Drinking Water Quality for Al-Mustansiriya University

Faaeza Ahmed Abd Al-Kareem
Building &Construction Engineering Department, University of Technology/Baghdad
Email: ahmedfaeeza@yahoo.com

Received on 10/5/2012 & Accepted on 4/4/2013

ABSTRACT

The aim of the research is to study water quality in Al-Mustansiriya university, which is supplied by water through a4 inch diameter pipe, water collected in a very old ground tank supplying water to the university departments which have their only tanks.

Samples of water from the main pipe and for each department in the university were taken for seven months (Jan. 2011 -Jul. 2011) Physical, chemical and bacteriological tests have been done.

Residual chlorine reduced as the temperature increased during the year .Samples from Arabic language department show the less residual chlorine content. Turbidity readings did not apply to the Iraqi and WHO standards because the ground tank contains large amount of sediments and was not cleaned for a long time , maximum turbidity reading was 6.8 NTU.

The samples were analyzed also to find the chemical properties such as heavy metals (Fe, Cu, Pb, Zn) and other parameters of water (TDS, CL, Na, S.S, pH, Mn, Ca) .Iron was the heavy metal which was found in large concentrations that exceeded the Iraqi and WHO standards because of the corrosion inside the ground tank, maximum iron reading was 8.4 mg/l. The percent of samples exceeding the standard limits for sodium, sulphate, chloride, hardness 55, 9.04, 6.19, and 5.71 % respectively.

Bacteriological examinations of water (total coli form, E coli, and total plate count) show good results although some bacteria were detected but still within the allowable limits, this is attributed to the present of residual chlorine and the continuous feeding of water supply due to high consumption of water.

دراسة نوعية مياه الشرب للجامعة المستنصرية

الخلاصة

https://doi.org/10.30684/etj.31.11A7
2412-0758/University of Technology-Iraq, Baghdad, Iraq

الهدف من البحث هو دراسة نوعية مياه الشرب للجامعة المستنصرية حيث تتغدى الجامعة من انبوب قطره ٤ انج يصل الى خزان قديم جدا يصل الى اقسام الجامعة يغذي عن طريق خزانات موجودة في سطح كل قسم من الاقسام . نماذج الماء جمعت من مصدر الماء الرئيسي ومن داخل كل قسم من اقسام الجامعة ,نتائج الفحوصات فيزياوية,كيمياوية وبكتريولوجية بينت ان تركيز الكلور يتغير بالنسبة للماء المجهز ويقل بارتفاع درجة الحرارة ويكون قليل بالنسبة لقسم اللغة العربية .
اما بالنسبة للكدرة فقد سجلت قراءات مخالفة للمواصفات الصحة العالمية والمواصفات العراقية وذلك بسبب الخزان الارضي الذي يحتوي على كميات من الاطيان ولم ينظف منذ فترة طويلة , سجلت اعلى قيمة للكدرة ٦,٨NTU. تم تحليل النماذج للايجاد الخواص الكيمياوية مثل تراكيز المعادن الثقيلة الحديد ,النحاس , الرصاص , الزنك والمتغيرات الاخرى المواد الصلبة الكلية ,الكلوريد , الصوديوم , المواد العالقة , الرقم الهايدروجيني والمنغيز فقد كان عنصر الحديد اكثر العناصر الثقيلة الذي سجل اعلى قيم مخالفة للمواصفات الصحة العالمية والعراقية حيث سجلت اعلى قيمة للحديد 8.4 mg/l اماعدد النماذج الخارجة عن الحدود المسموح بها للصحة للعناصر صوديوم , الكبريت , الكلوريد , العسرة ٥٥, ٩,٠٤١ ,٦,١٩٨ ,٥,٧١ % بالتتابع . الفحوصات البكتريولوجية للماء والتي شملت الكوليفورم , بكتريا القولون , العدد الكلي للبكتريا بينت نتائجها بانها جيدة بالرغم من ظهور عدد قليل من البكتريا والتي كانت ضمن الحدود المسموح بها وهذا يرجع الى وجود الكلور كعامل رئيسي في قتل البكتريا وتجدد الماء نتيجة الاستهلاك اليومي.

INTRODUCTION

Water is an essential element in the maintenance of all forms of life, and most living organisms can survive only for short period without water. This fact has resulted in the development of direct relationships between abundance of water, population density, and quality of life[1].The water supply for domestic and public purposes should be high in quality concerning its, physical, chemical, biological and radiological properties[2]. Distribution systems are especially vulnerable to contamination when the pressure falls, particularly in the intermittent supplies of many cities in developing countries. Suction is often created by direct pumping from the mains to private storage tanks, a practice which should be prohibited [3]. Water storage tanks are widely used which are fed with tap water from the main distribution system. These tanks must be inspected for deterioration and for infiltration of surface water and ground water. It is desirable for the land enclosing underground storage tanks to be fenced off, both to prevent access by people and animals and to prevent damage to the structures [4].

WATER QUALITY AND HEALTH

The term 'Water Quality' is a widely used expression which has an extremely broad spectrum of meanings .Water, must be aesthetically acceptable for drinking as it should be free from apparent turbidity, odor and from objectionable taste with reasonable temperature. Such water is termed 'potable', meaning that its quality has no concern for adverse effect on health [5]. The relationship between water quality and health effect has been studied throughout;

- Physical health effect

- Chemical health effect
- Bacteriological health effect

Physical Health Effect

The fact that physical contamination is normally associated with acute effects, places them in a lower priority category than microbial contaminants .The physical indicator involves taste, odor, turbidity and color. [5]

Temperature

The ideal temperature of drinking purpose in 15-12C^{o} above 25C^{o} water is not recommended for drinking [6].

Turbidity

The appearance of water with turbidity of less than 5NTU is usually acceptable to consumers, although this may vary with circumstances. The consumption of highly turbid water may constitute a health risk because excessive turbidity can protect pathogenic microorganisms from the effects of disinfectants. [7].

Odor and Taste

The taste and odor of drinking water should not be offensive to the consumer .However there is enormous variation in level and quality of taste and odor that are regarded as acceptable [8].

Chemical Health Effect

The health risk due to toxic chemicals in drinking water differs from that caused by microbiological contaminants. There are few chemical constituents of water that can lead to acute health problems expect through massive accidental contamination of supply [9].

Chlorine

Exposure to chlorine, hypochlorous acid, and hypochlorine ion through ingestion of household bleach occurs most commonly in children [10]. Intake of a small quantity of bleach generally results in irritation of esophagus, burning sensation in mouth and throat, and spontaneous or the extremely causic nature of the bleach that causes the tissue injury [11].A increased risk of bladder cancer appeared to be associated with the consumption of chlorinated tap water in a population based case control study of a adults consuming chlorinated or non chlorinated water for half of their lifetimes [12].

PH

Eye irritation and exacerbation of skin discords have been associated with pH values greater than 11 [13].

Total Dissolved Solid (TDS)

Inverse relationships were reported between TDS concentration in drinking water and incidence cancer, coronary heart diseases, atherosclerotic heart disease and cardiovascular disease [14].

Suspended Solid (SS)

Reliable data on possible effects associated with the ingestion of suspended solid in drinking water are not available. The result of early epidemiological studies suggested that even low contentions of SS in drinking-water may have beneficial effects and defects in lipid and carbohydrate metabolism [15].

Hardness

Studies have suggested that a variety of diseases are also inversely correlated with hardness of water, including an encephaly and various types of cancer [16].

Sulfate

The major physiological effects from the ingestion of sulfate are cantharis, dehydration and gastrointestinal irritation. Water containing magnesium sulfate at level above 600mg/l acts a purgative in humans [17][18].

Chloride (Cl)

Chloride toxicity has not been observed on humans except in the special case of impaired sodium chloride metabolism e.g. incongesive heart failure [19].

Sodium (Na)

Sodium level is typically less than 200 mg/l .On the basis of exceeding this limit ,no firm conclusions can be drawn concerning the possible association between sodium in drinking water and the hypertension[20]

Manganese (Mn)

Although no specific manganese deficiency syndrome has been described in humans, an association between manganese deficiency and disorders such as anemia, bone changes in children, and lupus erythematosus has been suggested [21][22]

Nitrate (NO_3)

Congenital malformations has been related to high nitrate level in drinking water ,however their observations were not confirmed, other studies also failed to demonstrate a relationships between congenital malformations and nitrate intake[23].Studies relating cardiovascular effect to nitratate level in drinking water gave in consistent results[24].

Iron (Fe)

The average lethal dose of iron is 200-250 mg/kg of body weight, but death has occurred following the ingestion of doses as low as 40mg/kg body[25].Autopsies have shown hemorrhagic necrosis and sloughing of areas of mucosa in the stomach with extension into the submucoasa [26].

Lead (Pb)

Lead is accumulative general poison infants, children up to 6years of age, the fetus and pregnant women being the most susceptible to adverse health effects. Its effects on the central nervous system can be particularly serious [27].

Zinc (Zn)

Auto toxicity results from the ingestion of excessive amounts of zinc salts, either accidentally or deliberately as an emetic or dietary supplement [28]. It was concluded that in the light of recent studies on humans derivation of health based guideline value is not required at this time .However drinking water containing zinc at levels above 3mg/l tends to be opalescent develops a greasy film when boiled and has undesirable astringent taste [29] .

Copper (Cu)

The copper status of healthy liver during the first few months of life is comparable to a person suffering from disease. Infants are more sensitive to factors that threaten copper homoeostasis than are older children and adults [30].

Bacteriological Health Effect

The bacteriological imputes are caused by the presence in water of the pathogenic or disease. Producing any type of bacteria makes water dangerous for patient's consumption and health [31]. The pathogenic bacteria are generally inherent coliaerogenous or coliform group of bacteria called the Escheria coli (E.coli) [32].

Coliform bacteria

Coli form bacteria may not cause disease but is an indicator of pathogenic organisms that cause diseases. The latter could cause intestinal infections dysentery hepatitis, typhoid fever, cholera and other illness [33].

Escherichia coli (E.coli)

The detection of pathogenic subtypes of E.coli in water supply has seldom been attempt. Although this may be necessary in epidemiological research, the available methods are not suitable for the routine examination of water sample [34].

WATER QUALIY STANDRDS

Water quality criteria and standards are therefore necessary to ensure that the appropriate quality of resource is available to a particular consumer process. The related legislation is used as an administrative mean to manage and maintain water quality for the maximum number of users of the water body. Water quality vary and standards originate in a number of possible ways; there are international standards set by the World Health Organization WHO [35] and Iraqi Central for Standardization and Quality Control [36].

Table (1) Water Quality Standards WHO 2010and (ICSQ) 2001. [35] [36].

Characteristics	Units	WHO	Iraqi
Physicals			
Color	C.U	20	10
Temperature	C^{o}	25	
Turbidity	NTU	5	5
Chemicals			
Chorine	mg/l	0.1-2	0.1-1.5
Total dissolved solid	mg/l	1500	1500
Sodium	mg/l	150	200
Sulphates	mg/l	100	200
pH		6.5-8.5	6.5-8.5
Nitrates	mg/l	50	50
Manganese	mg/l	0.5	0.1
Chloride	mg/l	250	200
Suspended solid	mg/l	0	0

Hardness	mg/l	60	500
Iron	mg/l	0.5	0.2
Copper	mg/l	0.1	0.1
Zinc	mg/l	0.1	0.1
Fluoride	mg/l	1	1
Lead	mg/l	0.01	0.01
Microbiological			
Total coliform	MPN/100ml	0	5
E.coli	MPN/100ml	0	0
Total plate count	Number	50	10

FIELD WORK AND SAMPLING

Samples of water have been taken from Al-Mustansiriya University in order to study the water quality of the supplied water to the different departments. Water is pumped from the main distribution system through a 4inch pipe to an old ground tank with a storage capacity of100 m^3 then pumped to each department having two upper storage tanks with capacity 1m^3 .Chemical and physical tests have been done by the Sanitary laboratory/ University of Technology, where the bacteriological and heavy metal tests were done at the Ministry of Environment laboratory. The tube fermentation method was performed to estimate the bacterial quantities of water recording the result as most probable number MPN [37]. Heavy metals Fe, Zn, Cu, Pb were tested by using spectrophotometer according to the standard method examination [38].

RESULTIS AND DISCUSSION

The results obtained from fieldwork investigations of seven months in different weather conditions winter, spring and summer for the water supply systems in the university were analyzed using statistical programs. Relations between water parameters were obtained in order to know what is that most influencing parameter concentration in potable water and storage tanks.

Figures (1to7) show the residual chlorine for different locations in the university during the period of research from January to July .Residual chlorine values 1.3-0.7 mg/l this is attributed to the consumption of chlorine in water supply. The lowest residual chlorine observations are clear in the Arabic dept. The increase in temperature leads to decrease in the value of residual chlorine.

The wide variation in the level of turbidity throughout this period could be seen for the different units of the university. Figure (8) shows this variation, this clearly indicates that there is a high accumulation of sediments inside the ground storage tanks and roof tanks which need to be cleaned urgently. It is easy to see the high suspended solid (SS) observation which occur from January to July ,the maximum value of SS1reached 5.90 mg/l inside the university pipe system because of high accumulation of sediments inside the ground storage tank and roof tanks.

Figure (9) represents the average heavy metals concentrations during the study period .The average iron concentration increased from 4.5 to 7.5 mg/l indicating the corrosions in the ground tank and the concentration increased with temperature

increasing .This concentration exceeded the Iraqi and WHO standards. Concentrations of other heavy metals were within the standards.

Figure (10) represents the average concentrations parameter TDS, SO_4, Mn, Cl, hardness, during the study period. Seepage also may happen to ground water tanks when increase the concentrations of element.

Figure (11) shows the relationship between TPC, turbidity and chlorine the raise of total plate count due to the raise of turbidity because of the sediment accumulation in the ground of the storage tank as this may lead to decrease residual chlorine concentration.

Table (2) shows the statistical description of the data for Al-Mustansiriya University . It has be notated the variation in the maximum total dissolved solid inside the university reached TDS1 97 mg/l and the maximum total dissolved solid TDS2 980 mg/l because of the large size of tanks which fill with water continuously and then evaporated leaving concentrated perecent of salts.

The percent of samples that exceeded the health limits for sodium ,sulphats , chloride , hardness were 55, 9.04 ,6.19 ,5.71 % respectively .

The manganese (Mn) concentration was within the allowable limits.

It has been noted the variations in the pH values measured were very little, values of the of main supply these values are within allowable limits. Maximum value for pH_1 inside university 8.9, the increasing in the pH value because of the corrosions in the ground tank.[5]

As for temperature, it varied through the study period and reached 40-56C^o in July.

Table (3) shows the statistical analysis for the heavy metals Fe, Cu ,Pb, Zn for the inside and main water supply for Al-Mustansiriya University, the maximum value for Fe_1 inside university 8.4 mg/l because the storage tank manufactured from iron and the corrosions in the ground tank. , while the variance 1.2225 and standard division 0.5477.

Table (4) shows the bacteriological examination frequency analysis of the water supply for Al-Mustansiriya University and figure12 shows the frequency of the results. The results show that no coliform and E.coli bacteria were dictated in the supply water. As for the total plate count a maximum of 49 count /100 ml was measured .This is more than the standard limits which may be due to the sediment accumulate in the ground storage tank as this may affect the decrease residual chlorine recommended by lechavellier (1980).

CONCLUSIONS

According to the results, the conclusions can be summarized in the following items:

1- Residual chlorine values reached (0.1-0.2) mg/l, and these values are acceptable as the minimum allowable limits.
2- Seepage and evaporation lead to increase concentration levels of different measured parameters chloride, total suspend solid, hardness, sulphate , sodium ,manganese inside university .

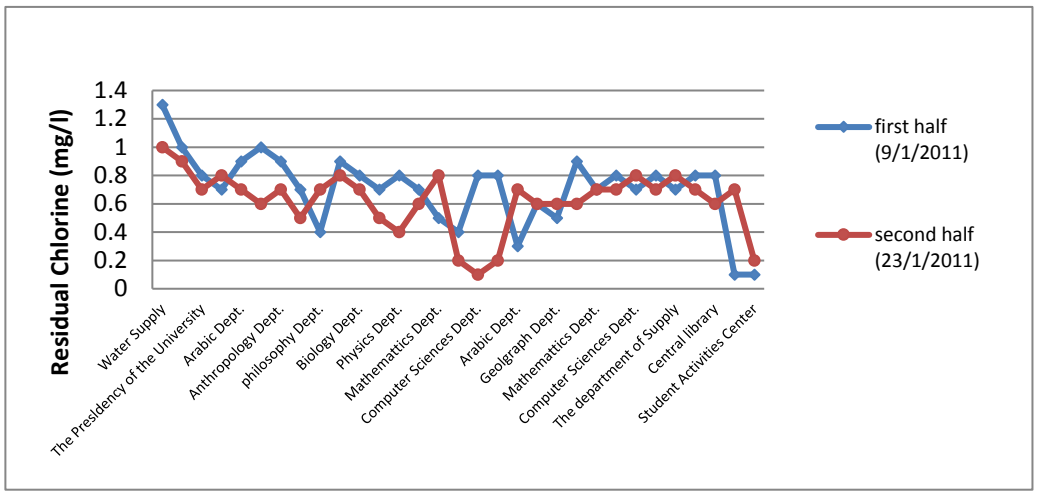
3- Iron was the heavy metals which found in large concentrations that exceeded the Iraqi and WHO standards because of the ground tank manufacture from iron and corrosion inside the ground tank
4- Turbidity level showed a wide variation and values not within the Iraqi and WHO standards for January to July ,this clearly indicates that there is a high accumulation of sediments inside the ground storage tank which needs to be cleaned urgently .
5- Bacteriological examination of water shows that water supply is with the allowable limits because of the presence of residual chlorine and the continuous feeding of water due to high consumption.
6- The water quality of Al-Mustansiniy University was with the allowable limits except for turbidity which reach 6.95 NTU and Fe concentrating reaching 8.4 mg/l.

REFERENCES

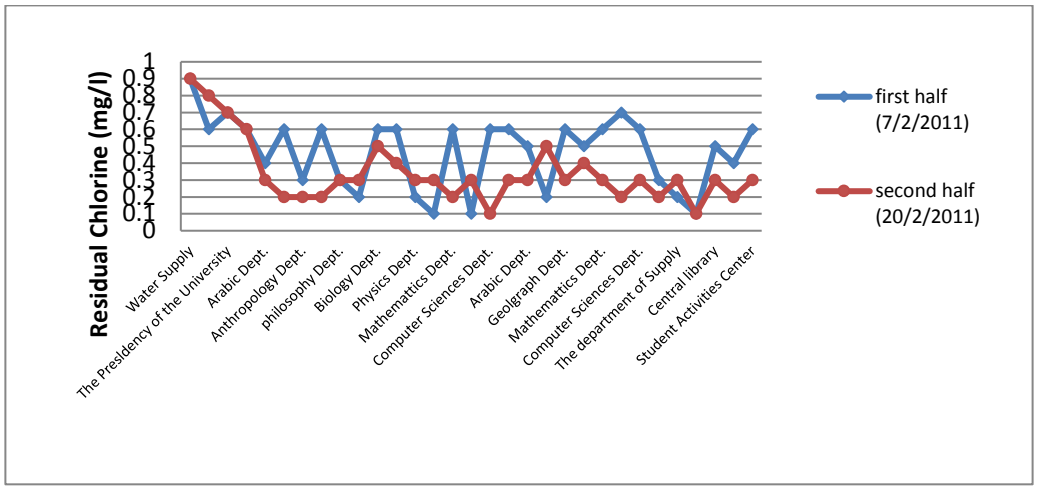
[1].Schroder, G.T., 1985, "water Quality" Characteristics. Modeling. Modification", Addison-Wesley.
[2].Department of National Health and Welfare, Canada, "Water Treatment Principles and Applications": A manual for production of Drinking -Water "1993.Ottawa, Canadian Government Publishing Centre.
[3].Visscher J. T., et al. 1987 "Slow Sand Filtration for Community Water Supply ". The Hague, International Reference Centre for Community Water Supply, (Technical paper series no. 24)
[4].Duggal, K.N., 1997,"Elements of Environmental Engineering", fifteen edition, Sichand and Company LTD,L.
[5].World Health Organization, "Guidelines for Drinking Water Quality"1997, 2nd ed., Vol.2, Amman, Jordan.
[6].World Health Organization,"Surveillance of Drinking Water Quality", 2000, 4th ed., Vol.4, Amman, Jordan.
[7].Elliot,T. 1986,"Turbidity the Final Element in Assessing Water Quality", J.AWWA ,Vol. 130, No.10.
[8].De Greef, Krasner, SW, 1983,"Drinking Water Contamination and Taste Assessment by Large Consumer Panels", Water Science and Technology, 15(6/7):13-24.
[9].Raju, R.S.N.,"Water Supply and Wastewater engineering", 1995, McGraw publishing company limited, New York.
[10].Alley, E.R., 2000" Water Quality Control Hand Book ", P.E. McGraw Hill, INC.
[11].Cario, P.R., Lee R.G.Aptowicz, B.S., 1988" Is your Chlorine Safe to Drink", J.AWWA., VOL.19, NO.17
[12]. Cantor, KIP, 1996 "Bladder Cancer Drinking Water Sources and Tap Water Consumption : A Case Control Study", J. Environmental Health perspective., VOL 70, NO.20.

[13]. Rose P., 1986," Alkaline pH and Health are view Prepared for the Water Research Centre "(Water Research Center Report NO.LR 1178-M).
[14].Eckenfelder, W.W.Jr., 1980, "Principles of Water Quality Management "W.Wesley, Eckenflder Jr.
[15].Sawyer CN, MC Carry PL. ", 2006 "Chemistry for Sanitary Engineer,2nd ED., New York ,Mcgraw-hill
[16].Crawford MD, Gardner MJ, 2004 "Infant Mortality and Hardness of Local Water Supplies ",, Sedgwick PA.
[17]. National Academy of Sciences," Drinking Water and Health ", 2009, Washington, DC, National Research Council.
[18]Bean EL., 1992, "Potable Water Quality Goals "J.AWWA, 22,34,12
[19]. Zateman BCJ., "Sensory assessment of Water Quality " 2006,New Yourk,NY,
[20].Sittig M., 1999,"Hand Book of Toxic and Hazardous Chemicals and Carcinogen", 2nd.prak .Ridge, NJ, Noyes publications.
[21].Griff AE., 1988 .," Significances and Removal of Manganese in Water Supplies", J.AWWA. ,52:19:29
[22].Hurley ls,Keen cl., 1987, Manganese. In: Mertz n,Ed. "Trace Elements in Human and Animal Nutrition", ,VOL.1,5th ed .New Yourk ,Ny, Academic Press.
[23].ICAIR Life Systems,Inc. 1987," Drinking Water Criteria Domument on Nitrate Nitrite",Office of Drinking Water
[24].International Organization For Standardartion.," 1986,Water Quality Determination of Nitrate "..,Geneva
[25].Finch CA ,Monsen ER.," 1998 ,"Iron Nutrition and the Fortification of Food with Iron ", ,J.American Medical Association,219:26 :34
[26].International Organization For Standardization., 1988, "Water Quality Determination of Iron", Geneva,(iso 6332:1988)
[27].Sherlock JC,1991, "Reduction in Exposure to Lead From Drinking Water and its Effect on Blood Lead Concentration"., ,Journal Environmental Health,52:346
[28].Yamagunchi M, Takashi k, Okavda s. ,"Zinc Induced Hypocalcemia and Bone Resorption in Rats",1983, Toxicology and Applied Pharmicalogy, 67:224-228
[29].Smith RM,1988 ,"Zinc Deficiency in Geophagia in Turkish Children and response to treatment with Zinc"Haematologica
[30].Fiberg l., Nordberg gf.,V ouk VB,1998,EDS Copper.in: Handbook on the Toxicology of Metals", ,Amsterdam, Elseveier,
[31].Singleton, P., 1997,"Bacteria in Biology Biotechnology and Medicine ", 4th, Edition,John Wiely &Sons.
[32]. Department of Health and Social Security, 1988 "The Bacteriological Examination of Drinking –Water Supplies ", London, Majestys Stationery Office.
[33].Dulka,B.j., and Vega,Lapez, 1989, "Potable Water Safety Assessed By Coliphage and Bacteria Test",Water Research ,Vol.33,No.2.
[34].Mcdaniels ,A.,E., and Bordner, R., 1983, "Effecting of Holding Time and Temperayure on Coliform Number in Drinking Water ", J.AWWA,Vol.75, No.9

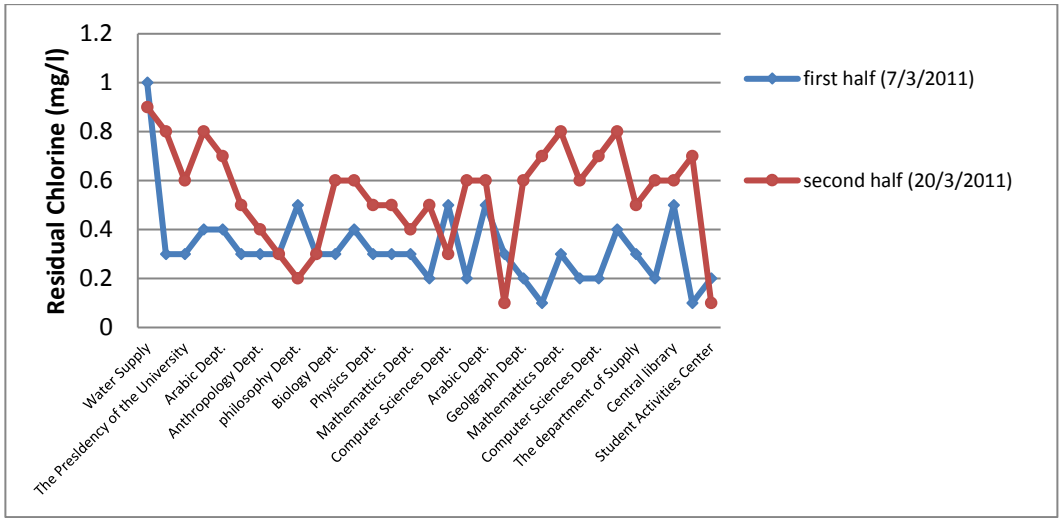
[35].International World Health Organization ,2010," Drinking Water Standards ",www.Drinking Water Standards/inenviro/water quality
[36]. Iraqi Central Organization for Standarization,2001,(Cited by the Ministry of Health ,Environment Law),pp.41-53,No.417
[37].Taylor, Edwin Windle, 1958,"The Examination of Water and Water Supplies" ,7th Edition ,j, and A. Churchill LTD, London .
[38].Standard Methods for the Examination of Water and Waste Water (1985), Sixtieth Edition, Prepared and Published Joint by: APHN, AWWA, WPCF.
[39].Lechavelier, M.W., and Sedler ,R. 1980," Enumeration and Characterization of Standard Plate Count Bacteria in Chlorinated and Row Water Supplies", J.AWWA .Vol.22.No.10.



Figure(1)Shows residual chlorine for different locations in the university in Jan 2011.



Figure(2), Shows residual chlorine for different locations in the University in Feb2011.



Figure(3) Shows residual chlorine for different locations in the University in March 2011.

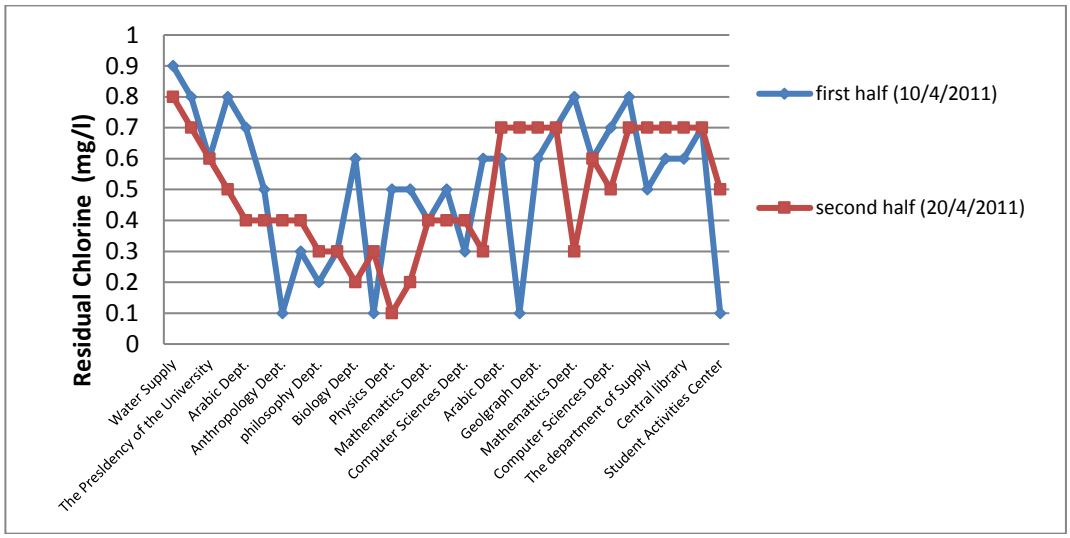
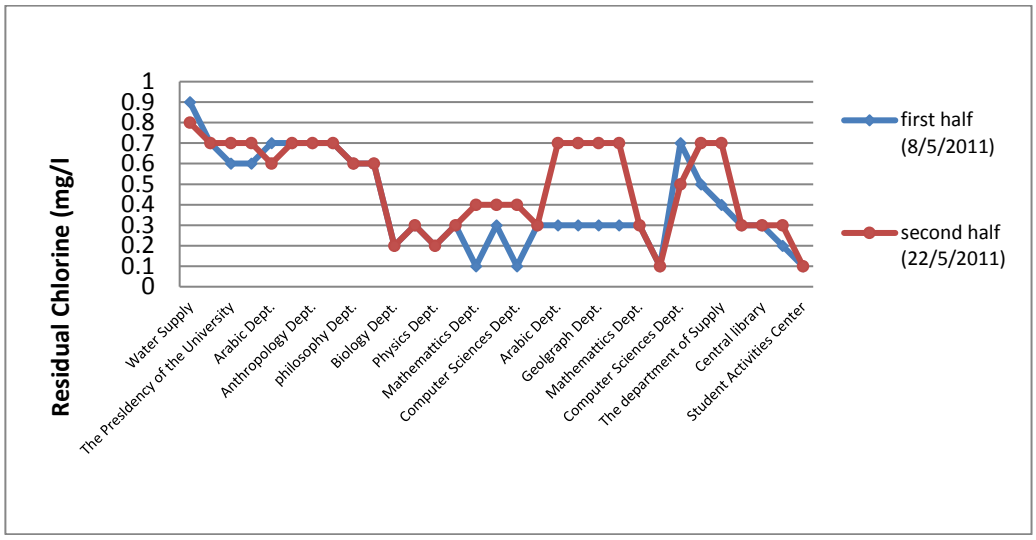


Figure (4) Shows residual chlorine for different locations in the University in April 2011.



Figure(5) Shows residual chlorine for different locations in the university in May2011.

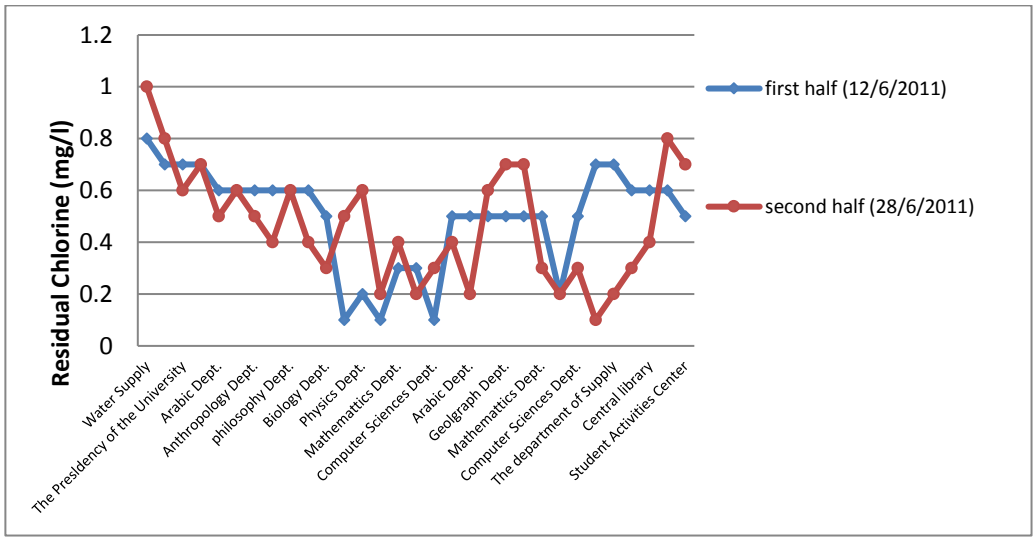


Figure (6) Shows residual chlorine for different locations in the University in June1 2011.

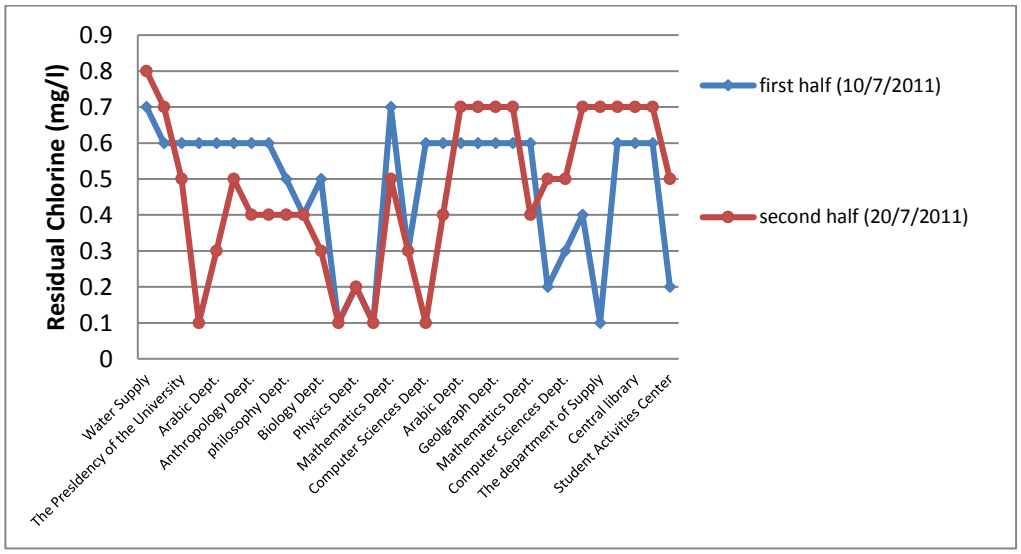


Figure (7) Shows residual chlorine for different locations in the university in July 2011.

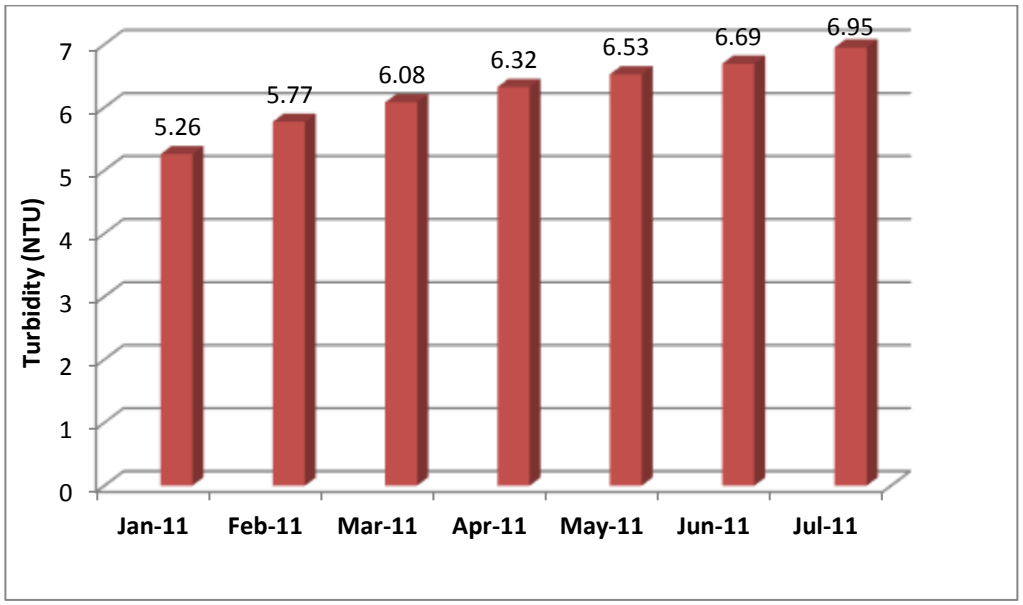


Figure (8) Average Turbidity of Drinking Water during (Jan-Jul).

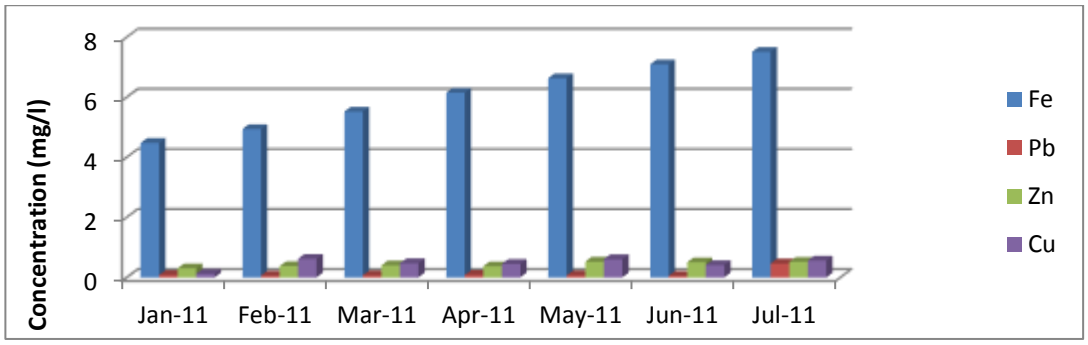


Figure (9) Average Heavy Metals of Drinking Water During (Jan-Jul).

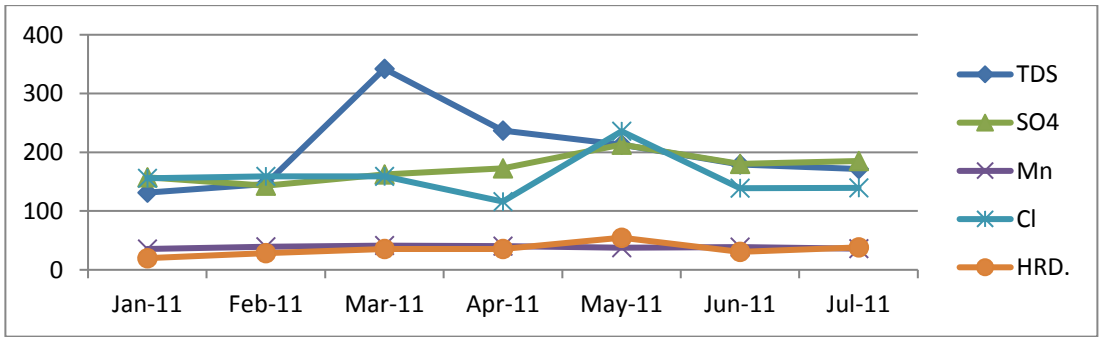


Figure (10) Average Parameters of Drinking Water during (Jan-Jul).

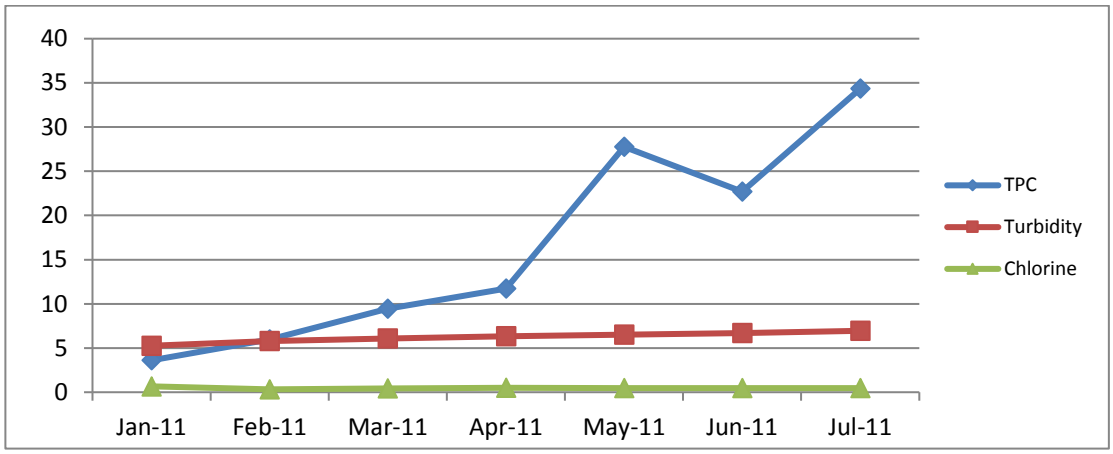


Figure (11) Relationship between TPC, Turbidity and Chlorine of Drinking Water During (Jan-Jul).

Table (2) Descriptive Statistics for Al-Mustansiriya University.

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Total Dissolved Solids1	420	952.00	28.00	980.00	92193.00	219.5071	183.72447	33754.680
Total Dissolved Solids2	14	92.00	5.00	97.00	312.00	22.2857	23.46988	550.835
Sodium1	420	693.00	17.00	710.00	72334.00	172.2238	84.87999	7204.613
Sodium2	14	30.00	3.00	33.00	229.00	16.3571	8.50888	72.401
Sulphates1	420	758.00	22.00	780.00	74562.00	177.5286	67.21132	4517.362
Sulphates2	14	34.00	10.00	44.00	323.00	23.0714	9.82512	96.533
Manganese1	420	.19	.01	.20	32.78	.0780	.04618	.002
Manganese2	14	.01	.01	.01	.13	.0096	.00134	.000
Chloride1	420	656.00	11.00	667.00	63900.00	152.1429	86.76605	7528.347
Chloride2	14	24.00	12.00	36.00	320.00	22.8571	8.62784	74.440
Hardness1	420	180.00	10.00	190.00	14882.00	35.4333	20.81141	433.115
Hardness2	14	21.00	2.00	23.00	147.00	10.5000	6.09855	37.192
Chlorine1	420	.90	.10	1.00	199.70	.4755	.21438	.046
Chlorine2	14	.60	.70	1.30	12.90	.9214	.14239	.020
Temperature1	420	44.00	12.00	56.00	13302.00	31.6714	9.96517	99.305

Temperature2	14	30.00	10.00	40.00	383.00	27.3571	10.95871	120.093
pH1	420	2.50	6.40	8.90	3117.79	7.4233	.48500	.235

Heavy metals	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic

pH2	14	1.40	6.50	7.90	97.90	6.9929	.41037	.168
Suspended Solids1	420	5.90	.00	5.90	935.98	2.2285	1.26576	1.602
Suspended Solids2	14	.00	.00	.00	.00	.0000	.00000	.000
Turbidty1	420	6.80	1.00	7.80	2169.60	5.1657	1.33347	1.778
Turbidty2	14	2.19	.70	2.89	20.75	1.4821	.70308	.494
Nitrate1	420	.89	.01	.90	28.83	.0686	.04431	.002
Nitrate2	14	.02	.01	.02	.22	.0161	.00561	.000

N= No. of samples.
1= samples inside the university.
2= samples for main water supply outside the university.

Table (3) Heavy Metals Descriptive Statistics.

Fe1	420	4.40	4.00	8.40	2623.20	6.2457	.05477	1.12250
Fe2	14	.05	.01	.05	.24	.0171	.00318	.01188
Pb1								.04432
Pb2								.01088
Zn1								.29660
Zn2								.01555
Cu1								.01422
Cu2								.01267

Total Plate Count

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	7	3.2	3.2	3.2
	2.00	1	.5	.5	3.7
	3.00	4	1.8	1.8	5.5
	4.00	5	2.3	2.3	7.8

Table (4), Bacteriology data Frequency Analysis

Statistics

		T.P.C.	Coli form	E.Coli
N	Valid	217	217	217
	Missing	0	0	0
Std. Error of Mean		.77688	.00000	.00000
Std. Deviation		11.44412	.00000	.00000
Variance		130.968	.000	.000
Range		49.00	.00	.00
Minimum		.00	.00	.00
Maximum		49.00	.00	.00

Frequency Table

Coli form

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	217	100.0	100.0	100.0

E.Coli

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	217	100.0	100.0	100.0

	5.00	5	2.3	2.3	10.1
	6.00	5	2.3	2.3	12.4
	7.00	9	4.1	4.1	16.6
	8.00	10	4.6	4.6	21.2
	9.00	9	4.1	4.1	25.3
	10.00	12	5.5	5.5	30.9
	11.00	12	5.5	5.5	36.4
	12.00	16	7.4	7.4	43.8
	13.00	10	4.6	4.6	48.4
	14.00	10	4.6	4.6	53.0
	15.00	2	.9	.9	53.9
	16.00	12	5.5	5.5	59.4
	17.00	3	1.4	1.4	60.8
	18.00	10	4.6	4.6	65.4
	19.00	11	5.1	5.1	70.5
	20.00	7	3.2	3.2	73.7
	21.00	2	.9	.9	74.7
	22.00	2	.9	.9	75.6
	23.00	2	.9	.9	76.5
	24.00	3	1.4	1.4	77.9
	25.00	2	.9	.9	78.8
	26.00	3	1.4	1.4	80.2
	27.00	2	.9	.9	81.1
	28.00	4	1.8	1.8	82.9
	29.00	5	2.3	2.3	85.3
	30.00	3	1.4	1.4	86.6
	31.00	1	.5	.5	87.1
	32.00	1	.5	.5	87.6
	33.00	1	.5	.5	88.0
	35.00	2	.9	.9	88.9
	36.00	1	.5	.5	89.4
	38.00	2	.9	.9	90.3
	39.00	4	1.8	1.8	92.2
	40.00	3	1.4	1.4	93.5
	41.00	2	.9	.9	94.5
	42.00	3	1.4	1.4	95.9
	44.00	3	1.4	1.4	97.2
	45.00	2	.9	.9	98.2
	46.00	3	1.4	1.4	99.5
	49.00	1	.5	.5	100.0
	Total	217	100.0	100.0	

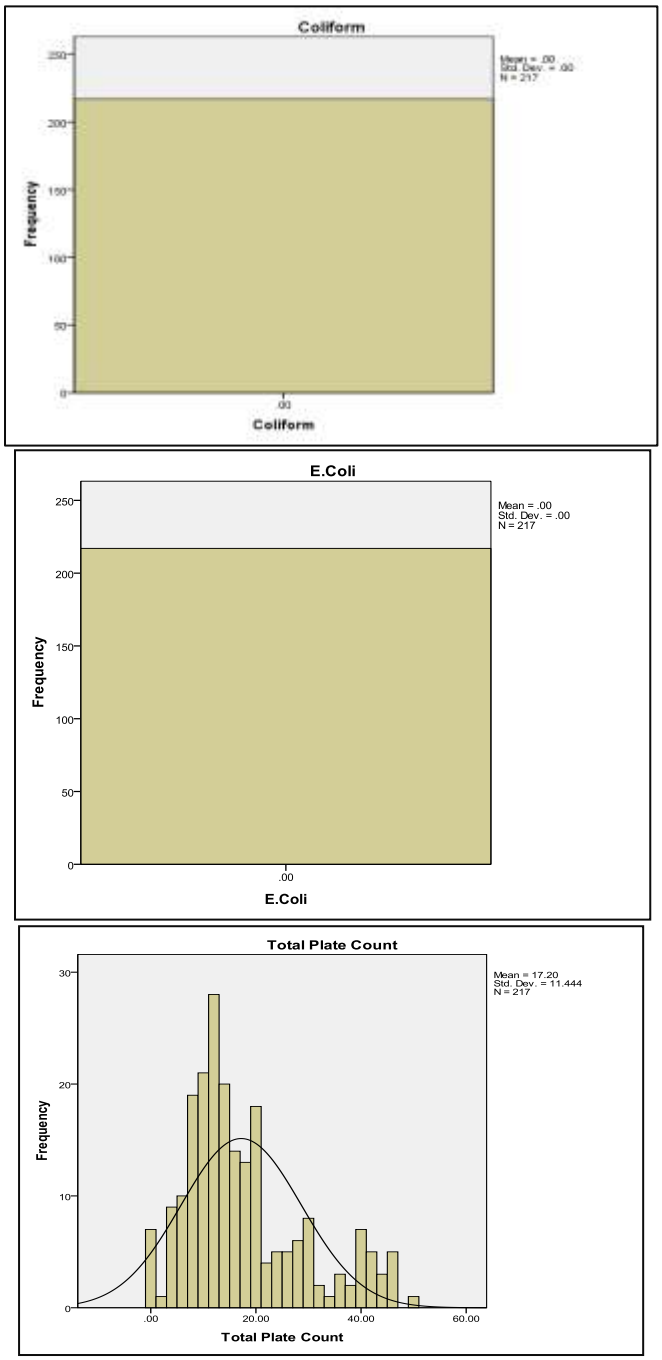


Figure (10) Bacteriological Tests of Water Supply in Al- Mustansiriya University.