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*Full Length Research Paper*

# Microbial, Physical and Chemical Quality of Water Used in Dental Chair Units (DCUs) in Makkah Primary health care Center, Saudi Arabia

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**This study was carried out to assess quality of water used in Dental Chair Units (DCUs) in Makkah Primary health care center (PHCC), Saudi Arabia. Out of thirty Primary health care center located inside Makkah city, and used Desalinated sea water. The findings of this study revealed that maximum concentration of Potassium (K) was 2.6 mg in sample from Prince Ahmed Primary health care center (PAPPHCC) inside Makkah while the minimum amount was zero which was found in dental units of Bahra (PHCC) outside Makkah. The findings of this study revealed that maximum concentration of K (2.6), Na (17.9), F (0.73), Cu (0.52), NO<sub>2</sub> (0.012), SO<sub>4</sub>(10), Fe(36), NO<sub>3</sub> (12.5), Mg (6.38), Ca (40) and Cl (68) (mg/l) respectively, while the maximum concentration of total hardness (TH) and total dissolved solids (TDS) was 40 and 109 (mg/l) respectively. All water samples were found free of sediments except one sample. Coliforms were detected in all water samples within permissible limits. In conclusion, chemical parameters did not exceed the permissible limits according to the Saudi Arabia standards of drinking water.**

**Keywords:** Microbial, physical, chemical, water, dental, Makkah

## INTRODUCTION

Health services are provided within the city of Makkah through ten general and specialized hospitals in addition to thirty- Primary health care center and forty five health centers around the holy city of Makkah. In each Primary health care center there is Dental Clinic contains Dental chair units. Dental chair units (DCUs) contain integrated systems that provide the instruments and services for a wide range of dental procedures. DCUs use water to cool and irrigate DCU-supplied instruments and tooth surfaces during dental treatment. Water is supplied to these instruments by a network of interconnected narrow-bore (2–3 mm) plastic tubes called dental unit waterlines

(DUWLs) (Coleman et al., 2009).

Most dental units inside Makkah are connected directly to municipal distribution systems for potable water; which are desalinated from sea water by Desalination station, unlike water used in most dental units outside makkah, even if chlorinated; this water hosts a diverse micro flora of bacteria, yeasts, fungi, viruses, protozoa, unicellular algae and nematodes (Jean, 2000). The water quality regulations provide a legal definition of the 'wholesomeness' of potable water, and include a number of chemical and microbiological parameters (Smith and Hood, 2001). Water is used as an air turbine coolant for

washing purpose when teeth are scraped or extracted and also for mouth rinsing and gargling (Banginwar and Dawande, 2014). The quality of dental unit water is of considerable importance since patients and dental staff are regularly exposed to water and aerosols generated from the dental unit (Caroline and Johnson, 1998). Dental patients and dental healthcare providers (DHCPs) are exposed to pathogenic microorganisms including viruses, such as Hepatitis B and Hepatitis C virus and human Immunodeficiency Virus, bacteria, such as Mycobacterium tuberculosis and staphylococci, and other microorganisms, which colonize or infect the upper aerodigestive tract or recirculate in blood (Giuseppe et al., 2013). Microbiological control of water quality in dental unit waterlines is extremely significant for patients and dental personnel. The quality of dental water is of considerable importance since patients and dental staff are regularly exposed to water and aerosols generated from the dental unit (Jolanta, 2003). In the other hand, the quality accreditation in the health services has become the main concern in most countries of the world, and it is used as a way to improve the quality of health care, Khoja, Tawfik A, (2011). The guidelines of the Centers for Disease Control (CDC) for dental healthcare settings recommend that the water used for routine dental treatment meet regulatory standards for drinking water established by Environmental Protection Agency (EPA) (Laura et al., 2014). In Makkah Primary health care center started to evaluate the water quality annually within the preparation of some of the centers for accreditation program to meet the (full name of CBAHI) CBAHI standards.

## MATERIALS AND METHODS

### Study settings

The study was carried out in 15 dental units at health centers inside Makkah City, Saudi Arabia namely Altaniem, Red Crescent, Almansour, Annakkasa, Almaabada, Annouria, Alameer Ahmed, Alhafair, Jarwal, GabalAnnour and Alezizia Elshargia, Aladl, Alkaakia, Alezizia Elgarbia, Sharie Alhaj and three health centers around Makkah City for comparing Bahra, Hada, Algamoom.

### Sampling

Eighteen samples were obtained from the dental units of studied health centers in sterile bottles in hygienic condition as the standard requirements of drinking water for physical, biological and chemical examinations. The sample bottles were clearly labelled and the required information was recorded in a form and supplied with the sample.

### Laboratory analysis

Analysis was carried out for various water quality parameters such as taste, odour, color, turbidity, conductivity, PH, sediments, total dissolved solids (TDS) and total hardness (TH), in addition to some heavy metals and minerals such as calcium (Ca), magnesium (Mg), chloride (Cl), iron (Fe), nitrate (NO<sub>2</sub>), nitrite (NO<sub>3</sub>), fluoride (F). TDS meter was used to measure the total dissolved solids while pH is measured by a pH meter. Concentrations of chemicals were measured using standard methods (WHO, 1998). Also bacteriological examination was done to detect microbial contamination with intestinal bacteria.

## RESULTS

The findings of this study revealed that maximum concentration of K (2.6), Na (17.9), F (0.73), Cu (0.52), NO<sub>2</sub> (0.012), SO<sub>4</sub> (10), Fe (36), NO<sub>3</sub> (12.5), Mg (6.38), Ca (40) and Cl (68) (mg/l) respectively, while the maximum concentration of TH and TDS was 40 and 109 (mg/l) shown in table 1. In table 2, the conductivity, pH, turbidity, and sediments of water samples from all dental units are listed, where minimum level of conductivity (2.7mg/l) was observed in Bahra and maximum of 228 in Algamoom, the minimum pH was 6.71 in Algamoom.

Maximum of 7.65 in Annouria, minimum turbidity was 0.378 found in Bahra and maximum one 64 found in Algamoom. All water samples were found free of sediments except sample from dental unit of Algamoom health centers which was found to be 0.396. Bacteriological examinations for water contamination with intestinal bacteria in all water samples was similar result for count which was (2.2).

**Table 1.** Chemical parameters of water used in Dental Chair Units in Makkah, Saudi Arabia

(mg/l)	K	Na	F	Cu	No <sub>2</sub>	So <sub>4</sub>	Fe	No <sub>3</sub>	Mg	Ca	Cl	T.H	TDS
Altaniem	1.4	9.5	0.17	0.1	0.007	1.3	0.02	4.4	1.232	20.8	56.4	20	59
Red Crescent	2.1	11.5	0.2	0.113	0.004	3.4	0.09	4.5	6.384	12.48	54	20	67
Almansour	0.7	9.9	0.02	0.12	0.003	9.8	0.08	3.8	1.12	16	44	20	62
Annakkasa	0.5	8.5	0.23	0.29	0.008	2.8	1.15	7.2	2.576	15.2	47.2	20	56
Almaabada	0.4	8.2	0.08	0.08	0.004	1.2	0.06	7.1	1.232	17.6	48.4	20	58
Annouria	0.5	13.1	0.21	0.1	0.006	2.7	0.19	8.2	4.032	14.88	51.6	20	65
Alameer Ahmed	2.6	17	0.1	0.1	0.003	5	0.04	5.4	1.68	10.56	32.4	20	72
Alhafair	0.4	6.2	0.01	0.118	0.002	1.3	0.032	7.3	2.8	17.12	52.8	20	52
Jarwal	0.2	2.3	0	0.09	0.002	2.1	0.312	6.8	0	1.6	4	0	14
GabalAnnour	0.6	8.4	0	0.194	0.012	5.4	0.178	9.9	2.128	16.48	48.8	20	62
AleziziaElshargia	.07	12.4	0	0.042	0.001	3.3	0.04	8.5	1.456	16.48	46.4	40	70
Aladl	1.8	10.8	0.58	0.522	0.003	0.4	0.03	11.5	2.24	17.6	52	20	78
Alkaakia	1.4	9.4	0.73	0.096	0.001	1.3	0.02	7.5	2.24	20.8	60	20	60
AleziziaElgarbia	0.4	9.5	0.31	0.058	0.001	0.7	0.025	7.4	3.36	25.6	76	20	61
SharieAlhaj	0.3	8.6	0.34	0.093	0.003	1.4	0.36	6.9	1.12	25.6	68	20	55
Bahra	0	0	0	0.08	0.002	1.8	0.01	8	0	0	0	0	1
Hada	0.9	13.2	0.05	0.045	0.004	10	0.148	8.8	3.36	20.8	64	20	74
Algamoom	1.2	17.9	0.07	0.044	0.002	14.4	0.043	12.5	2.688	22.24	65.2	40	109
<b>WHO Accepted range (&lt;)</b>	<b>20</b>	<b>175</b>	<b>1.5</b>	<b>2</b>	<b>3</b>	<b>250</b>	<b>0.3</b>	<b>50</b>	<b>150</b>	<b>200</b>	<b>250</b>	<b>500</b>	<b>1000</b>

**Table 2.** Physical properties of water used in dental centers in Makkah Almokrramah, Saudi Arabia

Dental center	Cond. mS/cm	pH	Turbidity(NTU)	Sediments
Altaniem	126	7.22	0.501	0
Red Crescent	143.1	7.04	0.788	0
Almansour	131.5	7.36	0.637	0
Annakkasa	117.3	7.62	8.68	0
Almaabada	123.6	7.4	0.737	0
Annouria	148.6	7.65	0.536	0
Alameer Ahmed	152.6	7.24	0.685	0
Alhafair	111	7.4	0.435	0
Jarwal	29	7.04	0.852	0
GabalAnnour	128.9	7.57	7.32	0
AleziziaElshargia	149.5	7.7	0.534	0
Aladl	140.7	7.53	0.577	0
Alkaakia	129	7.17	0.302	0
AleziziaElgarbia	132	7.33	0.252	0
SharieAlhaj	116	7.25	3.16	0
Bahra	2.7	6.71	0.378	0
Hada	161.9	7.21	1.76	0
Algamoom	228	7	64	0.396
<b>WHO Accepted range(&lt;)</b>	<b>0.0004</b>	<b>8.5-6.5</b>	<b>5</b>	<b>0</b>

## DISCUSSION

Water is used as a Coolant and irrigant for various dental procedures. This water that flows through the Dental Unit WaterLine (DUWL) should be free of contamination (Sanjeev et al., 2010). The quality of water in dental units

is of considerable importance because both patients and dental staff are regularly exposed to water and aerosol generated by these units (Cinthia et al., 2012). In the present study, all chemical parameters did not exceed permissible limits of Saudi Arabia standards of water. Thus the water that used in Dental Chair Units (DCUs) is

suitable to be used from chemical stand point of view; however some chemical pollutants such as trace elements and pesticides were not included in the analysis process.

Most of chemical parameters concentrations were very low when compared with Saudi Arabian Standard Specifications such as Fluoride (F) which was found to be of zero concentration in Dental Chair Units (DCUs) in Gabal Annour and Alezizia Elshargia health centers. The presence of fluoride parameter in drinking water is important because it prevents dental caries when fluoride is present at appropriate levels and for its role in dental fluorosis when present at high levels. The establishment of safety levels for fluoride in drinking water is an essential measure for protecting human health (Paulo et al., 2011). In a previous study conducted in Makkah on assessment of chemical parameters of ground water in Holly Makkah, the fluoride concentration ranged from 0.04 to 2.31 ppm, where 25 %, 80.3% samples showed fluoride less and higher than permissible limits, respectively (Anas et al., 2013). The result revealed that all waters used in dental units were soft and alkaline. Other chemical parameters in this study were within permissible limits.

Physical parameters were within limits of the standards except turbidity and sediments in some dental units. Turbidity level was high in Annakkasa (8.68 TU), Gabal Annour (7.32 TU) and was very high in Algamoom (64 TU). Thus, water in these units should be more treated or filtered before use to remove sediments and decrease turbidity levels to acceptable limits.

The conductivity of water was low which might lead to the soft nature of the water. This justification of softness was mentioned in a study carried out in Nigeria (Moshood, 2008).

Microorganisms are aquatic bacteria which colonize the dental unit waterlines (DUWLs) through the development of a multi-species biofilm (Giuseppe et al., 2013). To detect bacteriological contamination microbiologist usually depend on detection of coliforms. The presence of coliform bacteria in all samples was less than standards, however all water samples contained intestinal bacteria.

## CONCLUSION

Laboratory analysis of water used in Dental Chair Units in all studied health centers in Makkah exhibited that chemical parameters did not exceed permissible limits of Saudi Arabia standards of drinking water. There was a contamination with intestinal bacteria in all water samples. Also there was excessive turbidity in some water samples that were collected from health centers.

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