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ORIGINAL

Considerations for the calculation of the water quality risk Index according to current sanitary and epidemiological trends

Consideraciones para el cálculo del índice de riesgo de calidad del agua según las tendencias actuales sanitarias y epidemiológicas

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ABSTRACT

The prevalence of occasional epidemics associated with waterborne diseases, the presence of chemical contaminants (organic, inorganic, and heavy metals) in bodies that supply water for human consumption due to different anthropogenic activities of an industrial, agricultural, livestock, and care type. human. These contaminants have accumulated until they can be detected by current procedures and equipment, as well as to reach concentrations that can generate diseases. In this sense, the Water Quality Risk Index (IRCA) established by Resolution 2115 of 2007 proposes admissible parameters for drinking water of a microbiological, physical, and chemical nature, parameters that need to be reviewed to update the water monitoring instrument. drinking water supplied to the population. The different water quality indices are compared with respect to the number and frequency of criterion parameters, the reference values, and the methods for calculating the indices for common parameters. Likewise, the inclusion of other parameters associated with emerging contaminants associated with pesticides and microbial agents is analyzed. As a consequence of the investigation, parameters to be included are proposed, such as fecal coliforms, somatic coliphages, V Hepatitis A, OD, BOD, Cd, As, Hg, Pb, Zn, Cu and pesticides for which values have already been described admissible.

Keywords: Water Quality Indices; Emerging Contaminants.

RESUMEN

La prevalencia de epidemias ocasionales asociados a enfermedades transportadas por el agua, la presencia de contaminantes químicos (orgánicos, inorgánicos y metales pesados) en los cuerpos abastecedores de agua para consumo humano por diferentes actividades antrópicas de tipo industrial, agrícolas, pecuarias, y del cuidado humano. Dichos contaminantes, se han acumulado hasta poderse detectar por los procedimientos y quipos actuales, así como para alcanzar concentraciones que pueden generar enfermedades. En este sentido el índice de Riesgo de Calidad del Agua (IRCA) establecido por la Resolución 2115 del 2007 propone unos parámetros admisibles para el agua potable de tipo microbiológico, físico y químico, parámetros que es necesario revisar para actualizar el instrumento de seguimiento al agua potable suministrada a la población. Se comparan los distintos índices de calidad del agua respecto al número y frecuencia de parámetros criterio, los valores de referencia, y los métodos cálculo de los índices para los parámetros comunes. Asi mismo se analiza la inclusión de otros parámetros asociados a contaminantes emergentes asociados a plaguicidas y agentes microbianos. Como consecuencia de la indagación se propone parámetros a incluir como lo son los coliformes fecales, colifagos somáticos, V Hepatitis A, OD, DBO, Cd, As, Hg, Pb, Zn, Cu y los plaguicidas para los cuales ya se han descrito valores admisibles.

Palabras clave: Índices de Calidad del Agua; Contaminantes Emergentes.

INTRODUCTION

Water quality is essential for ensuring public health, preserving ecosystems, and promoting sustainable societal development. Various methodologies have been developed to assess this resource by creating water quality indices (WQIs) that synthesize complex information into understandable indicators for decision-making. In Colombia, one of the most widely used instruments is the Water Quality Risk Index for Human Consumption (IRCA), which seeks to establish the level of health risk of the water supplied to the population.[1,2,3,4,5,6,7,8]

However, despite being a widely implemented tool in the country, the IRCA has been subject to critical analysis compared to other international indices that integrate more parameters and evaluation criteria.[9,10,11,12] Some of these indices, such as the National Sanitation Foundation's WQI (WQINSF), the Dinius index, the ICAUCA, the UWQI, the ISCA, the IAP, and the AMOEBA index, have served as benchmarks for comparing approaches to water quality measurement from both quantitative and qualitative perspectives.[13,14,15,16] These indicators typically consider microbiological, physical, chemical (inorganic and organic), pesticide, and, in some cases, radioactive variables, with weightings and value ranges established by international organizations such as the World Health Organization (WHO), the US Environmental Protection Agency (EPA), the European Union, and Japan.[17,18,19,20]

This study provides a detailed review of the IRCA compared to the abovementioned indices and international standards, evaluating the presence or absence of specific parameters, the reference values adopted, and their relevance in the Colombian context.[21,22,23,24,25] Similarly, the relevance of including emerging contaminants, waterborne diseases, and pathogens not currently covered by the IRCA is examined. Identifying gaps, limitations, or possible improvements in this index is key to strengthening public health policies and optimizing drinking water quality monitoring systems.[26,27,28,29,30,31,32]

Within this framework, this paper proposes a technical evaluation of the IRCA, highlighting the fundamental elements that should be reviewed or incorporated to ensure a better approximation of health risk and greater alignment with the most up-to-date international standards.[33,34,35]

Objective

To propose parameters and weightings that should be considered in the calculation of the Water Quality Risk Index according to current health and epidemiological trends.

METHOD

Comparison of water quality indices

The IRCA was compared with different water quality indices and international quality standards in a qualitative and quantitative manner. It was examined which parameters are most frequently analyzed with water quality indicators and which ones are considered according to international standards, thus identifying the relevance of the parameters and trends in water quality.

Qualitative comparison

The IRCA will be compared with the WQINSF, Dinius, ICAUCA, DWQIUWQI, ISCA, IAP, IRCA, and AMOEBA indices by comparing the physical, chemical, and biological parameters they consider through an analysis of the number of parameters per index and their frequency among the different indices.

Likewise, the reference values used for the IRCA calculation will be compared with the WQINSF, Dinius, ICAUCA, DWQIUWQI, ISCA, IAP, IRCA, and AMOEBA indices using maximum values or ranges according to the parameter.

Likewise, the IRCA is compared with the water quality standards described in the documents Harmonization of Drinking Water Standards in the Americas (World Health Organization - WHO, 2005), Environmental Water Quality Criteria for Human Health (United States Environmental Protection Agency - EPA 2015), Water Supply Law (Japan, 2013) and Directive 2020/2184/EC on the quality and measurement methods, sampling frequency and analysis of surface water intended for the production of drinking water (European Community 2020).

Quantitative comparison

The standard parameters of the WQINSF, Dinius, ICAUCA, DWQI, UWQI, ISCA, IAP, and AMOEBA indices are based on the IRCA's reference values (the value of the standardized variable and its weighting), calculated according to their system, and compared with those of the IRCA.

Assessment of waterborne diseases based on the National Health Institute report for consideration as IRCA parameters

Taking into account the 2022 National Water Report, the etiological agents causing diseases related to acute diarrheal diseases are determined and compared with the IRCA parameters.

Analysis of possible emerging contaminants according to the CAS list for consideration as IRCA parameters.

The CAS list of chemical compounds, polymers, biological sequences, preparations, and alloys was reviewed.

RESULTS

Comparison of water quality indices

The different ACIs monitor biological, physical, and chemical parameters, the latter of which can be classified as inorganic or organic and, additionally, according to their origin as pesticides or radioactive, among others.

Qualitative comparison – Frequency and quantity of biological parameters analyzed by water quality indices

Table 1. Biological parameters analyzed by quality indices

Parameter	WQI NSF	Dinius	ICAUCA	DWQI	UWQI	ISCA	IAP	IRCA	AMOEBA	f
Total coliforms	0	1	0	0	1	0	0	1	0	3
Fecal coliforms	1	1	1	0	0	0	1	0	0	5
Escherichia coli	0	0	0	0	0	0	0	1	0	1
Cryptosporidium	0	0	0	0	0	0	0	1	0	1
Giardia	0	0	0	0	0	0	0	1	0	1
Microcystin	0	0	0	0	0	0	0	0	1	1
Total	1	2	1	0	1	0	1	4	1	

In this sense, coliforms are a group of gram-negative, rod-shaped, non-spore-forming bacterial species that can ferment lactose with acid and gas production when incubated at 35-37 °C, and are used as indicators of water and food contamination; however, not all coliforms are of fecal origin.(36,37,38,39,40) Given the above, this group includes fecal coliforms (those of intestinal origin), defined as Gram-negative, non-spore-forming bacilli that ferment lactose with acid and gas production at 44,5 °C +/− 0,2 °C within 24 +/− 2 hours. This group includes different genera such as Escherichia, Citrobacter, Klebsiella, and Enterobacter.(41,42,43,44,45,46,47,48) Finally, E. coli is the most predominant species of fecal coliforms and is associated with 99 % of cases of fecal contamination. Likewise, enteropathogenic E. coli are causal agents of acute diarrheal disease (ADD), ranging from severe diarrhea to bloody diarrhea.(49,50,51,52,53,54,55)

Therefore, the prevalence of fecal coliforms as a monitoring parameter is given because it is more specific for determining the contamination of water bodies by fecal matter. The choice of E. coli would be more specific due to its direct relationship with fecal contamination and the development of ADF. However, its determination must be more specific within the procedures and therefore more complex.

The IRCA monitors total coliforms and E. coli, thus providing a general and specific analysis of possible water contamination, especially by fecal matter. The closest index in this analysis is the Dinius index, which analyzes total and fecal coliforms. It provides a general and specific analysis of water contamination from fecal sources, as it explicitly covers other bacteria associated with gastrointestinal diseases.

Finally, the IRCA considers two parasites: Giardia lamblia, intestinalis, or duodenalis (a flagellated protozoan that resides in the small intestine of mammals and causes diarrhea and anorexia)(56) and Cryptosporidium parvum, hominis, canis, felis, melagredis, muris (a protist that causes chronic diarrhea and malnutrition); both parasites are indicators of water contamination by fecal matter. These cases are considered due to the prevalence of these diseases.

Qualitative comparison - Frequency and quantity of physical parameters analyzed by water quality indices

Physical parameters are associated with water's organoleptic characteristics, and their presence indicates untreated water or water that is unsuitable for human consumption.

In this sense, temperature is one of the least used parameters since it can vary due to discharges of water with a temperature higher than the ambient temperature, be associated with seasonal temperature changes (hot or cold seasons), or be water of thermal origin.

Turbidity and color are parameters associated with the content of suspended material due to the force of the water and dissolved substances due to the hydrological cycle through entrainment and dilution processes. Additionally, dissolved substances lead to increased conductivity. However, these parameters are also affected by increasing pollution.

The above parameters are related to the organoleptic characteristics of colorless water, which allows light to pass through it. In this way, the parameters are analyzed according to ICA standards to ensure that the water is treated or meets the desired characteristics for human consumption. Given the above, turbidity is the second parameter to be checked due to its ease of measurement in the field. However, the set of parameters for color, suspended solids, dissolved solids, and conductivity accompany the determination of turbidity for most ICAs (table 2).

Dissolved oxygen is an indicator of the eutrophication status of water, where oxygen-deficient waters are associated with microbial growth due to high organic matter content and sources of nitrogen and phosphorus that consume oxygen in their metabolic and lentic processes. Conversely, water with a high percentage of dissolved oxygen indicates fresh, lotic water with low pollution that does not give rise to large microbial populations. In this sense, oxygen is the primary physical parameter to be checked by the various ICAs, table 2.

Table 2. Physical parameters analyzed by quality indices

Parameter	WQI NSF	Dinius	ICAUCA	DWQI	UWQI	ISCA	IAP	IRCA	AMOEBA	f
Temperature	1	1	0	0	0	0	1	0	1	4
Dissolved oxygen	1	1	1	0	1	1	1	0	1	8
Turbidity	1	0	1	0	0	0	1	1	1	6
Color	0	1	1	0	0	0	0	1	0	3
Suspended solids	0	0	1	0	0	1	1	0	0	3
Dissolved solids	1	0	1	0	0	0	1	0	0	4
Conductivity	0	1	0	0	0	1	1	0	1	4
Total	4	4	5	0	1	3	6	2	4	

Qualitative comparison - Frequency and quantity of inorganic chemical parameters analyzed by water quality indices

The indices that consider the most significant number of inorganic chemical parameters to be monitored are DWQI, IRCA, AMOEBA, and IAP, with 18, 17, 16, and 14 parameters, respectively. The indices that include the fewest parameters in their analysis are ISCA, INCAUCA, WQINSF, and Dinius, with 0,3, 3, and 5 parameters, respectively (table 3).[58]

The parameter most frequently analyzed by the indicators is pH (table 3). Overly acidic water dissolves heavy metals (lead, copper, zinc) that, when ingested, negatively affect health. In addition, extreme pH values cause irritation of the mucous membranes and internal organs and even ulceration processes.[58]

Furthermore, nitrate is the second most analyzed parameter (table 3) since nitrite (NO2-) generally converts easily to nitrate (NO3-), which means that nitrite is rarely present in water. In this sense, nitrate is essential for plant growth, used as a fertilizer, and produced industrially in large quantities. This leads to two forms of water pollution by nitrogen compounds: point source pollution due to the livestock, industrial, or urban sectors (organic effluents from livestock activities, industrial discharges, urban wastewater), while dispersed or diffuse pollution is only due to agricultural activity.[59]

Likewise, the total phosphorus parameter is among those most analyzed (table 3). This is because the phosphate ion (PO4-) is formed from inorganic phosphorus as part of the cycle of this element in the environment and is considered a plant macronutrient. Water bodies close to agricultural soils have different amounts of phosphates contributed by runoff and infiltration of rainwater or irrigation water.[59]

Arsenic, cadmium, chromium, mercury, lead, zinc, and copper are also among the most analyzed heavy metals (table 3). These metals are toxic in low concentrations and chronically affect human health through bioaccumulation processes. Water bodies are polluted by discharges from mining, industrial, and urban activities.[60]

In addition, the most analyzed parameters include those related to fluorine (table 3), a highly reactive halogen that forms inorganic and organic compounds called fluorides. When ingested orally, fluorides have adverse health effects (reproduction, osteosarcoma, hypothyroidism, and neurotoxicity). However, this chemical enters the water supply through the fluoridation of public water supplies.[61]

Finally, among the most frequently analyzed parameters are chlorides (table 3), which are found in water as calcium or magnesium salts, and high chloride content can cause corrosion in metal pipes and structures.[58]

Table 3. Inorganic chemical parameters analyzed by quality indices

Parameter	WQI NSF	Dinius	ICAUCA	DWQI	UWQI	ISCA	IAP	IRCA	AMOEBA	f
pH	1	1	1	1	1	0	1	1	1	8
Fats and oils	0	0	0	0	0	0	0	0	1	1
Total nitrogen	0	0	1	0	0	0	1	0	1	3
Ammonia	0	0	0	1	0	0	0	0	1	2
Nitrites	0	0	0	1	0	0	0	1	1	3
Nitrates	1	1	0	1	1	0	1	1	1	7
Total phosphorus	0	0	1	0	1	0	1	0	1	4
Phosphates	1	0	0	0	0	0	0	1	0	2
Sulfates	0	0	0	1	0	0	0	1	0	2
Chlorine	0	0	0	0	0	0	0	1	0	1

Chlorides	0	1	0	1	0	0	0	1	0	3
Fluoride	0	0	0	1	1	0	0	1	0	3
Cyanide	0	0	0	0	0	0	0	0	1	1
Cyanide	0	0	0	0	1	0	0	0	0	1
Calcium	0	0	0	0	0	0	0	1	0	1
Alkalinity	0	1	0	0	0	0	0	1	0	2
Hardness	0	1	0	0	0	0	0	1	0	2
Arsenic	0	0	0	1	1	0	0	0	1	3
Cadmium	0	0	0	1	1	0	1	0	1	4
Chromium	0	0	0	1	0	0	1	0	1	3
Mercury	0	0	0	1	1	0	1	0	1	4
Molybdenum	0	0	0	0	0	0	0	1	0	1
Nickel	0	0	0	0	0	0	1	0	1	2
Lead	0	0	0	1	0	0	1	0	1	3
Zinc Zn	0	0	0	1	0	0	1	1	0	3
Boron	0	0	0	1	0	0	0	0	0	1
Aluminum	0	0	0	0	0	0	1	0	0	1
Copper	0	0	0	1	0	0	1	0	1	3
Iron	0	0	0	1	0	0	1	1	0	3
Aluminum	0	0	0	0	0	0	0	1	0	1
Manganese	0	0	0	1	0	0	1	1	0	3
Magnesium	0	0	0	0	0	0	0	1	0	1
Sodium	0	0	0	1	0	0	0	0	0	1
Selenium	0	0	0	0	1	0	0	0	0	1
Total	3	5	3	18	9	0	14	17	16	

Qualitative comparison - Frequency and quantity of organic chemical parameters analyzed by water quality indices

The main organic chemical parameter analyzed is biochemical oxygen demand (BOD) (table 4), which allows us to check whether there is organic matter that can be microbiologically degraded. This is because TOC is the most direct parameter for assessing organic load (carbon), although it cannot estimate oxygen consumption directly. Chemical oxygen demand (COD) determines the oxygen consumption in the digestion of organic matter. However, nitrites, sulfites, and ferrous ions also react with the reagents (dichromate) and will be recorded as oxygen consumption by organic matter.[62]

In addition, other parameters associated with organic substances that are water pollutants, such as polyaromatic hydrocarbons (PAHs), trihalomethanes (THMs), polychlorinated biphenyls (PCBs), and phenols, are monitored at a low frequency despite their environmental and public health importance (table 4).

Table 4. Organic chemical parameters analyzed by quality indices

Parameter	WQI NSF	Dinius	ICAUCA	DWQI	UWQI	ISCA	IAP	IRCA	AMOEBA	f
COT	0	0	0	0	0	1	0	1	0	2
DQO	0	0	0	0	0	1	0	0	1	2
DBO	1	1	1	0	1	0	1	0	1	7
HPA	0	0	0	0	0	0	0	0	1	1
THM	0	0	0	0	0	0	1	0	0	1
PCBs	0	0	0	0	0	0	0	0	1	1
Fenol	0	0	0	0	0	0	0	0	1	1
Total	1	1	1	0	1	2	2	1	5	

Qualitative comparison - Frequency and quantity of parameters associated with pesticides analyzed by water quality indices

Pesticide monitoring is rarely considered as a parameter and is only provided by the IRCA and AMOEBA indices, despite its importance for public health. However, the issue of pesticides for the IRCA is assessed as a group of substances, table 5.

Table 5. Parameters associated with pesticides analyzed by quality indices

Parameter	WQI NSF	Dinius	ICAUCA	DWQI	UWQI	ISCA	IAP	IRCA	AMOEBA	f
Pesticides	0	0	0	0	0	0	0	1	1	1
Organophosphate pesticides	0	0	0	0	0	0	0	1	1	1
Total	0	0	0	0	0	0	0	0	2	

Qualitative comparison – Reference values for the parameters used in the water quality index (IRCA) and international standards

Below is a comparative analysis of the values of the microbiological, physical, chemical (organic and inorganic), pesticide, and radioactive parameters indicated by the WHO, Europe, EPA-USA, and Japan concerning the IRCA.

Permissible limits for microbiological parameters

It can be seen that for most standards (IRCA, WHO, Europe, and EPA-USA), E. coli is taken as the most stringent parameter for verifying contamination by fecal matter. However, most standards, except Japan, consider two indicators to broaden the spectrum of risk analysis to bacteria that can cause diarrheal diseases. This case presents studies of E. coli and fecal coliforms or E. coli and total coliforms table 6.

Only the US EPA proposes Cryptosporidium and Giardia as health and epidemiological monitoring parameters, as they are associated with parasitic diseases transmitted by water and fecal contamination (table 6). Due to their outbreaks, they are also standards for controlling protozoa of medium importance, and Colombia has a prevalence of 10,6 %.(63)

The IRCA does not consider the determination of Clostridium as a water quality parameter, even though EPA standards do (table 6). However, Clostridium perfringens is usually found in soil and wastewater and is part of the intestinal microflora of humans and animals. For this reason, it is a parameter that indicates whether there is fecal contamination of water, addresses the presence of pathogenic microorganisms whose determination is costly and complex, and shows the efficiency of water filtration and disinfection processes. This microorganism is the causative agent of human diseases such as foodborne gastroenteritis and gas gangrene. Based on the quality criteria proposed by the EPA in its 2015 update, studies have been conducted to standardize the procedures for its determination by ISO 14189:2013 and those outlined in the Colombian Technical Guide, GTC 84 of 2003.(64)

In addition, the IRCA does not consider Legionella determination as a water quality parameter, even though EPA standards do (table 6). However, Legionella pneumophila is associated with outbreaks related to poorly maintained artificial water systems (cooling towers or evaporative condensers used for air conditioning and industrial refrigeration systems, hot and cold water systems in public and private buildings, and recreational facilities). L. pneumophila is the causative agent of a type of pneumonia called Legionnaires' disease.(65)

In addition, the IRCA omits microcystins as a water quality parameter in its monitoring parameters, even though WHO and European standards do (table 6). Microcystins are toxins produced by different species of blue-green algae (cyanobacteria of the genera Microcystis, Anabaena, Oscillatoria, and Nostoc) that grow abnormally in surface waters, causing poisoning in both animals and humans.(66) However, the prevalence of microcystins has not been reported in the epidemiological reports of the National Institute of Health.

Finally, the IRCA does not include microcystins as a water quality parameter in its monitoring parameters despite the fact that EPA standards take them into account (table 6). Somatic coliphages indicate raw water contamination by human or animal feces or wastewater and the inadequacy of treated water disinfection systems. They are also associated with an increased incidence of non-bacterial diarrhea.(67)

Table 6. Reference values for microbiological parameters

Parameter	Unit	IRCA Drinking water risk index	WHO Harmonization of drinking water standards in the Americas 2005	EUROPE Directive 2020/2184/ EC 2020	EPA - United States Environmental water quality criteria for human health: 2015	Japan Water Supply Act 2013
Total coliforms	UFC/100mL	0	ne	0	<5 % samples + /month	0
Fecal coliforms	UFC/100mL	ne	1	ne	1	Ne
Intestinal enterococci	UFC/100mL	ne	ne	0	ne	Ne
Escherichia coli	UFC/100mL	0	0	0	1	Ne
Legionella	UFC/100mL	ne	ne	ne	1	Ne
Clostridium perfringens	UFC/100mL	ne	ne	ne	1	Ne
Cryptosporidium	Oocysts	0	ne	ne	99 % elimination	Ne
Giardia	Cysts	0	ne	ne	99 % elimination	Ne
Microcystin	ug/L	ne	1	1	ne	Ne
Somatic coliphages		ne	ne	ne	1	Ne

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Permissible limits for physical parameters

Regarding physical standards, it was found that turbidity, the IRCA parameter, is less demanding by 1 NTU compared to the EPA and Japanese standards, and color is by the EPA. Still, some regulations, such as those in Japan, require 10 platinum cobalt units less. Total dissolved solids do not have a specified value in the IRCA, although EPA and Japanese standards require up to 500 mg/L. Conductivity is more restrictive for the IRCA, with a 1000 uS/cm value, compared to the European standard of 2500 uS/cm. Odor and taste determinations for the IRCA are based on the assessment of acceptability concerning the EPA's threshold value of 3 odor units and three odor intensity units table 7.

In this regard, the IRCA determines total dissolved solids based on conductivity, which is more restrictive than national standards. However, the parameters for turbidity and color may be more stringent, assuming the values of the EPA and Japanese standards.

Table 7. Reference values for physical parameters

Parameter	Unit	IRCA Drinking water risk index	WHO Harmonization of drinking water standards in the Americas 2005	EUROPE Directive 2020/2184/ EC 2020	EPA - United States Environmental water quality criteria for human health: 2015	Japan Water Supply Act 2013
Turbidity	NTU	2	ne	ne	< 1 NTU daily measurements <0,3 NTU 95 % of daily measurements during the month	1
Color	UPC	15	ne	ne	15	5
Total dissolved solids	mg/L	ne	ne	ne	500	500
Conductivity	uS/cm	1000	ne	2500	ne	Ne
Odor	TON	acceptable	ne	ne	3	3
Taste	TIO	acceptable	ne	ne	3	ne

Permissible limits for inorganic chemical parameters

The IRCA's lower pH limit (pH=6,5) is aligned with European and EPA standards. However, the upper pH limit (pH=9) is less restrictive than the EPA standard (pH=8,5) but is in line with European values (pH=9,5), table 8.

According to IRCA permissible values, the parameters for detergents, bromate, silver, beryllium, boron, aluminum chlorate, thallium, and sodium are not considered, even though there are maximum permissible values according to international standards. Likewise, the allowable limits for cyanide, fluoride, mercury, nickel, zinc, antimony, iron, and manganese should be reviewed, as international standards propose more restrictive values (table 8).

According to the IRCA, the standard for free residual chlorine is higher (free residual chlorine = 5 mg/L) than international standards (free residual chlorine = 1-4 mg/L). However, this value is not harmful to health and helps to ensure the disinfection of treated water during transport, table 8.

Table 8. Reference values for inorganic chemical parameters

Parameter	Unit	IRCA Drinking water risk index	WHO Harmonization of drinking water standards in the Americas 2005	EUROPE Directive 2020/2184/EC 2020	EPA - United States Environmental water quality criteria for human health: 2015	Japan Water Supply Act 2013
pH		6,5-9	ne	6,5 - 9,5	6,5 - 8,5	Aprox7,5
Detergents	mg/L	ne	ne	ne	0,5	0,2
Ammonia	mg/L	ne	1,5	0,5	ne	ne
Nitrites	mg/L	0,1	3	0,5	ne	ne
Nitrates	mg/L	10	50	50	10	10
Phosphates	mg/L	0,5	ne	ne	ne	ne
Sulfates	mg/L	250	ne	250	250	ne
Free residual chlorine	mg/L	ne	5	ne	4	1
Chlorides	mg/L	250	ne	250	250	250
Fluoride	mg/L	1	1,5	1,5	4	0,8
Bromate	mg/L	ne	0,01	0,01	0,01	ne

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Cyanide	mg/L	0,05	ne	0,05	0,2	0,01
Calcium	mg/L	60	ne	ne	ne	10-100
Alkalinity	mg/L	200	ne	ne	ne	ne
Hardness	mg/L	300	ne	ne	ne	300
Arsenic	mg/L	0,01	0,01	0,01	0,05	0,01
Cadmium	mg/L	0,003	0,003	0,005	0,005	0,01
Chromium	mg/L	0,05	0,05	0,05	0,1	0,05
Mercury	mg/L	0,001	0,006	0,001	0,002	0,0005
Magnesium	mg/L	36	ne	ne	ne	10-100
Molybdenum	mg/L	0,07	ne	ne	ne	0,07
Nickel	mg/L	0,02	0,07	0,02	ne	0,01
Silver	mg/L	ne	ne	ne	0,01	ne
Lead	mg/L	0,01	0,01	0,01	ne	ne
Zinc	mg/L	3	ne	ne	5	1
Antimony	mg/L	0,02	0,02	0,05	0,006	0,02
Barium	mg/L	0,7	1,3	ne	2	ne
Beryllium	mg/L	ne	ne	ne	0,004	ne
Boron	mg/L	ne	2,4	1	1	1
Aluminum	mg/L	0,2	ne	ne	ne	ne
Chlorate	mg/L	ne	0,7	ne	ne	ne
Copper	mg/L	1	2	2	1,3	1
Iron	mg/L	0,3	ne	0,2	0,3	0,3
Aluminum	mg/L	ne	0,2	0,2	0,05-0,2	0,1
Manganese	mg/L	0,1	0,1	ne	0,05	0,05
Thallium	mg/L	ne	ne	ne	0,002	ne
Sodium	mg/L	ne	ne	200	ne	200
Selenium	mg/L	0,01	0,04	0,01	0,05	0,01

Permissible limits for organic chemical parameters

For the IRCA, it is worth noting the usefulness of using TOC as a parameter for monitoring organic matter, even though international standards do not suggest this (table 9). However, it should be accompanied by the determination of COD or BOD, preferably the latter, to see the relationship between dissolved oxygen, microbial load, and organic matter.

The acceptable value for THM in the IRCA (THM = 0,2 mg/L) needs to be reviewed, as international standards have more restrictive values (THM = 0,08 to 0,1 mg/L).

However [29] organic compounds for which international standards have already reported permissible limits. However, the IRCA has not set a maximum permitted value for each. Nevertheless, the IRCA indicates that a maximum acceptable value of 0,0001 mg/L,[41] should be assumed for the following chemical characteristics: i) chemicals recognized by the Ministry of Social Protection as carcinogenic, mutagenic, and teratogenic; ii) chemical substances with a recognized minimum oral LD50 value of less than or equal to 20 mg/kg, iii) substances classified as extremely or highly hazardous by the Ministry of Social Protection, iv) chemical substances of natural or synthetic origin for which it is considered necessary to apply precautionary standards, in the sense that, despite not having sufficient scientific information, table 9.

Table 9. Reference values for organic chemical parameters

Parameter	Unit	IRCA Drinking water risk index	WHO Harmonization of drinking water standards in the Americas 2005	EUROPE Directive 2020/2184/ EC 2020	EPA - United States Environmental water quality criteria for human health: 2015	Japan Water Supply Act 2013
COT	mg/L	5	ne	ne	ne	ne
HAP	mg/L	0,01	ne	ne	ne	ne
THM	mg/L	0,2	ne	0,1	0,08	0,1
PCBs	mg/L	0,0001*	ne	ne	0,0005	ne

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Dioxinas	mg/L	0,0001*	ne	ne	0,00000003	1
AHA	mg/L	0,0001*	ne	ne	0,06	ne
Fenol	mg/L	0,0001*	ne	ne	ne	0,005
Benceno	mg/L	0,0001*	0,01	0,001	0,005	0,01
Bromoformo	mg/L	0,0001*	0,1	ne	ne	0,09
Diclorobenceno	mg/L	0,0001*	1	ne	0,075	0,3
Triclorobenceno	mg/L	0,0001*	ne	ne	0,07	ne
Benzo (a) pireno	mg/L	0,0001*	0,0007	0,00001	0,0002	ne
dibromoclorometano	mg/L	0,0001*	0,1	ne	ne	0,1
bromodiclorometano	mg/L	0,0001*	0,02	ne	ne	0,03
diclorometano	mg/L	0,0001*	0,02	ne	0,005	0,02
cloroformo	mg/L	0,0001*	0,3	ne	ne	0,06
dicloroacetonitrilo	mg/L	0,0001*	0,02	ne	ne	0,01
1,2 dicloroetano	mg/L	0,0001*	0,03	0,003	0,005	0,004
Formaldehido	mg/L	0,0001*	ne	ne	ne	0,08
Tetracloruro de carbono	mg/L	0,0001*	0,004	ne	0,005	0,002
Tetracloroeteno	mg/L	0,0001*	0,04	0,01	0,005	0,01
Tricloroeteno	mg/L	0,0001*	0,02	0,01	0,005	0,3
Tolueno	mg/L	0,0001*	0,7	ne	1	0,4
Xylene	mg/L	0,0001*	0,5	ne	10	0,4
Vinyl chloride	mg/L	0,0001*	0,0003	0,0005	0,002	ne
Ethylbenzene	mg/L	0,0001*	0,3	ne	0,7	ne
Styrene	mg/L	0,0001*	0,02	ne	0,1	ne
Monochlorobenzene	mg/L	0,0001*	ne	ne	0,1	ne
Epoxy resin	mg/L	0,0001*	0,0004	0,0001	ne	ne
Hexachlorobutadiene	mg/L	0,0001*	0,0006	ne	ne	ne
Ethylene diamine tetra acetic acid	mg/L	0,0001*	0,6	ne	ne	ne
Acrylamide	mg/L	0,0001*	0,0005	0,0001	ne	ne

Permissible limits for radioactive chemical parameters

The IRCA does not assume monitoring values for radioactive substances despite the standards indicating this (table 10). However, there would be no need to establish permissible values for these parameters since the activities carried out in Colombian territory do not involve the generation of such pollutants.

Table 10. Reference values for radioactive chemical parameters

Parameter	Unit	IRCA Drinking water risk index	WHO Harmonization of drinking water standards in the Americas 2005	EUROPE Directive 2020/2184/ EC 2020	EPA - United States Environmental water quality criteria for human health: 2015	Japan Water Supply Act 2013
Uranium	mg/L	ne	0,03	ne	0,03	0,002
Alpha particles	Bq/L	ne	0,1	ne	0,555	ne
Beta particles	Bq/L	ne	1	ne	1,48	ne
Radium 226 and Radium 228	Bq/L	ne	ne	ne	0,185	ne
Tritium (^{3}H)	Bq/L	ne	ne	100	ne	ne

Permissible limits for parameters associated with pesticides

There are fifty-eight (58) pesticides for which international standards have already reported permissible limits. However, the IRCA has not set a maximum permitted value for each. However, the IRCA indicates that the total sum of the concentrations of pesticides and other substances, whose maximum permissible value is 0,0001 mg/L, may be 0,001 mg/L at most, without exceeding the individual values in any case,[41] table 11.

Given the above, reviewing this general standard and establishing an individual permissible value for each pesticide is necessary. In addition, the pesticides Aldrin, Chlordane, Cyanazine, 1,2-dibromo-3-chloropropane, Endrin, 1,2-dibromomethane, Ethylene Dibromide, Peptacloro, Heptachlor epoxide, and Lindane require a review of the acceptable permissible limit since they are above the values of international standards, table 11.

Table 11. Reference values for parameters associated with pesticides

Parameter	Unit	IRCA Drinking water risk index	WHO Harmonization of drinking water standards in the Americas 2005	EUROPE Directive 2020/2184/ EC 2020	EPA - United States Environmental water quality criteria for human health: 2015	Japan Water Supply Act 2013
Pesticides	mg/L	0,0001*	ne	0,0005	ne	ne
Alachlor	mg/L	0,001**	0,02	ne	0,002	ne
Aldicarb	mg/L	0,001**	0,01	ne	ne	ne
Aldrin	mg/L	0,001**	0,00003	0,00003	ne	ne
Dieldrin	mg/L	0,001**	ne	ne	ne	ne
Atrazine	mg/L	0,001**	0,1	ne	0,003	ne
Bentazone	mg/L	0,001**	ne	ne	ne	0,2
Carbofuran	mg/L	0,001**	0,007	ne	0,04	0,005
Chlordane	mg/L	0,001**	0,0002	ne	0,002	ne
Chlorothalonil	mg/L	0,001**	ne	ne	ne	0,05
Chlorotoluron	mg/L	0,001**	0,03	ne	ne	ne
Cyanazine	mg/L	0,001**	0,0006	ne	ne	ne
Dalapón	mg/L	0,001**	ne	ne	0,2	ne
DDT	mg/L	0,001**	0,001	ne	ne	ne
Diazinon	mg/L	0,001**	ne	ne	ne	0,005
1,2-dibromo-3-chloropropane	mg/L	0,001**	0,001	ne	0,0002	
2,4-dichlorophenoxyacetic acid	mg/L	0,001**	0,03	ne	0,07	0,03
1,2-dichloropropane	mg/L	0,001**	0,04	ne	0,005	0,06
1,3 dichloropropane	mg/L	0,001**	ne	ne	ne	
1,3-dichloropropene	mg/L	0,001**	0,02	ne	ne	0,002
Dichlorvos	mg/L	0,001**	0,02	ne	ne	0,008
Dinoceb	mg/L	0,001**		ne	0,007	ne
Diquat	mg/L	0,001**	0,03	ne	0,02	ne
Endo Alquitran	mg/L	0,001**	ne	ne	0,1	ne
Endrin	mg/L	0,001**	0,0006	ne	0,002	ne
1,2-dibromoethane, ethylene dibromide	mg/L	0,001**	0,0004	ne	0,00005	ne
Fenitrothion	mg/L	0,001**	ne	ne	ne	0,003
Glyphosate	mg/L	0,001**	ne	ne	0,7	ne
Peptacloro	mg/L	0,001**	ne	0,00003	0,0004	ne
Heptachlor epoxide	mg/L	0,001**	ne	0,00003	0,0002	ne
Hexachlorobenzene	mg/L	0,001**	ne	ne	0,001	ne
Isoproturon	mg/L	0,001**	0,009	ne	ne	ne
Lindane	mg/L	0,001**	0,002	ne	0,0002	ne
Molinar	mg/L	0,001**	ne	ne	ne	ne
Oxamyl	mg/L	0,001**	ne	ne	0,2	ne
Pentachlorophenol	mg/L	0,001**	0,009	ne	0,001	ne
Permethrin	mg/L	0,001**	ne	ne	ne	ne
Picloram	mg/L	0,001**	ne	ne	0,5	ne
Propanil	mg/L	0,001**	ne	ne	ne	ne
Pyridate	mg/L	0,001**	ne	ne	ne	ne
Simazine	mg/L	0,001**	0,002	ne	0,004	0,003
Terbutylazine	mg/L	0,001**	0,007	ne	ne	ne
Toxaphene	mg/L	0,001**	ne	ne	0,003	ne
Trifluralin	mg/L	0,001**	0,02	ne	ne	ne
2,4-db	mg/L	0,001**	0,09	ne	ne	ne
Dichloroprop	mg/L	0,001**	ne	ne	ne	ne

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Fenoprop	mg/L	0,001**	0,009	ne	0,05	ne
Mcpb	mg/L	0,001**	ne	ne	ne	ne
2,4,5-t	mg/L	0,001**	0,009	ne	ne	ne
Thiuram	mg/L	0,001**	ne	ne	ne	0,006
Thiobencarb	mg/L	0,001**	ne	ne	ne	0,02
Isoxathion	mg/L	0,001**	ne	ne	ne	0,008
Isoprothiolane	mg/L	0,001**	ne	ne	ne	0,04
Propyzamide	mg/L	0,001**	ne	ne	ne	0,05
Fenobucarb	mg/L	0,001**	ne	ne	ne	0,03
Chloronitrophen	mg/L	0,001**	ne	ne	ne	0,005
Iprobenfos	mg/L	0,001**	ne	ne	ne	0,008
Epn	mg/L	0,001**	ne	ne	ne	0,006
Triclopir	mg/L	0,001**	ne	ne	ne	0,006
Organophosphate pesticides	mg/L	0,0001*	ne	0,0001	ne	ne

Quantitative comparison – Reference values and water quality indices

Taking into account the common reference values for permissible water quality limits described for the IRCA, the calculation of the other indices (WQINSF, Dinius, ICAUCA, DWQI, UWQI, ISCA, IAP, and AMOEBA) is presented below, taking into account their calculation methods and assuming values that are considered unacceptable for the IRCA.

Quantitative comparison - IRCA vs WQINSF

The two indices have in common the parameters of turbidity, pH, phosphates, nitrates, and total coliforms. The WQINSF index gives a numerical value similar to that of the IRCA. They have in common that the most relevant parameters in order of importance are total coliforms and turbidity, table 12. However, it should be noted that the comparison does not use the dissolved oxygen saturation and BOD parameters of the WQINSF index, which, according to their weight, contribute 17 % and 11 % of the analysis to water quality. In turn, E. coli and free residual chlorine from the IRCA index are not considered, which, according to their weight, contribute 25 % and 15 %, respectively, to the water quality analysis.

Table 12. Comparison of IRCA and WQINSF water quality indices for common parameters

Parameter	Maximum value	Units	Test value	IRCA score	Q-value (Qi)	Weighting (Wi)	Qi*Wi
Turbidity	2	UNT	3	15	91,9	0,08	7,4
pH	6,5 -9	$H3O^+$	6,4	1,5	46,3	0,077	3,6
Phosphates	0,5	mg PO_4^{3} / L	0,6	1	56,1	0,1	5,6
Nitrates	10	mg NO_3^- / L	11	1	49,2	0,09	4,4
Total coliforms	0	UFC /100 cm3	1	15	137,6	0,09	12,4
IRCA Index Value				33,5	NSF WQI Index Value		33,3
Medium risk level					Bad		

Quantitative comparison – IRCA vs Dinius

The two indices have in common the parameters of apparent color, pH, total alkalinity, total hardness, chlorides, nitrates, and total coliforms. The Dinius index has a different numerical value from the IRCA, where it presents its quality classification in ascending order, with low values associated with poor water quality and high values with good water quality. On the other hand, the IRCA presents its quality classification in ascending order, with low values associated with good water quality and high values with poor water quality table 13.

However, if we consider that the Dinius index classification is based on 100 points, we can subtract the Dinius value from 100 points, giving a value of 95,8. This indicates that the parameters calculated are low within an additive model, and for this reason, the water classification is low if only the parameters between the two indicators are considered.

Both indices have in common that the most relevant parameters are total coliforms, followed by pH, total alkalinity, and nitrates. However, it should be noted that the comparison does not use the parameters of fecal coliforms, DO, and COD from the Dinius index, which, according to their weight, contribute 11,6 %, 10,9 %, and 9,7 % of the analysis to water quality. In turn, E. coli and free residual chlorine from the IRCA index are not considered, which, according to their weight, contribute 25 % and 15 %, respectively, to the water quality analysis.

Table 13. Comparison of IRCA and Dinius water quality indices for common parameters

Parameter	Maximum value	Units	Test value	IRCA score	Q-value (Ii)	Weighting (Wi)	Ii^Wi
Appearance color	15	UPC	16	6	54,3	0,063	1,3
pH	6,5	H3O$^+$	6,4	1,5	2,2	0,077	1,1
Total alkalinity	200	mg $CaCO_3$ / L	201	1	35,8	0,077	1,3
Total hardness	300	mg $CaCO_3$ / L	301	1	39,4	0,063	1,3
Chlorides	250	mg Cl^- / L	251	1	28,2	0,065	1,2
Nitrates	10	mg NO_3^- / L	11	1	3,6	0,074	1,1
Total coliforms	0	UFC/100 cm3	1	15	27,3	0,090	1,3
IRCA Index Value				26,5	Dinius Index Value		4,2
Medium risk level					Very Poor		

Table 14. Comparison of IRCA and DWQI water quality indices

Parameter	Maximum value	Units	Test value	Contribution to IRCA (%)	Excess range	Normalized sum of excesses	Amplitude	Scope	Frequency
Apparent color	15	UPC	16	6	0,1				
Turbidity	2	NTU	3	15	0,5				
Free residual chlorine	2	mg/L Cl2	2,1	15	0,1	0,85	45,84	22,73	8,33
Total coliforms	0	UFC/100 cm3	1	15	9,0				
E. coli	0	UFC/100 cm3	1	25	9,0				
IRCA Index Value				76,0		DWQI Index Value			70,1
High risk level						Regular			

Quantitative comparison – IRCA vs ISQA

Given that ISQA evaluates temperature, COD, total suspended solids, dissolved oxygen, and conductivity, it is not possible to compare the two indices, as IRCA does not consider these parameters according to Decree 2115 of 2007.

Quantitative comparison – IRCA vs IAP

The two indices have the parameters of apparent color, turbidity, manganese, zinc, and total iron in common. The IAP index has a different numerical value from the IRCA, where it presents its quality classification in ascending order, with low values associated with poor water quality and high values with good water quality. On the other hand, the IRCA presents its quality classification in ascending order, with low values associated with good water quality and high values with poor water quality table 15.

In this sense, the values between the two indices are different since the vast majority of the parameters considered by the IAP index to obtain the indicators for both toxic substances (ST) and organic substances (SO) are not considered by the IRCA, these being trihalomethanes, cadmium, chromium, lead, nickel, mercury, pyridine chlorochromate, for the first indicator and copper for the second indicator. Likewise, the comparison does not consider the parameters temperature, dissolved oxygen, biochemical oxygen demand, thermotolerant coliforms, total nitrogen, total phosphorus, and solids. The IQA-CETESB indicator, which belongs to the IAP index, table 15.

Table 15. Comparison of IRCA vs. IAP water quality indices

Parameter	Maximum value	Units	Test value	Contribution to IRCA (%)	Quality (qi)	Weighting (wi)	CETESB IQA	Toxic Substances (TS)	Organoleptic Substances (OS)	ISTO (ST*SO)
Apparent color	15	UPC	16	6	80	0,08	8,52			
Turbidity	2	NTU	3	15	50	0,12				
Manganese	1	mg Mn/L	0,2	1,0						
Zinc	1	mg Zn/L	5,5	1,0				0,53	0,81	0,43
Total iron	1,5	mg Fe/L	0,4	1,5						
IRCA Index value				24,5		IAP Index Value (ISTOxIQA CETESB)				3,64
Medium risk level							Terrible			

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Quantitative comparison – IRCA vs AMOEBA (Nutrient pollution index (NPI))

Since the AMOEBA project includes several indices to represent quality concerning different aspects, the index that can be used is the nutrient pollution index, as they have turbidity, pH, phosphates, nitrates, and nitrites in common. In this case, the AMOEBA-NPI index exceeds the desirable value for these parameters, as shown in table 16. However, ammonium, total nitrogen, total phosphorus, chlorophyll a, and conductivity are not considered, and when calculated over all parameters, the indicator gives a low result.

Table 16. Comparison of IRCA and AMOEBA water quality indices

Parameter	Maximum value	Units	Test value	Contribution to IRCA (%)	Quality (qi)	Weighting (wi)	Ln qi^Wi
Turbidity	2	UNT	3	15	99,2	0,2	0,92
pH	6,5 -9	H3O+	6,4	1,5	94,4	0,2	0,91
Phosphates	0,5	mg PO43- /L	0,6	1	100,1	0,2	0,92
Nitrates	10	mg NO3-}/L	11	1	72,9	0,2	0,86
Nitrites	0,1	mg NO3-/L	0,2	3	99,5	0,2	0,92
IRCA Index Value				21,5	Valor del Índice AMOEBA -NPI		92,6
Medium risk level							92,6/70

Quantitative comparison – IRCA vs UWQI

The two indices have the parameters of apparent color, pH, nitrates, and total coliforms in common. The UWQI index has a different numerical value from the IRCA, where the index presents its quality classification in ascending order, with low values associated with poor water quality and high values with good water quality. On the other hand, the IRCA presents its quality classification in ascending order, with low values associated with good water quality and high values with poor water quality table 17.

In addition, the UWQI index considers other parameters that the IRCA does not take into account, such as cadmium, cyanide, mercury, selenium, arsenic, fluoride, nitrogen, OD, pH, BOD, and total phosphorus, and when calculated on all parameters, the indicator gives a low result.

Table 17. Comparison of IRCA and UWQI water quality indices

Parameter	Maximum value	Units	Test value	Contribution to IRCA (%)	Q-value (Li)	Weighting (Wi)	Qi*Li
pH	6,5 -9	H3O+	6,4	1,5	46,3	0,029	3,6
Nitrates	10	mg NO3-/L	11	1	63,6	0,086	4,4
Total coliforms	0	UFC /100 cm3	1	15	137,6	0,114	12,4
IRCA index value				17,5	UWQI index value		20,4
Medium risk level					Poor		

Quantitative comparison – IRCA vs ICAUCA

The two indices have the parameters of apparent color, pH, and total coliforms in common. The ICAUCA index has a different numerical value from the IRCA, where the index presents its quality classification in ascending order, with low values associated with poor water quality and high values with good water quality. On the other hand, the IRCA presents its quality classification in ascending order, with low values associated with good water quality and high values with poor water quality table 18.

In addition, the ICAUCA index considers other parameters that the IRCA does not, such as BOD, turbidity, %DO, total solids, pH, total coliforms, total nitrogen, total phosphorus, and total suspended solids. When calculated for all parameters, the indicator gives a low result.

Table 18. Comparison of IRCA vs. ICAUCA water quality indices

Parameter	Units	Test value	Maximum value	Contribution to IRCA (%)	Q-value (Ii)	Weighting (Wi)	Ii^Wi
Apparent color	UPC	16	15	6	65,4	0,05	1,2
pH	H3O+	6,4	6,5	1,5	574570061	0,08	5,0
Total coliforms	UFC/100 cm3	1	0	15	96,4	0,15	2,0
IRCA index value				22,5	ICAUCA index value		12,3
Medium risk level					Terrible		

Assessment of waterborne diseases in relation to the IRCA

According to the 2022 National Report on Water Quality for Human Consumption (INCA), estimates of ADI cases due to dietary water consumption are made based on SIVICAP data, applying probabilistic models for total coliforms, E. coli, Giardia spp, Cryptosporidium, and hepatitis A (table 19).

Table 19. Comparison between the microbiological parameters analyzed by the IRCA vs. the determinations of the causal agents of acute diarrheal diseases INCA (2022)

Etiological agent	Statistics	IRCA parameters
Total coliforms	28,6 % of values (60 out of 210 results)[68]	Yes
E. coli	28,6 % of values (22 out of 210 results)[68]	Yes
Giardia spp	28,6 % of values (10 out of 210 results)[68]	Yes
Cryptosporidium	7 % of values (60 out of 210 results)[68]	Yes
Hepatitis A.	12,7 % of municipalities report infections[68]	No

Analysis of potential emerging contaminants according to the CAS list to be considered as IRCA parameters

None of the 1 079 191 CAS numbers for chemical compounds, polymers, preparations, and alloys,[69] are directly included in the IRCA monitoring parameters. Some of them have been assessed for risk, others are being studied for their hazardousness, and others are unknown in terms of risk.

According to the national pesticide registry, there are 3 507 different commercial pesticide products and 71 physiological control products,[70] none of which are covered by the IRCA.

CONCLUSIONS

The most common parameters in water analysis include microbiological parameters such as fecal coliforms, which should be included in the IRCA as they provide a more specific assessment of microorganisms associated with fecal contamination of water. Total coliforms cover a range of microorganisms not related to acute diarrheal diseases.

The most common physical parameters are temperature, turbidity, dissolved oxygen, dissolved solids, and conductivity. However, temperature is not considered relevant due to the difficulty of changing the temperature of a body of water. Dissolved solids, which can be measured by conductivity, are also not considered appropriate. In addition, it is essential to include DO to assess the degree of eutrophication of water due to microbial activity that degrades organic matter, and to complement microbiological parameters and BOD.

The most predominant inorganic chemical parameters are pH, nitrates, and total phosphorus. The IRCA considers the first two, and the last encompasses all phosphorus species. Given the above and the fact that phosphate is formed from inorganic phosphorus and is the most abundant species, it must be maintained and is an indicator of contamination by agricultural inputs.

In addition, the most analyzed inorganic chemical parameters include arsenic, cadmium, chromium, mercury, lead, zinc, and copper, which must be considered when analyzing water contamination with heavy metals.

On the other hand, the parameters for cyanide, fluoride, mercury, nickel, zinc, antimony, iron, and manganese should be reviewed if the permissible limit may be more restrictive, as proposed by international standards.

Among the most commonly analyzed organic chemical parameters is BOD, which should be included as it allows for the detection of microbiologically degradable organic matter and complements microbiological parameters and DO.

Finally, international standards report twenty-nine organic compounds related to organic substances associated with pesticides, with permissible limits that must be considered in water analysis.

In addition, it is necessary to review the permissible limits for the pesticides Aldrin, Chlordane, Cyanazine, 1,2-dibromo-3-chloropropane, Endrin, 1,2-dibromomethane, Ethylene Dibromide, Pentachloro, Heptachlor Epoxide, and Lindane, since international standards set stricter values than those established for pesticides by the IRCA.

Water quality and epidemiological reports show that the parameters commonly analyzed in water are Total Coliforms. E. coli, Giardia spp, and Cryptosporidium. However, international standards are beginning to analyze somatic coliphages, as viruses produce many AWEs. Likewise, according to the incidence of hepatitis A, it is considered a water quality parameter. Therefore, it is believed that the IRCA should consider both coliphages and hepatitis A.

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CONFLICT OF INTEREST

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