VOL. 3, NO. 12, December 2013 ISSN 2225-7217
**ARPN Journal of Science and Technology**

http://www.ejournalofscience.org

# Determination of Some Inorganic Constituents of Drinking Water in Zalingei Town Central Darfur State, Sudan

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## ABSTRACT

In this study Four samples of water collected from River Aribo, Azom and underground wells of Zalingei Town Central Darfur state ,Sudan: at same dates and different times and they were analyzed for the following parameters: PH ,Ec, TDS ,Hardness , anions ($Co_3^{-2}$,$HCO_3^-$N,$S0_4^{-2}$, $Cl^-$ and cations :($Na^+$ ,$K^+$ ,$Ca^{++}$). The result showed that the pH Values were between (6.6-7.2).TDS values for all the samples (281-720 ppm) were within the permissible value of WHO (1000PPM). The result of chloride (19-95ppm) and sulphate (1.15-1.41 ppm) were agreement with the WHO standards (250 ppm $Cl^-$ and 400ppm $SO_4^{-2}$). For hardness ,sample s from Aribo and Azom (73-77ppm) were classified as Moderately hard water according to the with WHO (150-200ppm).the concentrations of cation $Na^+$ (6-35ppm), $K^+$(2-7.5PPM) and $Ca^{++}$ (24-54ppm) were within the permissible limit recommended by WHO (200ppm $Na^+$, 10ppm $K^+$ and 200$Ca^{++}$) from this study we found that all the drinking sample were suitable for human consumption **.**

**Keywords:** *Drinking water, Zalingei, inorganic Constituents, jamal*

## 1. INTRODUCTION

There is an increase in the demand of water by man over the ages. As per the international standards and in order to sustain human life, water should be available in sufficient quantities and free from pathogenic organisms and chemical contamination in water quantities as well as poor quality of water could be detrimental to man progress in life [15]. The compliance of water supply to all international drinking water regulations should be confirmed ,so that ,water born diseases can be avoided , [6]Water has constant chemical composition, however, chemically pure water is not found in nature, because of the almost universal solvent power of the water. Different sources of water have different chemical characteristics, because the sources have different types of soils moving from place to another and the water dissolves the constituents of each type to different extents, [6]. The demand for ground water is expected to increase drastically in the short and medium term as the countries strive to achieve millennium goal of water supply for all by year 2025[4]. Surface water include rivers, lakes seas ,ponds and reservoirs [15] few mineral content high hardness, large volume and convenience for many people are the common characteristic of surface water. Surface water is easily contaminated and the total bacterial and fungal contents are high, thus man requires proper treatment necessary before its utilization consumption. The simple treatment such as filtration and chlorination are making it important for domestic purposes to make it suitable for human consumption [5].

### 1.1 Objectives of the Study

The aim of this study is to determine quantitatively some physical and chemical parameters namely, pH, EC,

TDS, hardness, calcium,, potassium, and sodium of wells waters and River in the area of Zalingei locality and to compare the results with those recommended by [15].

## 2. MATERIALS AND METHODS

### 2.1 Sampling

The samples of the drinking water were collected from Sudan, Central Darfur Zalingei locality (Aribo, Azom, Forest well and Alwahida well,) in different dates and times and stored in reagent bottles (1 liter). See table (1) for the locations of the samples, the dates and times collected.

**Table 1:** Location of samples and Time collection

| Sample No. | Location | Date of collection | Time of collection |
|---|---|---|---|
| 1 | A ( Aribo) | 23/10/2007 | 4:00 pm |
| 2 | B (Azom) | 23/10/2007 | 6:11 pm |
| 3 | C (Forest ) | 23/10/2007 | 4:25 pm |
| 4 | D (Alwahida) | 23/10/2007 | 5:00 pm |

## 2.2 Methods: Determination of pH

PH is the negative common logarithm of the hydrogen ion activity [15] PH values was measured by pH meter. The pH meter was calibrated by the standard solutions of pH 4, 7 and 9 at 25°C, Temperature plays a role in the determination of pH at which neutrality occurs [7].
, the pH values of samples were then recorded.

## 2.3 Electrical conductivity (EC)

Electrical conductivity is the measure of the ability of water to conduct an electrical current. The specific electrical conductance is defined as the conductance of a cubic centimeter of any substance compared with the same volume of water. Pure water has very low electrical conductance and conductivity of water will increase with the presence of dissolved minerals [7].Water with high specific conductance can cause corrosion of iron and steel. Electrical conductivity is expressed in micro mhos per centimeter (μmohs/cm) [10].The conductivity cell was rinsed with distilled water, and then with 0.01 M KCl solution. The temperature of the conductivity meter and the sample was adjusted to 25°C, and by using water bath. The conductivity of KCl solution was measured and adjusted to 1.413 μmohs (reference solutions). The conductivities of samples were determined in the same manner [5].

## 2.4 Total Dissolved Solids (TDS)

The dissolved solids in water comprise inorganic salts and a small amount of organic matter. The principal anions contributing to the TDS include: carbonate, bicarbonate, chloride, sulphate and nitrates. Also TDS includes the cations: calcium, magnesium, potassium and sodium. TDS in water influence other qualities of drinking water, such as; taste hardness and corrosion properties [15]. 100 ml of water sample was transferred to weighted beaker and evaporated to dryness by heating for 4- 5 hours at 180°C.

## 2.5 Hardness

Alkalinity is due to the bicarbonate, carbonate and hydroxide ions in water, usually in association with calcium, magnesium, sodium and potassium. No limits are set for alkalinity level in water, although high concentration of sodium bicarbonate can give rise to taste problems [10].1ml ammonia buffer solution and 30 mg of eriochrome black T indicator were added to a 50 mls water sample in a 250 mls conical flask, the solution was then titrated with the 0.01M EDTA solution until the color changed from wine red to blue end point, [2].

## 2.6 Chloride

Chloride is the major anions in water. Chlorides are present as sodium chloride (NaCl, common salt) and to lesser extent as calcium and magnesium chlorides [2].The main problem caused by excessive chloride in water concerns the acceptability of the supply. Concentration above 250 mg/L can impart a distinctly salty taste to water [10]. For people suffering from heart and kidney diseases, high chloride water usage has to be restricted [15]. Excessive chlorides concentration increase rates of corrosion of metals in the distribution system. 50 ml of each sample was placed in a 250 ml conical flask, 1 ml of $K_2CrO_4$ indicator was added, the solution was then titrated with (0.014 M) Ag $NO_3$ solution (Ag $NO_3$ solution was standardized by mohr method using standard KCl solution) until a pinkish yellow precipitate was produced. The distilled water being used as a blank was treated in the same manner [15].

## 2.7 Sulphate

The concentration of sulphate in natural water can be found in various ranges from a few mg/L to several thousand mg/L. the highest level usually occurs in ground water. The sources of sulphate are the solutions of minerals containing sulphates and oxides of sulphur, sulphides and thiosulphates. The presence of sulphate in drinking water can cause noticeable taste. The taste varies with the associated cation. Taste threshold has been found to range from 250 mg/L for sodium sulphats to 1000 mg/L for calcium sulphate, [15] Geneva. Sulphate in domestic water contributes the major source for permanent hardness. High levels can impart taste and when combined with magnesium or sodium can have laxative effective effect, [15] Amman. 50 ml of water sample was placed in a 250 ml conical flask. The pH was adjusted with HCl (1:1) to 4 – 5 using pH-meter. The solution was then heated to boiling. Warm barium chloride ($BaCl_2$) solution was then added while stirring until complete precipitation. The solution was kept overnight, filtered through ashless filter paper, dried and ignited at 800˚C for 2 – 3 hours. The residue was cooled in desiccators and weighted [15].

## 2.8 Carbonate and Bicarbonate

Carbonate and bicarbonate in water are two of the three forms of the components of the carbonates equilibrium [15].The concentration of carbonate and bicarbonate in deep underground water may by quite high. When the concentration of carbonate and bicarbonate in water is high, water becomes corrosive to metals and concrete [1]. A50 ml of water sample was titrated with standard 0.05 HCl using phenolphthalein indicators until the color changed from colorless to red; the titrant volume (x) was recorded. Another 50 ml the sample was titrated with standard 0.05 ml HCl using methyl orange indicator, until the color changed from yellow to orange. The titrate volume (y) was recorded, [15].

## 2.9 Calcium

Calcium is the fifth amongst the elements in order of abundance [5]. It is present in water as $Ca^{2+}$ and is

VOL. 3, NO. 12, December 2013 ISSN 2225-7217
ARPN Journal of Science and Technology

http://www.ejournalofscience.org

readily dissolved from rocks rich in calcium minerals particularly as carbonates and sulphates [4]. The taste threshold for the calcium ion is in the range (100g/L300 m/L) depending on the associated anions (WHO,1995). A50 ml water sample was placed in a 250 mls conical flask; pH was adjusted to 12 – 13 by addition of 2 ml ammonia solution; one tablet of murexide indicator was added while stirring; the solution was then titrated with EDTA solution, until the color change from pink to purple.

### 2.10 Potassium and Sodium

Potassium as $K^+$ is usually found in low concentration in natural water, since rocks which contains potassium are relatively resistant to weathering .$K^+$ concentration in natural water is usually less than 10 mg /L , where concentration as high as 1000 mg /L, 2500 mg/L can occur in hot spring s and brines respectively[8]. Sodium is the most abundant of the alkali elements, some ground water contains high concentration of sodium and this can increase salinity in rivers and streams. Sodium is the most extra cellular cation and, together with its associated anions contributes significantly to the osmotic activity of the extra cellular fluid. Sodium is not an acutely toxic metal, because the body has a very effective method of controlling sodium levels [1, 3].Potassium and sodium were determined by flame photometry [15]. Calibration curve were constructed from the standard solution of each element. The samples emittance intensities were measured and their concentrations were determined from the standard curves.

## 3. RESULTS AND DISCUSSION

### 3.1 Result of pH, EC and TDS

**Table 2:** The pH, electrical conductivity (EC) and total dissolve solids (TDS) for Zalingei water samples.

| Sample no | Sample type | pH | EC inµ mohs/cm | TDS in ppm |
|---|---|---|---|---|
| 1 | Wadi 1(Aribo) | 6.9 | 0.270 | 281 |
| 2 | Wadi 2(Azom) | 6.6 | 0 .300 | 304 |
| 3 | Well 1(forst) | 7.0 | 0.350 | 350 |
| 4 | Well 2(Wahida) | 7.2 | 0.738 | 720 |

The values reported are the mean of three experiments**.**

**Table 3:** Results of the concentrations of some anions and hardness

| Sample no | Sample type | $SO_4^{2-}$ in ppm | $CO_3^{2-}$ in ppm | $HCO_3^{2-}$ in ppm | $Cl^{-1}$ in ppm | Hardness in ppm |
|---|---|---|---|---|---|---|
| 1 | River1(Aribo) | 1.15 | 30 | 183 | 29 | 73 |
| 2 | Rivr2(Azom) | 1.23 | 36 | 200 | 19 | 77 |
| 3 | Well 1(forest) | 1.40 | 60 | 244 | 44 | 152 |
| 4 | Well2(Wahida) | 1.41 | 64 | 251 | 95 | 164 |

**Table 4:** the result of $K^+$, $Na^+$ and $Ca^{+2}$

| Sample no | Sample type | $K^+$ in ppm | $Na^+$ in ppm | $Ca^{+2}$ in ppm |
|---|---|---|---|---|
| 1 | River(Aribo) | 2 | 6 | 26 |
| 2 | River(Azom) | 2.10 | 28 | 24 |
| 3 | Well(Forest) | 6.6 | 35 | 54 |
| 4 | Well(Wahida) | 7.50 | 43 | 56 |

*these values are averages of three readings.

The results of pH table 2, and fig 1, showed that, the PH varies between 7.2 and 6.6, which indicate that all the samples fall in the neutral and acidic side .Therefore, the pH values obtained were within the WHO standards summarized in table The result of the total dissolved solids table 2, and fig 2, Showed that all the samples agree with WHO measure for fresh water.

### 3.2 Electrical conductivity (EC)

The data in table 2 , And fig 3, Showed that the samples from Well Forest and Well Wahida had high EC values compared to those of sample from River Aribo and River Azom, this is due to the presence of cations and anion, namely $Na^+$, $K^+$ and $Ca^{2+}$. Fig5 Concentration of **Cat ions** of Zalingei water**.**

### 3.3 Chloride

The data in table 3,and fig ,4 showed that the concentration of chloride for all the samples were in

VOL. 3, NO. 12, December 2013 ISSN 2225-7217
ARPN Journal of Science and Technology

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agreement with the WHO standards in table 4, The concentrations of $Cl^-$ in Wells samples are higher than those of the Rivers.

### 3.4 Sulphate

The data in table 3, and 4, Showed that the sample s from Aribo and Azom contain very low sulphate concentrations compared to samples from Forest well and Wahida well. . The values obtained for $SO_4^{2-}$ concentration for all samples were in agreement with the WHO standard.

### 3.5 Carbonate and Bicarbonate

Generally the results of carbonate and bicarbonate table 3, and fig 4, Showed that the concentrations of $CO_3^{2-}$ were lower than those of $HCO_3^{2-}$. Samples from Forest and Wahida wells had lower concentrations than samples Aribo and Azom River .This is due to the concentrations of carbonic acid in the air that result from rain water and carbon dioxide interaction.

### 3.6 Total Hardness

The results of hardness table 3, and fig 4, Showed that samples 1and 2 are moderately soft while sample 3 and 4 are moderately hard based on hardness level (table2).

### 3.7 Sodium, Potassium and Calcium

The result of Cation in table 4 and fig 5, Showed that the concentrations of the cationic species ($K^+$, $Na^+$,$Ca^{2+}$ ) Species for all the sample are within the WHO standards in table 3. The concentration of $K^+$, $Na^+$, and $Ca^{2+}$ in Wells samples is high compared to those of Rivers Samples. This explains the high value of (EC) for Wells compared to Rivers.

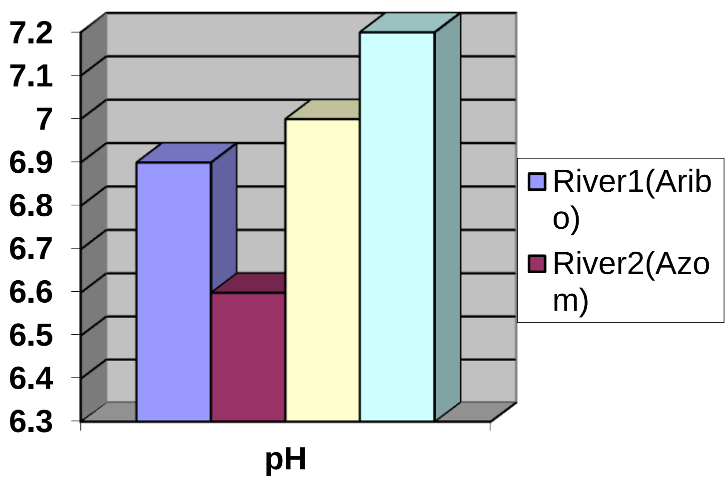


**Fig 1:** The pH of Zalingei water.

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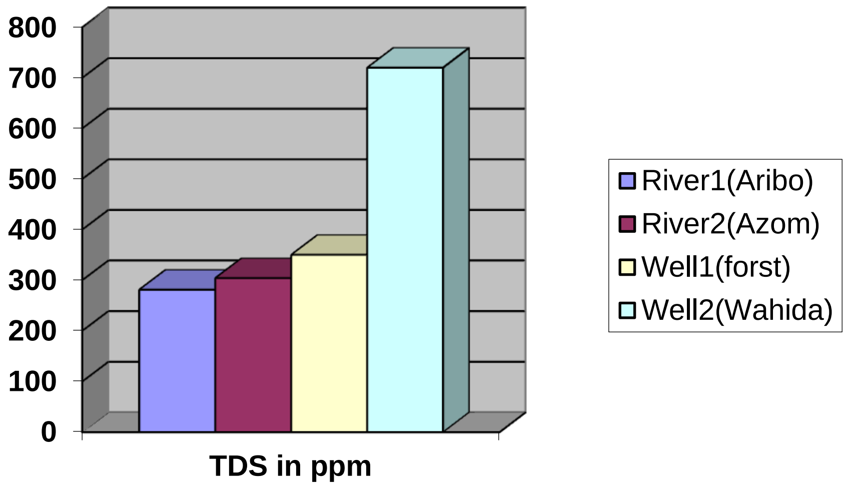


**Fig 2:** The total dissolved solids (TDS) of Zalingei

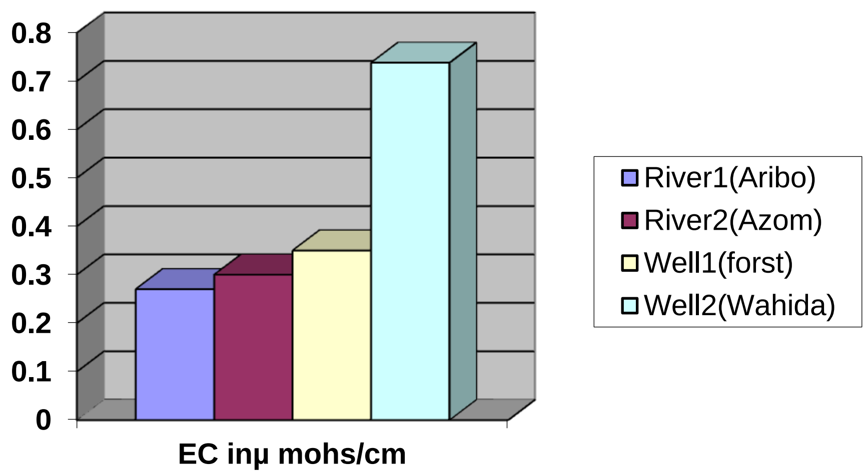


**Fig 3:** The Electrical conductivity (EC) of Zalingei Water.

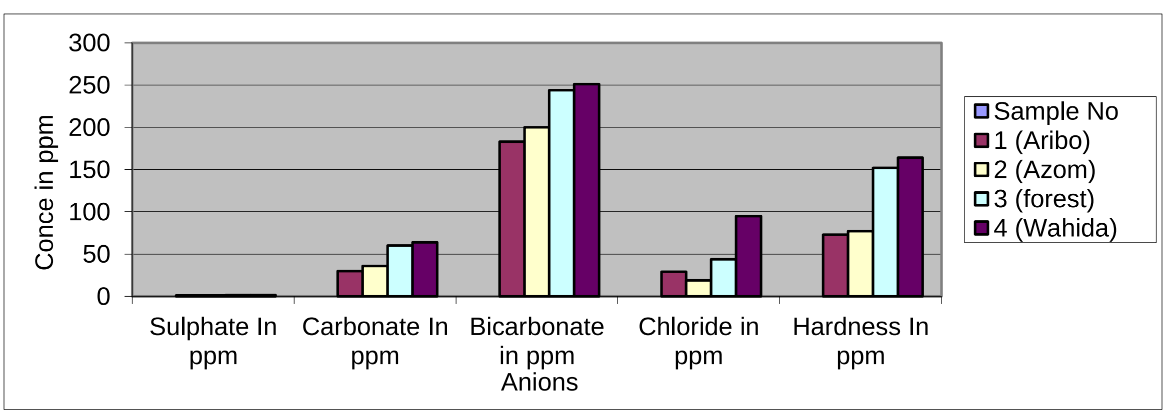


**Fig 4:** Concentration s of anions and hardness of Zalingei water

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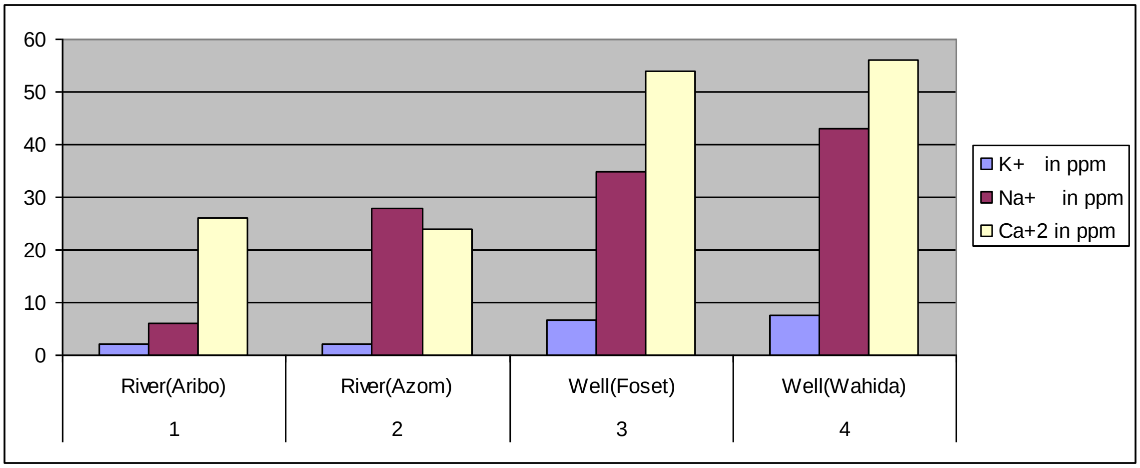


**Fig 5:** Concentration s of anions and hardness of Zalingei water

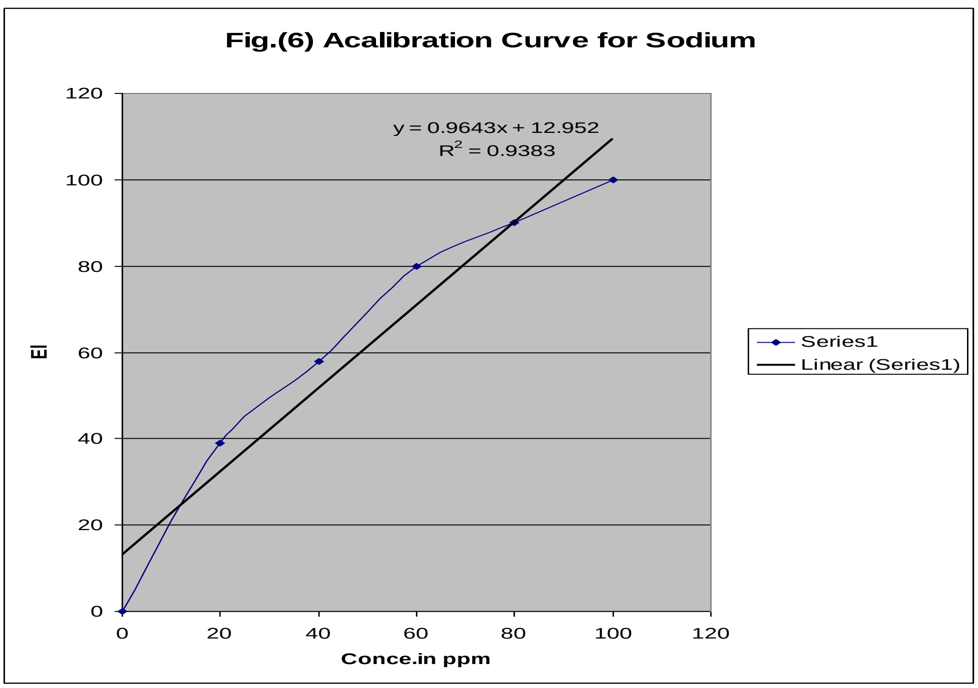


**Fig 6:** Acalibration Curve for Sodium

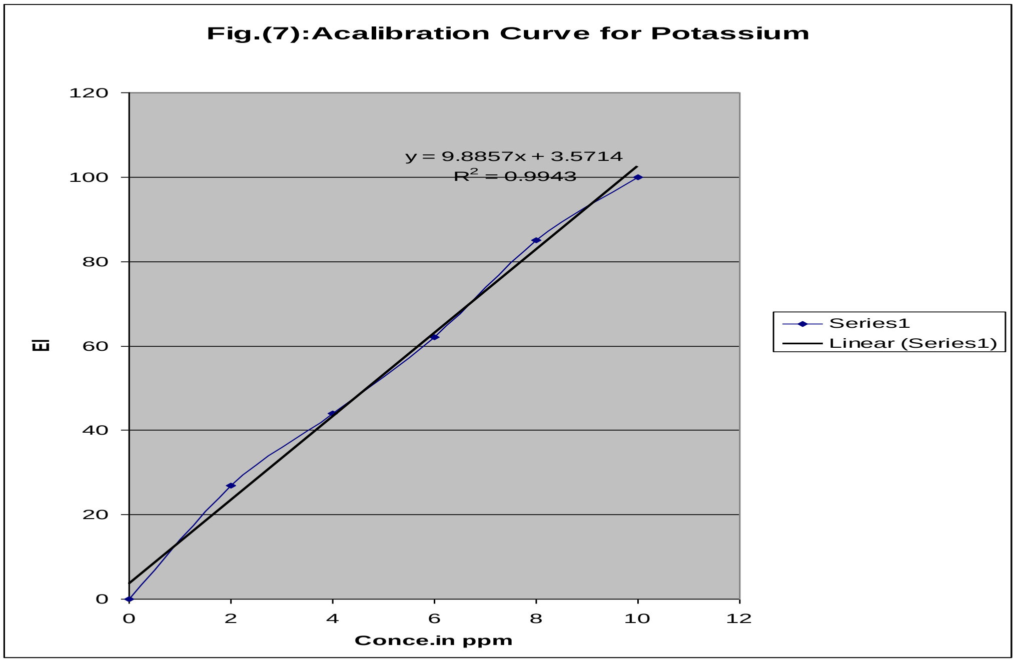


**Fig 7:** Acalibration Curve for Potassium

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