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# Evaluate the tap water quality at Kirkuk university using the Canadian Water Quality Index (CCME WQI)

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## Abstract

The Canadian mathematical model was used to compare the water quality and examine the qualitative aspects of Kirkuk University's tap water. samples from the College of Education for Pure Sciences, the College of Human Education, seven other Kirkuk University locations, the College of Human Education Cafeteria, College to Science, College to Law, Girls' Dormitory, and Boys Dormitory have had their physical, chemical, and bacteriological properties estimated. pH, $EC_{25}$, DO, T.A, TH, Ca, Mg, Na, Cl, $SO_4$, $NO_3$, $PO_4$,TPC, and F. Coliform bacteria were among the fourteen criteria used to construct the water quality index.

According to the study's findings, the Water Quality Index (CCME WQI) scores for the majority of the features under investigation exceeded the World Health Organization's acceptable limits, however were less than the permissible limits of pH, chloride, sodium, phosphate and sulphate. The study shows that 71% of the samples are questionable and 29% of the samples are neutral.

**Keywords:** Tap water; Canadian Water; Quality Index; Drinking Water Quality Guide; Kirkuk.

## 1. Introduction

The misuse of life is the squandering of wealth and the abuse and neglect of the water resources that surround us, the health, the wealth The miracle of natural life God gave to all living creaturesis, water. Therefore, saying 'No life without water' will be wise. Since water resources are in abundant quantities and constitute a free reward from God to all mankind for drinking (for humans and animals) and for and civil agricultural and industrial purposes, their management is necessary in a scientific manner to preserve life [1]. The release of industrial and home wastewater into natural water sources has contaminated nearly all of Iraq's water [2]. The way the water systems are managed could result in major issues with water quality and availability. Since water quality and human health are so linked, water analysis before usage is extremely high on the list of priorities .Also are some of the physical, chemical, and microbiological standards that the water is palatable and safe to drink before it can be said to be potable and if can be used for aquatic life, as well as irrigation and other uses [3]. Increase in the number of people suffering water problems, which are becoming dangerous every day for children with 1 billion people in over African and Asian and South American societies and 450 million people in 29 countries are without safe drinking water leading to many deaths. Thousands of deaths, particularly diarrheal diseases that kill children in poor countries, are due to the consumption of contaminated water to reach more than a million deaths [4]. Water quality evaluation becomes crucial since it may be one of the primary routes for the spread of dangerous materials and pathogenic microorganisms [5]. The Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) is a useful tool for simplifying complicated environmental data. Many organizations and researchers have adapted the technique for use with other countries and animals around the world. The index is based on a formula developed by the British Columbia Ministry of Environment, Lands, and Parks and adjusted by Alberta Environment. It includes the Canadian Water Quality Index (CCME WQI)

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research of [6]. The result ranges from 0 (bad water quality) to 100 (great water quality). The study aimed to provide an overview of the health and safety of drinking water at Kirkuk University, given its large number of staff, students, and workers, and to assess its quality using the Canadian model water quality index CCMEWQI.

## 2. Materials and Methods

### 2.1. Methodology

Over a five-month period, from November 2023 to March 2024, thirty-five tap water samples were collected monthly from seven locations at Kirkuk University using clean polyethylene plastic containers, ensuring comprehensive representation of the study sites.The parameters measured included physical factor (EC), chemical factor (DO, TA,TH, Ca, Mg, Na, Cl, PO4, NO3, SO4), and biological factor (TPC, F.Coliform) parameters, all immediately after collection [7].

**Table 1** Selected tap water samples from Kirkuk University

| No. | Locations |
|---|---|
| 1 | College of Education for Pure Sciences |
| 2 | College of Humanities |
| 3 | Cafeteria of the College of Human Education |
| 4 | college of Science |
| 5 | college of Law |
| 6 | Girls' Dormitory |
| 7 | Boys' Dormitory |

### 2.2. Water Quality Index of the Canadian Council of Ministers of the Environment (CCME WQI)

The Canadian mathematical model for understanding water quality has high accuracy, and this model has been used in the studied tap water for drinking purposes. To calculate the index and to estimate three factors, the model was applied to 14 characteristics [8]:

F1(Scope): shows the proportion of variables that, in relation to the total number of variables assessed, fail to accomplish their objectives at least once during the relevant time frame (referred to as "failed variables"):

$$F1 = \frac{Number\ of\ failed\ variables}{Total\ numbers\ of\ variable} \times 100 \ldots\ldots\ldots\ldots..(1)$$

$F_2$(Frequency) : represents the percentage of individual tests that do not meet objectives ("failed tests"):

$$F2 = \frac{Number\ of\ failed\ tests}{Total\ numbers\ of\ tests} \times 100 \ldots\ldots\ldots\ldots..(2)$$

$F_3$(Amplitude) : represents the amount by which failed test values do not meet their objectives. *F3* is calculated in three steps.

Step 1: The number of times a person's focus surpasses (or falls short of, when the target is a minimum) the objective is known as a "excursion." When the test value is unable to surpass the goal:

$$excursion = \frac{failed\ test\ value\ \ i}{objective\ i} - 1 \ldots\ldots\ldots\ldots..(3)$$

Step2: The entire number of tests (total points of excursions less excursions of tests meeting aim) is divided by the sum of each test's deviations from its objectives. The term above determines the normalized sum of excursions, or nse, variable.:

$$nse = \frac{\sum_{i}^{n}=1\ excursion}{Total\ Number\ of\ test} \ldots\ldots\ldots..(4)$$

Step3: An asymptotic function is then used to scale the normalized sum of the excursions from objectives (nse) to convert it to a range between 0 and 100 .

$$F3 = \frac{nse}{0.01\,nse + 0.01} \ldots\ldots\ldots\ldots..(5)$$

The index itself can be calculated by integrating the factors as if they were vectors once the data has been collected. These are equal to the square of the index since they are the sum of the squares of each factor. Because of this, this method views the index as a three-dimensional space with the factors acting as its axes. With this methodology, changes in each of the three parameters directly affect the index.

$$CCME\ WQI = 100 - \frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732} \ldots\ldots\ldots..(6)$$

The outcome of the resultant values are normalised by the divisor 1.732 resulting in values between 0 and 100, where 0 is the 'worst' and 100 the 'best' water quality.

**Table 2** CCME WQI categorization schema [9]

| **Rank** | **WQI value** | **Description** |
|---|---|---|
| Excellent | 95-100 | Conditions are extremely close to natural or pristine, and (among the index values) can only be achieved when all measures almost always fall within objectives, indicating that there is almost no threat or deterioration to the water's quality.. |
| Good | 80-94 | Conditions rarely deviate from natural or optimal levels, and water quality is protected with only a slight threat or damage. |
| Fair | 65-79 | Even while water quality is frequently maintained, it can occasionally be threatened or jeopardized; conditions can occasionally depart from optimal or natural levels. |
| Marginal | 45-64 | Conditions regularly deviate from natural or ideal levels, and water quality is often jeopardized or compromised. |
| Poor | 0-44 | Conditions typically deviate from natural or ideal levels, and water quality is nearly always endangered or compromised. |

## 3. Results and Discussion

The change of the water source quality reflected in the pH measurement. The average pH values in this study was from (6.9 - 8.0) within permissible limits, pH is a vital factor affecting the sustainability of aquatic organisms through its impact on mineral solubility. High acidity increases the solubility of many salts, which can have either a positive or negative impact on the lives of aquatic organisms [10]. EC Conductivity is one among the most useful and frequently tested parameter to determine water quality, as it is required for any application: i.e. measuring the quality of drinking water and water in aquaculture systems, agriculture and industries. Conductivity can be described as that property which a solution has to conduct electricity. The EC 1920 µs/cm depends on ionic strength of the sol, ions present and ion concentration that and the lowest value of EC 2325 µs/cm and the highest value of EC 2675 µs/cm [11]. Dissolved oxygen is one of the most important water quality parameters, and an indicator of physical and biological processes in water . A clear sign of organic pollution is dissolved oxygen, because dissolved oxygen is used by biological decomposition (and may be detrimental to the living animals). Some substances are toxic because of inadequate oxygen consumption, otherwise known as pollution. The concentrations of dissolved oxygen in the studied drinking water are generally (10.2 - 6 mg/l ) [12]. The presence of nitrates in water at relatively high concentrations is undesirable due to their negative effects on public health, causing methaemogloinaemia and some types of cancer, such as stomach cancer, which negatively impacts the quality of drinking water, where values range between (7- 89 mg / l) [13]. The alkalinity of water is a number of ions (and which arise from the dissolution of salts in aquatic environments). They range between (76-254 mg/l), Carbon and bicarbonate ions are of great importance to aquatic organisms, playing a vital role in the natural alteration of overall alkaline values resulting from human intervention[14]. Because high chloride concentrations indicate contamination of the raw water sources feeding desalination plants, chloride is an important indicator of water quality, with values ranging from (14 to 141 mg/L). Studies have shown that chloride ions have a laxative effect, indicating their ability to stimulate bowel movements and facilitate elimination. However high concentrations are associated with increased blood pressure and negative effects on kidney function [15]. The main source of sulphate can be from run off waters of agricultural lands (bad fertilizing and irrigation management in the surrounding agricultural areas) and human activities, which manifest in their involvement in the concentration of sulphate in the tap water; and recorded its minimum value at 4 mg/l, maximum at 396 mg/l [16,17]. Sodium ion is one of the most important impurities present in the alum and chlorine added in the treatment stages. The range of their sodium value was (2-152 mg/l) [18,19,20]. The observed values for total hardness in the water samples ranged from minimum of 170 mg/l to maximum of 1275 mg/l /T.H (Mono Ca) (Mg) Hardness that is one of the main chemical properties that determine the suitability of water for drinking in homes and industries and for agriculture , being reliant on the existence of dissolved magnesium and calcium salts [21] . By the deposition of the calcium and magnesium salts, polluted waters become harder to increases. That while $Ca^+$ and $Mg^+$ ranges were between (50 and 835 mg/l) and (27 and 725 mg/l) respectively. Calcium was also above the Iraq recommended permissible drinking water level [22] . Phosphate pollution in aquatic ecosystems is mainly driven by $PO_4$ anthropogenic activities. Non point sources of nutrients are difficult to measure and regulate because the activities that produce nutrients are distributed over a very expansive land area, and vary both in time due to weather and climate changes. The results ranged from (0.028-0.29 mg/l) [23,24]. Examination for bacteriological contamination is a very important test that provides a clear picture of the extent of water contamination by microorganisms during water transport in pipes and water tanks in homes, apartment buildings, and government offices. It also provides a clear picture of the resulting health problems [21,25]. Biological tests are essential because they reveal the extent of fecal contamination and, consequently, the likelihood of the presence of various pathogens. Bacteriological test results indicate that the total bacterial count ranges from (0 to 120 cells/ml). Fecal coliform values range between (0 to 16 cells/ml).

### 3.1. Assessment of water for drinking

Table (3) shows the results of water quality index (CCMEWQI) and various factor F1, F2, F3 of the seven studied sites for drinking water, where water quality index values range between (46.436 – 69.34). In addition, 71% of the studied water samples are classed as water marginal and the remaining as fair. Otherwise, excessive levels of electrical conductivity, dissolved oxygen, total basicity, total hardness, calcium and magnesium ions, and nitrates are the primary causes of this decline in water quality, total bacterial count, and fecal coliform bacteria) and reflected negatively in a deterioration in the quality index values (values of F1, F2, F3) [26,27].

**Table 3** Evaluation and classification of the quality of drinking water at Kirkuk University**.**

| No | $F_1$ | $F_2$ | $F_3$ | CCME WQI | Ranking |
|---|---|---|---|---|---|
| 1 | 64.285 | 42.857 | 21.931 | 53.629 | Marginal |
| 2 | 57.142 | 48.571 | 40.701 | 50.734 | Marginal |
| 3 | 64.285 | 52.857 | 40.993 | 46.436 | Marginal |
| 4 | 57.142 | 30 | 29.643 | 58.995 | Marginal |
| 5 | 50 | 45.714 | 38.31 | 55.064 | Marginal |
| 6 | 35.714 | 32.857 | 21.563 | 69.34 | Fair |
| 7 | 42.857 | 35.714 | 17.028 | 66.324 | Fair |

## 4. Conclusions

The results of the current study indicated that 71% of the samples are in the doubtful (fourth) category of the Canadian Model Quality Index, indicating that the water is no longer ideal for drinking. Additionally, 29% of the samples fall into the Fair category of water quality.

*Recommendations*

Periodic tests of the level of residual chlorine in tap water to identify any incorrect conditions. It suggests covering water tanks in government departments tightly so that pollution from air currents carrying dust and animal and bird feathers cannot be mixed.

## Compliance with ethical standards

*Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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