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# Evaluation of the Effect of Three Local Methods on Treatment of Contaminated Water in Rural Area in Sudan.

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***Abstract: Background:*** *Water contamination was playing a major role in the health hazards. Scientific verification for some natural methods used to treat water is still limited.* ***Aim:*** *This laboratory based study aimed to evaluate the effect of Broad bean seed (vicia faba), Fenugreek seed (Trigonela foenum gracium) and Zir in treatment of contaminated water.* ***Materials and methods:*** *One sample of water from Gabarona Camp in West Omdurman was examined for Physical, Chemical and microbial parameters before and after treatment with Broad bean seed, Fenugreek seed and stored in Zir in different duration of times for 5, 10,15,30,45 and 60 minutes .* ***Results:*** *The addition of Fenugreek, Broad bean seeds and storage in Zir lead to partially reduction of Physical characteristics of water. The results of chemical analysis of GWTBB, GWTF and GWTZ, showed that total dissolved salts (TDS) were ranged from (520-900 mg/l). After treatment with the Fenugreek, Broad bean and Zir the level of Total hardness was improved to minimum of 50, 45, and 48 at 60 min respectively. The reduction in total hardness and total dissolve salts for GWBB, GWTF and GWTZ was found to be statically differences ($p \leq 0.05$). The addition of Broad bean and storage in Zir reduced water fluoride content at 5 min to 1.3 mg/l, 1.5 mg/l. respectively. While treated water using Fenugreek exhibited lower reduction from 1.7 mg/l to 1.3 mg/l at 60 minutes. The MPN of untreated water sample was (440). The results indicate a reduction in the microbial load in GWTF, GWTBB and GWTZ by increased time duration of treatments. Our results showed that these common local methods for treatment of water slightly reduced the microbial, chemical and physical contamination of water.*

**Keywords:** contaminated water, local method, Broad bean seed (*vicia faba*), Fenugreek seed (*Trigonela foenum gracium*) , Zir

## Introduction:

More than one billion people depended on rivers, streams, or other unsafe sources for drinking water [1]; access to safe drinking water has been an important national goal in developing countries [2].

Drinking water can become contaminated following its collection from communal source such as wells and taps stands, as well as during it is storage. People are exposed for contamination during daily activities. However, the mechanisms leading to contamination between the points of supply and consumption have not been documented [3].

Treated water by using chemical materials now costing money and also it is very critical point since the materials and substances used in the treatment may be toxic and corrosive. However, the methods of water treatments from biological materials by exploring the active ingredients of natural coagulants will indeed be cost effective in providing water at a very cheap and affordable price and at all time in every household, mechanism of many biological treatments which lead to reduce contaminations are unknown due to lack of studies in this area . Today, more attention is focusing on treat water with natural material of plant origin, it became a common practice. Little observations suggested that adding natural materials to treat drinking water have reduced the microbial and chemical contamination of drinking water. However, researches on using plants and other natural materials are limited and still under study[4;5].

Fenugreek seed (*Trigonella foenum graecum*) is an annual herb, belonging to the family Leguminous, has a sharp, spicy aroma. It originated mainly from India but now it is widely grown in Sudan, Egypt, Middle Eastern countries, America and Russia.

The use of Fenugreek in the treatment of drinking water is still limited and under study, but the available data shows that Fenugreek seed was used to reduce the turbidity of drinking water and also reduce 64-84% removal of faecal coliforms of the water sample as reported by Okonko and Shittu[6] .

Faba bean (*visia faba*), formerly known as broad bean, is among the oldest crops in the world. The center of origin is believed to be between the oriental Mediterranean countries and Afghanistan. Faba bean with its about 30% of seed protein content constitutes a valuable source of protein for food in developing countries, also its high in carbohydrates and fiber and low in fat and provide vitamins and minerals [7]. Faba bean was used in treatment of contaminated water in many rural areas in Sudan.

Zir is a jar which made of backed clay used for storing and cooling drinking water. Zirs are distributed in streets, schools, market places and hospitals.

Fenugreek, Faba bean and Zir are common methods used for treatment of contaminated water in many rural areas in Sudan.

This wide distribution serves a large number of users. Some scientific reports have supported the idea that these public jars may serve as vehicles of public hazards. However, due to the need for drinking water by the street-passers and the absence of suitable practical alternatives, the wise step is need to this system. This step needs to be preceded by sufficient full component of data on all the dimensions of the problem [8].

This innovative, pioneer, preliminary study was aimed to evaluate the effect of three Sudanese local methods on treatment of contaminated water.

**Materials and methods:**

**Study area:**

This was laboratory based study. It was carried out at Gabarona Camp in West Omdurman Province. The microbiological investigations carried in Microbiology laboratory in Ahfad University for Women, while the Physical and Chemical tests were carried in Mogran Water Corporation, Khartoum -Sudan. This study aimed to provide scientific verification for three common methods used in Sudan.

**Sample collection**:

One sample of drinking water collected in the early morning was examined for physical, chemical and microbial investigations before and after addition of Broad bean (*visia faba L*), Fenugreek (*Trigonella foenum graecum*), both seeds were added in ratio of (10 gm seed: 100 ml water**),** Zir was used as storage method, the result was obtained in different duration of time for 5, 10, 15, 30, 45 and 60 minutes for each method. Sample of water was collected in sterile bottles containing 0.1 ml 10% sodium thiosulphate and care was taken to prevent accidental contamination of the water during its collection.

**Statistical analysis:**

Data from lab results was assessed by analysis of variance (ANOVA), [9] and by the Duncan multiple range test with a probability $p \leq 0.05$ [10].

**Method**s:

**Physical and Chemical Methods:**

The methods described by Clesceri and his colleagues [11] were used to measure the physical and chemical method, Turbidity was measured by using (HACH, 2100N) turbidity meter the results reported in (NTU), Electrical conductivity (EC) was measured by using (HACH, 107) Conductivity meter, result reported in micromohs/cm. Total dissolved solids (TDS) was measured by direct reading using (HACH/107N) Conductivity meter, results reported in mg TDS/L water. Titration method was used to determined the level of Chloride ,Sample titrated Vs standard Silver Nitrate solution in the presence of Potassium Chromate as indicator, and then followed by directs reading using (HACH, DR/4000v) spectrophotometer, results reported in mg Cl/L water. Titration method was used to measure the total hardness .The pH of the water sample adjusted to 10 ml with Ammonium Hydroxide solution; followed by addition of Eriochrome black T indicator, then titrated by Vs Ethylene diamine tetra acetic acid (E.D.T.A), and directs reading by Digital burette. The data was recorded as mg/L total hardness. Fluoride present in water sample was determined by using SPANDS method which was a conventional method to measure fluoride [11].

**Microbiological methods:** The microbial load of the water sample was determined by multiple tube fermentation technique and the target bacteria was faecal coliforms, the tubes were overnight incubation as the methods described by Fawole and Oso [12],for detection of most probable number(MPN) counts of the faecal coliforms in water sample, and the results obtained were compared with the MPN index table of Seeley and Demark to estimate the number of coliform per 100 ml. [13]

**Results and Discussion:**

Table (1) showed the results of the physical tests, Gabarona untreated water sample (GUWS) has a pH of 8.8 with electrical conductivity (EC) and Total dissolved salt of 1064 micromhs/cm , 932mg/l respectively, these values were above the limit of SSDW, in table (1) the chemical contents of GUWS were high compared to SSDW, the concentration of Fluoride ion was found to be 1.7 mg/l and TDS of 932mg/l, GUWS was highly microbial contamination of 440 MPN/100ml.

**Table (1) Physical, chemical and microbial parameters of Gabarona Untreated water sample (GUWS):**

| **Parameter** | **Raw water** |
|---|---|
| **Physical properties** | |
| pH | 8.8 |
| Electrical conductivity | 1064 micromhs/cm |

| | |
|---|---|
| Turbidity | 6.8 NTU |
| **Chemical properties** | |
| Total dissolved salt | 932mg/l |
| Total hardness | 119.5 mg/l |
| Chloride | 265mg/l |
| Fluoride | 1.7mg/l |
| **Microbial results** | |
| Most probable number(MPN)/100 ml | 440 faecal coliforms/100 ml |

The water parameters during the treatments were summarized in Table (2), pH of the samples ranges from (8.7-8.9) at 5 min which were slightly higher compared to that mentioned in Sudanese standards for drinking water (SSDW) [14], the change may be because of measurement deviation. A pH effect on human health depends on the degree of pH change and on the strength of acid and base. Strong acid and base are corrosive and may effect on the water quality. However, higher pH value obtained in the untreated water sample also associate with the source of water and to high level of some chemical substance soluble in the water which it increase the pH of water. Similar explanation was mentioned by Eedema and his colleagues [15].Jahn and Hamid [16] reported that if the plant suspensions were applied as water coagulant aids in combination with alum treatment, the pH decreased, from Table (2) the pH decrease as the time increased reached to the minimum of 6.0 at 60 min for Zir.

EC of water samples was 1078, 1095 and 1098 micromhs/cm for Gabarona water treated broad bean (GWTBB) ,Gabarona water treated Fenugreek(GWTF) and Gabarona water treated Zir (GWTZ), at 45,30 ,45min respectively (Table 2) , EC is the ability of water sample to carry an electrical current, water itself is a very weak conducts, but some minerals soluble in water may causes an increase on its conductivity. In this study the method use for treatment (especially Zir) may be responsible for this increasing in EC. The changes of EC by the treatments seem to be not significant and might be because of measurement deviations.

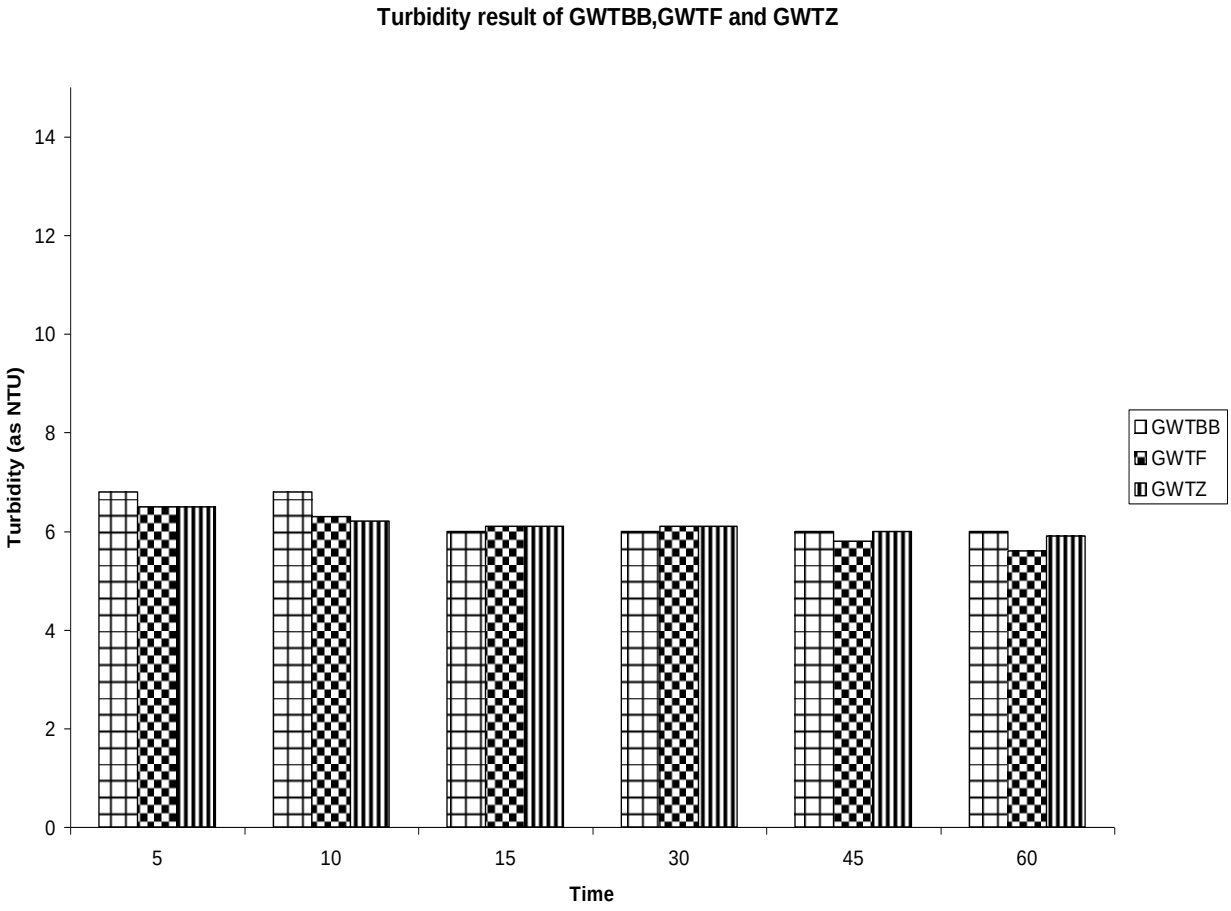
**Table (2): Physical properties of Gabarona water treated with three methods.**

| Parameter | 5 min | 10min | 15 min | 30 min | 45 min | 60 min |
|---|---|---|---|---|---|---|
| pH of Broad Bean | 8.7 | 8.0 | 7.5 | 7.6 | 7.8 | 7.9 |
| pH of Fenugreek | 8.6 | 8.0 | 7.8 | 7.4 | 7.2 | 7.7 |
| pH of Zir | 8.9 | 8.9 | 8.8 | 8.3 | 7.0 | 7.0 |
| Electrical Conductors (EC) of Broad Bean | 1070 | 1071 | 1071 | 1073 | 1078 | 1070 |
| Electrical Conductors (EC) of Fenugreek | 1097 | 1088 | 1089 | 1095 | 1062 | 1067 |
| Electrical Conductors (EC) of Zir | 1092 | 1097 | 1110 | 1114 | 1098 | 1095 |

Figure (1) showed the results of turbidity in different duration of times, the result of water samples were ranged from (5.6 -6.8 NTU) which were higher compared with the normal level of drinking water recommended by SSDW[14]. In Fig (1) the turbidity of water was reduced after treated with Broad bean, Fenugreek and Zir at 30, 45, 60 minutes respectively. There were a lot of factors

may affect the turbidity measurement, components made up of Zir, liquid and solid waste definitely are also contribute to water quality as affected by waste discharges, as shown in Fig (1) as the time increased the turbidity slightly decreased. Okonko and Shittu [6], mentioned that there is no direct correlation between the amount of suspended matter of *Calotropis procera latex* and the measurement of turbidity of the water sample; this may explain our results for Fenugreek. There were statically differences ($p \leq 0.05$) regarding the turbidity.

**Figure**
**GWTBB,GWTF,GWTZ turbidity results**




The results of chemical analysis of GWTBB, GWTF and GWTZ, showed that total dissolved salts (TDS) were ranged from (520-900 mg/l) these value agreed with that mentioned in SSDW[14]. TDS is essential for drinking water, since it play an important role in the metabolism, catabolism and contamination inside human body. Slightly change was occurred after treatment with the three methods.

The total hardness of the water samples were found to be higher , 119.5 , 110 and 100 for GWBB, GWTF and GWTZ , respectively when treated at 5 min which was hard water according to Haman and Bottcher [17]. After treatment with the Fenugreek, Broad bean and Zir the level of Total hardness was improved to minimum of 50, 45, and 48 at 60 min respectively. There was a direct correlation between the decreased total hardness and the increased the time of treatment. The reduction in total hardness and total dissolve salts for GWBB, GWTF and GWTZ was found to be statically differences ($p \leq 0.05$).

In table (4, 5 and 6) the addition of Broad bean partially decreased the chloride level from 265 mg/l to 250 mg/l, GWTF and GWTZ showed the same results above five minutes, but the Their was no statically differences ($p \leq 0.05$) regarding the chloride . In table (4,5 and 6), the addition of Broad bean and storage in Zir reduced water fluoride content at 5 min to 1.3 mg/l ,1.5 mg/l. respectively. While treated water using Fenugreek exhibited lower reduction from 1.7 mg/l to 1.3 mg/l at 60 minutes. There was no statically differences ($p \leq 0.05$) regarding the fluoride.

**Table (4): Gabarona water treated with Broad bean (GWTBB)**

| Parameter/Time(min) | 5 | 10 | 15 | 30 | 45 | 60 |
|---|---|---|---|---|---|---|
| Total dissolved salt | 838 | 746 | 648 | 521 | 568 | 542 |
| Total Hardness | 119.5 | 112.4 | 99 | 87 | 50 | 45 |
| Chloride | 250 | 241 | 236 | 231 | 243 | 240 |
| Fluoride | 1.3 | 1.2 | 1.1 | 1.0 | 0.8 | 0.6 |

**Table (5): Gabarona water treated with Fenugreek (GWTF)**

| Parameter/Time(min) | 5 | 10 | 15 | 30 | 45 | 60 |
|---|---|---|---|---|---|---|
| Total dissolve salt | 832 | 720 | 734 | 731 | 660 | 639 |
| Total Hardness | 110 | 89 | 77 | 74 | 56 | 50 |
| Chloride | 255 | 238 | 230 | 224 | 220 | 228 |
| Fluoride | 1.7 | 1.6 | 1.6 | 1.4 | 1.4 | 1.3 |

**Table (6): Gabarona water treated with Zir (GWTZ)**

| Parameter/Time(min) | 5 | 10 | 15 | 30 | 45 | 60 |
|---|---|---|---|---|---|---|
| Total dissolve salt | 900 | 835 | 786 | 746 | 720 | 660 |
| Total Hardness | 100 | 92 | 86 | 78 | 59 | 48 |
| Chloride | 256 | 238 | 241 | 246 | 225 | 228 |
| Fluoride | 1.5 | 1.3 | 1.0 | 1.1 | 1.1 | 1.1 |

The antimicrobial effect of the 3 methods was showed in table (7). The MPN of untreated water sample was (440). The results indicate a reduction in the microbial load in GWTF, GWTBB and GWTZ by increased time duration of treatments. The maximum reduction of microbial contamination was recorded at 45 minutes for GWTBB, GWTF constituting 4,6 MPN/100ml respectively, while in GWTZ it was determined at 60 minutes constituting 2 MPN/100 ml, So time required for treatment of drinking water with these three methods was best in 45 minutes by using broad bean and Fenugreek,while in Zir it was in 60 minutes.

Okonko and Shittu [6] , reported that reduction in the microbial load of raw water sample treated by *Calotropis procera latex* reduced to 98.4% after one hour of treatment and 100% after 24 hours of treatment.

Danish field experiment in the Sudan with *Moringa oleifera* seeds used for coagulation of artificial Nile water found a reduction of *E.coli* by 90-100 %, the feacal coliforms removed by 36.4%, 44% when treated with *Blepharis persica*, *vicia faba* respectively as reported by Jahn [18].

**Table (7): Microbial results of Gabarona water treated with three different methods.**

| Microbial load (MPN) /100ml | | | | | | |
|---|---|---|---|---|---|---|
| Time /min | | | | | | |
| Water Samples | 5 | 10 | 15 | 30 | 45 | 60 |
| GWTF | 415 | 300 | 145 | 60 | 6 | 48 |
| GWTBB | 425 | 365 | 280 | 45 | 4 | 25 |
| GWTZ | 415 | 295 | 186 | 42 | 10 | 2 |

As shown in Table (7) the effectiveness of the treatments was clearly evaluated.

In conclusion treatment of drinking water playing a major role in the good human health. Our results showed that there was a high degree of chemical, physical and microbial contaminations in Gabarona Camp water samples so the traditional common treatments methods Faba bean, Fenugreek and Zir are effective. So this preliminary study gives scientific verification for these methods.

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