inactivation		-	0	-	-	-	0 oocysts/1000 cm_3
Virus and protozoos		-	It is desirable that no virus or protozoa be present		-	-	-	-	-	-

Source: [a] (Ontario, 2003). [b] (Ontario, 2003).[c] (Canada, 2020).[d] (Germany, 2016). [e] (Colombia, 2015). [f] (Alberta, 2014). [g] (Ontario, 1990). [h] (Germany, 1997). [i] (Colombia, 2007) and (Sanchez, 2011).

Table 2. Main physical and chemical parameters

PARAMETER	UNIT	DRINKING WATER					SWIMMING POOL			
		CANADA			GERMANY	COLOMBIA	CANADA		GERMANY	COLOMBIA
		ONTARIO Reg. 169/03 (a)	GUIDELINE FOR ONTARIO (b)	GUIDELINES FOR CANADIAN (c)	BGBl. I 2016, 476 (d)	Resolution 2115/07 (e)	Alberta Reg. 204/2014 and Government (f)	Ontario Reg. 565/1990 (g)	DIN 19643 (h)	Resolution 1618/10 (i)
Temperature	oC	-	15	<= 15	-	-	35-45	-	-	-
Conductivity	uS/cm	-	-	-	2790 at 25 oC	1000	-	-	-	max 2400
Odour and taste		-	Inoffensive	Inoffensive	3 - 23 oC as Ton/ Acceptable	Acceptable	-	-	-	Acceptable
ORP	mV	-	-	-	-	-	700 - 770	600 - 900	-	Min 700
pH		-	6.5 - 8.5	7,0 - 10,5	≥ 6,5 und ≤ 9,5	6,5 - 9,0	6,8 - 7,6	7,2 - 7,8	6,5 - 7,2	7,0 - 8,0
Alachlor	mg/L	0,005	0,005	-	-	-	-	-	-	-
Aldicarb	mg/L	-	0,009	-	-	-	-	-	-	-
Acrylamide	mg/L	-	-	-	0,0001	-	-	-	-	-
Aldrin +Dieldrin	mg/L	-	0,0007	-	-	-	-	-	-	-
Aluminum	mg Al/L	-	0,1	< 0.1	0,2	0,2	-	-	-	< 0,2
Ammonium	mg/L NH_4	-	-	-	-	-	-	-	-	< 1,5
Antimony	mg Sb/L	0,006	0,006	0,006	-	0,02	-	-	-	-
Arsenic	mg As/L	0.01	0,025	0,01	-	0,01	-	-	-	-
Antrazine	mg/L	0,005	0,005	0,005	-	-	-	-	-	-
Azinphos-methyl	mg/L	0,02	0,02	0,02	-	-	-	-	-	-
Barium	mg Ba/L	1	1	2	-	0,7	-	-	-	-
Bendiocarb	mg/L	-	0,04	-	-	-	-	-	-	-
Benzene	mg/L	0,001	0,005	0,005	0,001	-	-	-	-	-
Benzo(a)pyrene	mg/L	0.00001	0,00001	0,00004	-	-	-	-	-	-
Boron	mg B/L	5,000	5,0	5,0	1	-	-	-	-	-
Bromate	mg/L	0,010	0,010	0,01	0,01	-	-	-	2	-
Bromoxynil	mg/L	0,005	0,0050	0,005	-	-	-	-	-	-
Cadmium	mg Ca/L	0,005	0,0050	0,007	-	0,003	-	-	-	-
Carbaryl	mg/L	0,090	0,09	0,09	-	-	-	-	-	-
Carbofuran	mg/L	0,090	0,09	0,09	-	-	-	-	-	-
CarbonTetrachloride	mg/L	0,002	0,005	0,002	-	-	-	-	-	-
Copper	mg Cu/L	-	1	2	-	1	-	-	-	< 1,0
Chrome	mg Cr/L	-	-	-	0,05	0,05	-	-	-	-
Free and dissociable cyanide	mg CN/L	-	-	-	-	0,05	-	-	-	-
Cyanazine	mg/L	-	0,01	-	-	-	-	-	-	-
Cyanide	mg/L	0,2	0,2	0,2	0,05	-	-	-	-	-
1,2 Dichloromethane	mg/L	-	0,005	0,005	0,003	-	-	-	-	-
2,4-Dichlorophenol	mg/L	0,05	0,9	0,9	-	-	-	-	-	-

Fluoride	mg/L	1,5	1,5	1,5	1,5	-	-	-	-	-
Terbufos	mg/L	0,001	0,001	0,001	-	-	-	-	-	-
Tetrachloroeth-ylene (perchlo-roethylene)	mg/L	0,01	0,03	0,01	0,01	-	-	-	-	-
Uranium	mg/L	0,02	0,02	0,02	0,01	-	-	-	-	-
Iron	mg Fe/L	-	0,3	<= 0,3	0,2	0,3	-	-	-	<0,3
Magnesium	mg Mg/L	-	-	-	-	36	-	-	-	-
Manganese	mg Mn/L	-	0,05	0,12	0,05	0,1	-	-	-	-
Mercury	mg Hg/L	0.001	0.001	0,001	0,001	0,001	-	-	-	-
Molybdenum	mg Mo/L	-	-	-	-	0,07	-	-	-	-
Nickel	mg Ni/L	-	-	-	-	0,02	-	-	-	-
Lead	mg Pb/L	0,01	0,01	0,005	-	0,01	-	-	-	-
Selenium	mg Se/L	0,05	0,01	0,05	0,01	0,01	-	-	-	-
Zinc	mg Cr/L	-	5	<=5	-	3	-	-	-	-
Total Chromium	mg Zn/L	-	-	-	-	0,05	-	-	-	-
Total Trihalome-thanes	mg THMs/L	0,1	0,1	0,1	-	0,2	-	-	0,02	-
Aromatic Hy-drocarbons	mg PAH/L	-	-	-	-	0,01	-	-	-	-
Strontium	mg Sr/L	-	-	7,0	-	-	-	-	-	-
Silver	mg Ag/L	-	-	-	-	-	-	-	-	< 0,1
Apparent colour	TCU	-	5	<= 15	-	15	-	-	-	-
Turbidity	NTU	-	5	<= 0,3	1,0	2	-	-	0,5	2
Alkalinity	mg $CaCO_3$/L		30 - 500	-	-	200	60 - 180	80 - 120	-	< 140
Calcium	mg Ca/L	-	-	-	-	60	-	-	-	-
Total Organic Carbon (TOC)	mg/L	-	5	-	without abnor-mal change	5	-	-	-	-
Oxidability	mg/L - O_2	-	-	-	5	-	-	-	-	-
calcite dissolv-ing capacity	mg $CaCO_3$/L	-	-	-	5	-	-	-	-	-
Total Hardness	mg $CaCO_3$/L	-	80 - 100	80 - 100	-	300	-	-	-	< 400
Sodium	mg Na/L	-	-	<= 200	200	-	-	-	-	-
Sulphide	mg S^2/L	-	0,05	<=0,05	-	250	-	-	-	-
Chlorides	mg/L	-	250	<= 250	250	-	-	-	-	-
Fluorides	mg F-/L	-	1,5	1.5	-	1	-	-	-	-
Nitrates	mg NO_3-N/L	-	10	10	-	10	-	-	20	-
Nitrites	mg NO_3-N/L	-	1	1	-	0,1	-	-	-	-
Phosphates	mg PO4-/L	-	-	-	-	0,5	-	-	-	-
Sulfate	mg SO_4/L	-	500	<=500	250	250	-	-	-	-
Free residual chlorine	mg/L - Cl_2	-	-	-	-	0,3 and 2	1,0 - 2,0	0,5 - 10	0.3 - 0.6 mg/L	1 - 3 mg/L
Combined Chlo-rine	mg/L	-	-	-	-	-	-	-	max 0,2	< 0,3
Cyanuric Acid	mg/L	-	-	-	-	-	50	Max 60	-	< 100

Source: [a] (Ontario, 2003). [b] (Ontario, 2003).[c] (Canada, 2020).[d] (Germany, 2016). [e] (Colombia, 2015). [f] (Alberta, 2014). [g] (Ontario, 1990). [h] (Germany, 1997). [i] (Colombia, 2007) and (Sanchez, 2011).

4. Conclusions

The regulations or standards and guidelines constitute a minimum level of water quality. All water must be free of pathogenic microorganisms regardless of its use, whether for swimming pool waters, hot springs, or drinking water.

The pollution of hot springs must be minimized by reducing anthropogenic pollution and suitable water treatment must be complemented. Lastly, in Colombia, it is evident that there is very little research that can provide information to develop standards and controls on this type of water resource.

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