

Sudan University of Science and
Technology

College of graduate Studies and Scientific
Research

Analytical Quality Study of Drinking Water of Merowe city

**A Thesis submitted for M.S.
Degree in Chemistry**

Submitted by:

Mutaz Salah Mohmmed Elsaim

Supervisor:

Dr Elmugdad Ahmed Ali Khalid

Co - Supervisor

Dr Mohamed Aadam Abuo Hussien

2012

Approval page

The Thesis of..... is approved

1- External Examiner

Name

date.....

2- Internal Examiner

Name.....date.....

Supervisor

Name.....date.....

(i)

وجعلنا من الماء كل شئ
(حي)

الانبياء الايه (30) صدق الله العظيم

DEDICATION

To my

Family,

Friends,

And

City

(ii)

Acknowledgements

I would like to express my deep thanks to ***Dr. Elmugdad Ahmed Ali Khalid*** for his close supervision, guidance and encouragement throughout the period of my study. Great thanks to ***Dr Mohamed Adam Abu Hussein*** for his continuous, numerous assistance which has clear reflection in this work.

Finally, I would like to express my sincere thanks to the Merowe Dam, Hospital, Water station, college, people, and chemistry Department, Faculty of Science, Sudan University of Science and Technology.

(iii)

Abstract

The study was done to investigate the drinking water quality of Merowe city distributed the pipe line of water net work seven sites of the city water net work were selected comprising raw water Nile, Two hundred and sixteen samples were collected during the period August 2008-June 2009. three samples monthly collecting from each site to evaluate each parameter examined in this study. Samples were subjected to physical, chemical, microbiological and radio- activity examination and analyzed to investigate the level of the expected health hazards in each sample. The data obtained were subjected to statistical analysis. The results obtained were compared with international and national drinking water guide-lines in an attempt to evaluate the quality of drinking water in Merowe city.

The results obtained indicated that the turbidity level ranged from (32.93-11.42 NTU) thus exceeding the permissible level of international standards WHO (1993) and Sudanese standards and metrology organization (SSMO) standards (5 NTU).

The concentration range of minerals such were as follows: chloride (8.71 -3.25 mg/dm³)sulfate (22.92 - 3.23 mg/dm³), calcium (27.23 -12.20 mg/dm³), alkalinity (100 - 60mg/dm³), fluoride(3 - 0.02 mg/dm³),

magnesium (10.75 - 4.49 mg/dm³), TDS (167.13-101.56 mg/dm³), hardness (109 - 52.96 mg/dm³), sodium (16-27-9.14 mg/dm³), potassium (5.71 - 2.73 mg/dm³) iron (0.42 - 0.11 mg/dm³) nitrate (14.90 - 8.47mg/dm³), nitrite (6.35 - 0.26mg/dm³), electrical conductivity (310 - 138 mg/dm³), T.S.S (34.76 - 6 - 12 mg/dm³), pH (9.01 - 7.21 mg/dm³). All these values fall below the maximum values stated by WHO and (SSMO).

During this study period there were 309 people in Merowe city suffering from typhoid, 116 with Para typhoid, 654 with Diarrheal diseases city, 2707 with malaria and 268 with Essential hypertension and 434 with Diseases of oral cavity and 114 with Mucosa's of skin.

All of these diseases could be water-related although other environmental

(iv)

factors may also be important.

The study revealed that raw water of Merowe city was polluted by coli form and the results do not cope with international (WHO, 1993) and the national Sudanese standards metrology organization (SSMO, 2002).

After treatment of raw water the pollution incidence in tap water samples was decreased, however, slight pollution occurs in some of treated water sample.

It may be stated that most of the tap water sample collected from the main distribution net work are, suitable for human

consumption a number of recommend actions were suggested to improve the drinking water quality.

((v

ملخص البحث

أجريت الدراسة علي مياه الشرب لمدينة مروى بواسطة شبكة مياه المدينة في الفترة من أغسطس ٢٠٠٨ إلي يوليو ٢٠٠٩) وقد اختيرت ستة مواقع من المدينة علي حسب توزيع شبكة مدينة مروى وأجريت عليها التحاليل الفيزيائية الكيمائية

والميكروبيولوجية للتأكد من صلاحية المياه بالنسبة للاستهلاك
الآدمي.

تم جمع 260 عينه من سبعة مواقع (النهر- الماء الخام داخل محطة
المياه - حي التعمير- حي السوق - حي الثورة -حي الدومة - حي
ابو دوم) يتم جمع ثلاثة عينات كل شهر من كل موقع ثم اختباره
لمدة عام واجري عليه التحليل الإحصائي .

تمت مقارنة النتائج بالخصائص العالمية والمحلية لتقيم صلاحية
المياه للشرب بمدينة مروحي ووجدت أن معظم العينات المختارة
تعتبر صالحه للاستعمال الآدمي .

لقد أوضحت الدراسة أن مستوي العكارة للسته مواقع تتراوح ما
بين (11.24-30.93) والنتيجة لا تتفق مع خصائص منظمة الصحة
العالمية (1993) وهيئة المواصفات والمقاييس السودانية للعام
(2002) وهي (5) وأظهرت الدراسة أيضا أن نسبة تركيز الكلور
تتراوح بين (3,25-8,71) والكبريتات تتراوح ما بين (22,92-3,23)
ملجم\دسم³)والكالسيوم ما بين(27,23-12,20 ملجم\دسم³)
القلوية ما بين (100-60 ملجم\دسم³) والماغنسيوم ما بين(4,49-
10,57 ملجم\دسم³) والأملاح الكلية ما بين (101,56-
167.13 ملجم\دسم³) وعسر الماء ما بين (52.96-
109.00 ملجم\دسم³) والحديد (0.42-0.11 ملجم\دسم³)
والصوديوم (16.27-9.14 ملجم\دسم³) والبيوتاسيوم (5.71-2.73
ملجم\دسم³) والنترات ما بين (14.90-8.47 ملجم\دسم³)
والنتريت ما بين (6.35-0.26 ملجم\دسم³) والموصلية الكهربائية ما
بين (310.00-138.14) (vi)

ملجم\دسم³) والفلور ما بين (3.00-0.20 ملجم\دسم³) والرقم
الهيدروجيني ما بين (9.01-7.21) وقد وجد إن كل العناصر كانت
اقل من الحد الأقصى المسموح به في مواصفات كل من منظمة
الصحة العالمية (١٩٩٣) وهيئة المواصفات والمقاييس السودانية
للعام (٢٠٠٢ م).

وقد وجدت الدراسة إن حوالي 364 مصابون بمرض الالتهاب المعوي أثناء فترة الدراسة و 2707 مصابون بالمalaria و 268 بالكوليرا و 309 بالتايكويد و 654 بالدستاريا و 268 بارتفاع ضغط الدم و 434 بأمراض الأسنان و 114 بأمراض جلديه

وكل الأمراض السابقة يمكن أن تكون متعلقة بالماء بالرغم من وجود العوامل البيئية الاخرى , بعد معالجة الماء قلت نسبة التلوث في المياه تحت الاختبار ولكن ظهرت نسبة التلوث البكتيري لبعض المواقع بعد دخولها الشبكة العامة.

لقد أوضحت الدراسة أن معظم العينات المختارة من الشبكة العامة لمدينة مروي صالحه للاستهلاك الآدمي

(vii)

CONTENT

Content	i
Acknowledgement.....	ii
Abstract (English).....	iii
Abstract (Arabic).....	iv
Content of table.....	v
Content of figure.....	vi

Chapter One

Introduction

1.	
Introduction.....	1
1.1. Importance of water.....	2
1.2. Water resources.....	2

1.2.1.	Sudan	water	
resources.....			3
1.3.	Water Chemistry.....		4
1.4.	Drinking water.....		14
1.4.1.	Drinking	water	quality
standards.....			14
1.4.2.	Methods	of	Water
.....			Purification
			16
			(viii)
1.5.	Water	quality	and
Diseases.....			19
1.5.1.	Chemical	related	illness
.....			23
1.5.2.	Merowe diseases'	
			27
1.6.	Water Pollution	

2.1. Location of study area	33
2.2. Collection of samples	38
2.3. Physical parameters	40
2.3.1. pH	40
2.3.2. Turbidity	43
2.3.3. Electrical conductivity	45
2.4. Chemical Parameters	47
2.4.1. Total dissolve solids	47
2.4.2. Concentration of nitrate	49
2.4.3. Concentration of nitrite	51

2.4.4. Total Alkalinity	53
2.4.5. Concentration of Total Hardness	55
2.4.6. Concentration of sulphate	57
2.4.7. Concentration of Iron	59
2.4.8. Concentration of fluoride	61
2.4.9. Concentration of sodium	63
2.4.10. Concentration of Potassium	65
2.4.11. Concentration of Calcium	67
2.4.12. Concentration of Magnesium	69
2.4.13. Concentration of chloride	71
2.5. Microbiological parameters	73

..... 75	2.5.2. Total coli form bacteria
77	2.5.3. Faecal coli form
...79	2.5.4. Escherichia coli (E. coli)
.....81	2.5.5. MPN of bacteria

(x)

Chapter Three

Discussion and Conclusion

83	3.1. Discussion
86	3.2. Conclusion
89	3.3. Recommendation

3.4. References
92

(xii)

List of Tables

Table 1.1. : Dissolved oxygen (DO) in Water
.....16
Table 1.2. : Drinking Water standard
..... 20
Table 1.3 : Bathing water quality standards
.....21

Table 1.4 : The main water-related diseases	30
Table 1.5 : Total diseases cases in Merowe City	37
Table 1.6 : Investigate Urine in Merowe city	38
Table 1.7 : Investigated Blood in Merowe city	38
Table 1.8 : Deaths Cases in Merowe city	38
Table 2.1 : pH	52
Table 2.2 : Turbidity	54
Table 2.3 : Electrical conductivity	56
Table 2.5 : Total dissolved Solids	60
Table 2.6 : Concentration of Nitrate	62
Table 2.7 : Concentration of Nitrite	64
Table 2.8 : Total Alkalinity	

.....66

(xii)

Table 2.9 : Concentration of Total Hardness
.....68

Table 2.10 : Concentration of sulfate
.....68

Table 2.11. : Concentration Of Iron
.....70

Table 2.12. : Concentration of fluoride
.....72

Table 2.13. : Concentration of sodium
.....74

Table 2.14. : Concentration of potassium
.....76

Table 2.15. : Concentration of calcium
.....78

Table 2.16. : Concentration of magnesium
.....80

Table 2.17. : Concentration of chloride
.....82

Table 2.18. : Total coli form bacteria
...84

Table 2.19. : Faecal coli form
.....86

Table 2.20 : *Escherichia coli* (*E. coli*)
 ...88

Table. 2.21. :Most probably Number (MPN) of bacteria
90

(xiii)

List of Figures

Figure 1.1. : Water bond
7

Figure 1.2. : Orbital representations of water molecule
8

Figure 1.3. : Covalent bond
9

Figure 1.4. : Polar covalent bonding simulated in water
10

Figure 1.5. : Hydrogen bond
12

Figure 2.1. : Location of study area in sudan map
44

Figure 2.2. : Location of Meroe City	45
Figure 2.3. : Merowe water Treatment	47
Figure 2.4. : Municipal water-treatment flowchart	48
Figure 2.5. : pH	53
Figure 2.6. : Turbidity	55
Figure 2.7. : Electrical conductivity	57
Figure 2.9. : Total dissolved Solids (TDS)	61
Figure 2.10. : Concentration of Nitrate	63
Figure 2.11. : Concentration of Nitrite	65
Figure 2.12. : Total Alkalinity	67
Figure 2.13. : Concentration of Total Hardness	69
Figure 2.14. : Concentration of sulfate	71
Figure 2.15. : Concentration of Iron	73

Figure 2.16. : Concentration of fluoride	75
Figure 2.17. : Concentration of sodium	79
Figure 2.19. : Concentration of calcium	81
Figure 2.20. : Concentration of magnesium	83
Figure 2.21. : Concentration of chloride	85
Figure 2.22. : Total coli form bacteria	85
Figure 2.23. : Faecal coli form	87
Figure 2.24. : Escherichia coli (E. coli)	88
Figure 2.25. : MPN of bacteria	91

(xv)

List of Abbreviations

NTU : Nephelometric turbidity units

TDS : Total dissolved solids

TSS : Total solvent solids

EC : Electrical conductivity

T.H : Total Hardness

WHO: World Health Organization

UNESCO: United Nations Education Science and Cultural
Organization

MPN : most probable Number

BOD : Biochemical Oxygen Demand

COD : Chemical Oxygen Demand

(xv)



