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Estimation and Characterization of Grey Water in Karbala City During 2018

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Abstract: Grey water use is important because it restricts fresh water demand and reduces stress on treatment system. Therefore, it is the last option for the water conservation. The main goal of this study is to estimate and characterize the quality of grey water produced form households in Karbala city during the year of 2018. The study shows that the quantity of grey water produced from different sources in a chosen household in Karbala city was 170 L/c.d which was account about 37.8% of the proposed quantity of drinking water supplied by the municipality for urban areas (450 L/c.d). The results show that the lowest concentrations were observed in August which were (84 NTU), (194.9 mg/L), (480 mg/L), for Tur., Cl and T.H, respectively. While for TDS and Ca were (749 mg/L) and (240 mg/L), in July. Also, the lowest value of COD, BOD and Mg were (179 mg/L), (117 mg/L) and (43.74 mg/L), respectively, in June and the pH was 7.1 in March.

Key words: Fresh water, quality, Karbala city, urban areas, concentrations, lowest value

INTRODUCTION

Grey water refers to the untreated wastewater that is generated and can be collected from baths, showers, washing machines, laundry troughs, dishwashers and kitchen sinks, excludes toilet wastes. The sewage from the toilets is not used because of the possibility that it contains unhealthy microorganisms (Yousefi *et al*., 2013; Mohamed *et al*., 2014).

Characteristics of grey water are highly variable, grey water amount varies from 50-80% of wastewater volume produced by households. It tends to be slightly alkaline and many plants do not thrive if irrigated with grey water having elevated alkalinity (Albalawneh and Chang, 2015). Because of low amounts of polluting pathogens and nitrogen, reworking and reusing of grey water are enjoying increasing attention. The characteristics of grey water depend firstly on the quality of the water supply, secondly, on the type of distribution net for both drinking water and the grey water (leaching from piping, chemical and biological processes in biofilm on the piping walls) and thirdly from the activities in the household (Yousefi *et al*., 2013; Rana *et al*., 2014). The characteristics of grey water produced by any household varies according to the dynamics of the household, the number and age distribution of occupants, their lifestyle characteristics and water usage patterns (Chan *et al*., 2014). The characteristics of bathroom grey water effluent are quite variable among households due to the type of personal care, shampoo brand and inclusion of urine and diaper washing during bathing. Common chemical contaminants typically include soap, shampoo, hair dye, toothpaste and cleaning products. Bathroom grey water also contains pathogenic bacteria and viruses through body washing, soiled clothes and nappy washes (Mohamed *et al*., 2014).

Wastewater emerging from the kitchen sink has high organic material from the food dishes as well as oil and grease. The characteristics of kitchen wastewater effluent are quite variable among households due to the type of cooking's and dietary preferences. Found kitchen wastewater had highest *Escherichia coli (E.coli)* due to input of provider with treatment (Mohammed *et al*., 2013).

Grey water derives from homes in residential areas, schools, office buildings and human dwellings. It is generally, less polluted than domestic or industrial wastewater but it may still contain high levels of pathogenic microorganisms, suspended solid and substance such as oil, fat, soap, detergents and other household chemicals (Chan *et al*., 2014).

A report prepared by the city of Los Angeles (Anonymous, 1992) showed that grey water generation ranged from 21-59 gallons/capita/day and that the ratio of grey water to total household wastewater ranged from 53-81%. The report also presented an estimate of the various types of water use in a suburban home as follows:

- Toilet 34.1%
- Kitchen 12.0%
- Bathroom 24.5%
- Laundry 23.2%
- Miscellaneous 6.2%

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Grey water can be treated onsite or offsite for non-potable use purposes such as irrigation, toilet flushing, car washing, dust control, soil compaction in construction works and in industrial processes like cooling boilers and other appliances. Reuse of grey water in toilet flushing and gardening can save 31-54% of potable water in households (Khatun and Amin, 2011).

MATERIALS AND METHODS

Estimation of grey water quantity: To estimate the grey water produced by a household in Karbala city, samples were collected from a chosen households in a separate containers depending on the source (washing machines, kitchen sink, bath and laundry). Collection of separate grey water types ensured that unequal portions were supplied in the grey water influent. An interview for daily activities was done to know the activities under taken routinely by the occupants of the house.

It was estimated that the quantity of grey water produced from different sources in a chosen household in Karbala city during the period of study are as follows and shown in Fig. 1 as a pie chart:

Bath	=	90 L/c.d = 53%
Washing machines	=	35 L/c.d = 21%
Laundry	=	23 L/c.d = 13%
Kitchen sink	=	22 L/c.d = 13%
Total	=	170 L/c.d

which is account about 37.8% of the proposed quantity of water supplied by municipality for urban areas (450 L/c.d).

Grey water characteristics: Grey water may contain organic compounds, chemicals, suspended solids, heavy metals, nutrients and pathogens. The kitchen grey water and the laundry grey water are higher in both organics and physical pollutants compared to the bathroom and the mixed grey water. The quality of grey water also varies from one household to another depending on the residents.

Grey water samples were collected over 24 h using barrels previously graduated for the purpose of flow measurement. Contents of the barrels were mixed thoroughly before sampling. Sampling container preparation and preservation has been done, according to the Standard Method for Examination of Water and Wastewater.

Collected samples were transferred to Environmental Engineering Department Lab, College of Engineering, Babylon University, for analyzes selected and significant physical and chemical characteristics. Table 1 explains the characteristic of grey water during the study period.

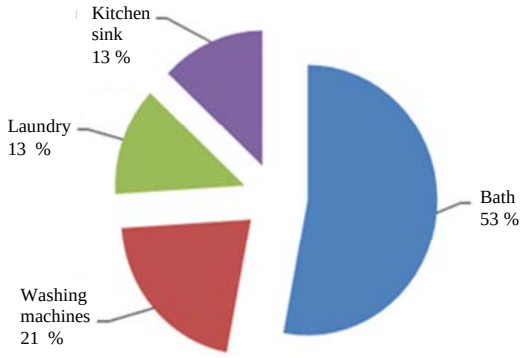

Fig. 1: The percent of grey water produced in a household

Table 1: Characteristic of grey water during the study period

Parameters/Units	Range
Hydrogen Ion Concentration (pH)	7.1-7.8
Total Dissolved Solids (TDS) (mg/L)	749-1260
Chemical Oxygen Demand (COD) (mg/L)	179-488
Biological Oxygen Demand (BOD) (mg/L)	117-353
Turbidity (Tur.) (NTU)	84-234
Oil and Grease (O and G) (mg/L)	59.3-94.6
Total Hardness (T.H) (mg/L)	480-630
Calcium (Ca) (mg/L)	240-320
Magnesium (Mg) (mg/L)	43.74-75.33
Chloride (Cl) (mg/L)	194.9-309.9

RESULTS AND DISCUSSION

Hydrogen ion concentration (pH): This research has shown that all examined grey water samples had measurable pH values as shown in Fig. 2. The highest value of pH was 7.8 in May and the lowest value was 7.1 in March. The pH of grey water strongly depends on the pH of the water supply but cleaning products usually influence the final pH of grey water discharged. In the present study, raw grey water was observed to have exceptionally high pH value (7.8) in May. This has partly been attributed to the sodium hydroxide-based soaps and bleach used or suggesting where the chemical contents for cleansing are alkaline in nature.

Total Dissolved Solids (TDS): Total dissolved solids are used as a primary indicator of water quality measurement and solids are composed mainly of salts and minerals and can contain organic substances.

The values of TDS affect the solubility of gases and insoluble compounds in water and increase water-causing corrosion of metal tubes.

The variation of TDS with time is showing in Fig. 3. It was observed that the maximum value was 1260 mg/L which has been occurred in April. Moreover, at July, it was reached a value of 749 mg/L.

There is a relationship between the electrical conductivity and the solubility of soluble solids, water

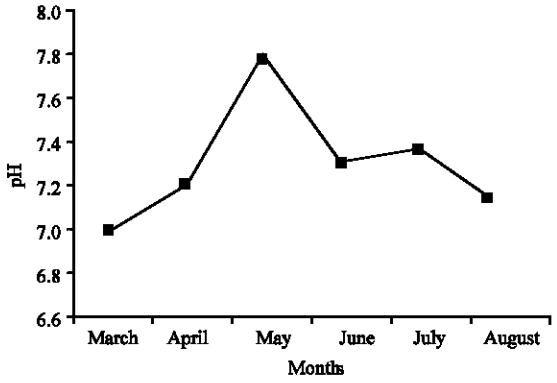

Fig. 2: Variation of pH with month

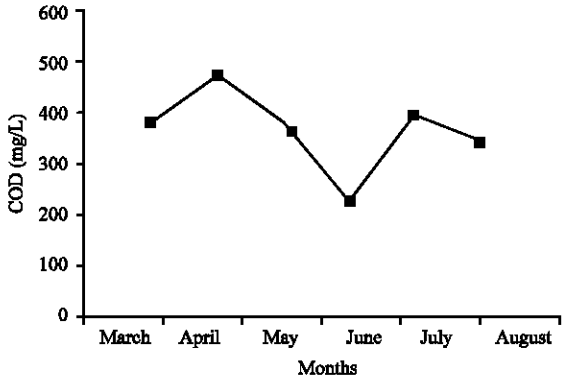

Fig. 4: Variation of COD with month

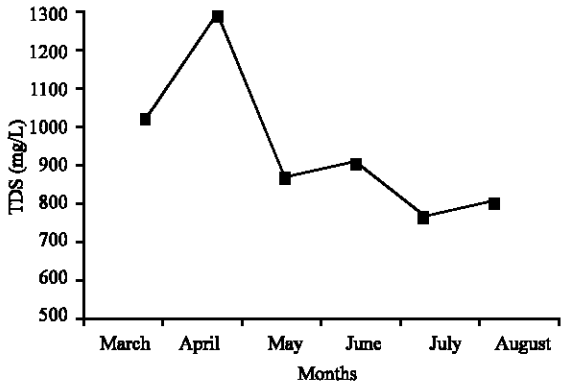

Fig. 3: Variation of TDS with month

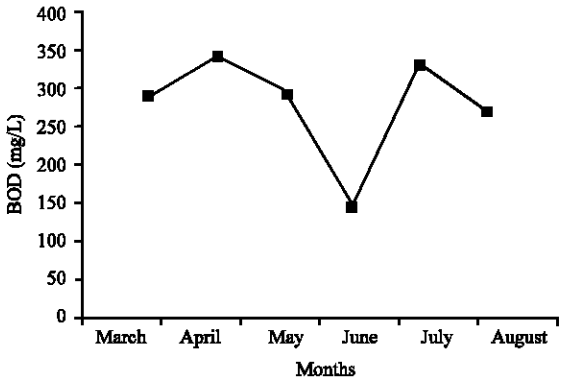

Fig. 5: Variation of BOD with month

gains the power of conductivity due to the presence of dissolved ions in it. Since, electrical conductivity is directly related to the concentration of salts dissolved in the water and therefore to the Total Dissolved Solids (TDS). This strengthens the theory that the concentration of dissolved salts has decreased after post treatment.

Chemical Oxygen Demand (COD): This test is one of the most important tests of water quality, a measure of the concentration of organic substances that can oxidized chemically without microbiological intervention. The COD test enables us to obtain an approximation of the total organic matter that is chemically oxidizable and does not distinguish between organic matter changeable and non-changeable.

The concentration of COD decreased the value from 488 mg/L in April to 179 mg/L in June. The variation of COD during the period of the study is shown in Fig. 4.

The COD in the grey water is due to the presence of biodegradable and non-biodegradable organic matters. The high COD is probably due to the presence of detergents from laundry powders and dishwashing liquids. As well, that the presence of anionic surfactant, builder and other oil substances in the grey water could increase the COD concentration.

Biological Oxygen Demand (BOD): This test is an important test to determine the concentration of organic matter in water indirectly. It expresses the amount of oxygen consumed by the microorganisms to oxidize the organic matter in the water and can be oxidized by aerobic microorganisms.

Figuer 5 gives the variation of BOD concentration during the period of the study. The concentration of BOD decreased from 353 mg/L in April to 117 mg/L in June.

The BOD in the grey water was due to the presence of biodegradable organic matters. Kitchen grey water contains biodegradable dissolved food particles which contribute to the BOD. Moreover, kitchen and laundry grey water are higher in both organics and physical pollutants compared to bathroom and the mixed grey water. Thus, the highest BOD which mostly contributed by organics compound contained from the

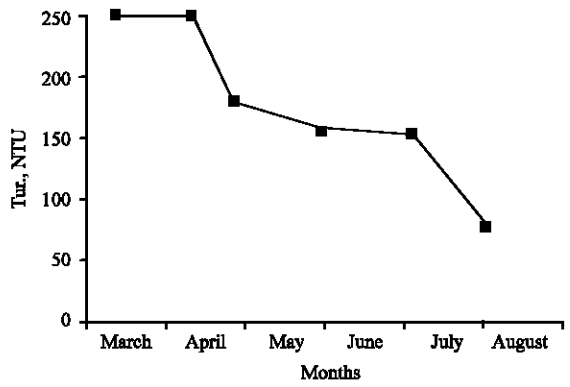

Fig. 6: Variation of Tur. with month

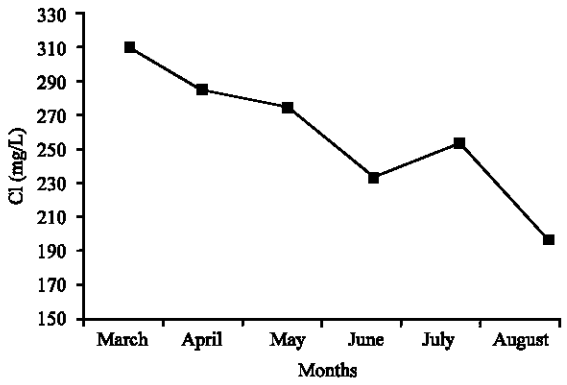

Fig. 7: Variation of Cl with month

ordinary household chemicals like detergents, perfumes, shampoos, preservatives, dyes, glues and cleaners.

The results show a strong positive correlation between BOD and turbidity in which the turbidity increases with the organic matter and the number of microorganisms in the water and with the COD. This is evidence of the occurrence of the processes of chemical oxidation and bio-oxidation of organic matter in almost parallel in the grey water.

Turbidity (Tur.): Turbidity resulted from the presence of solid substances stuck in water from silt and gluten and may be due to the presence of bacteria, microorganisms and floating plants.

The various samples were studied for various months and the graph has been plotted as shown in Fig. 6. According to the experimental results, more specifically the value was as 234 NTU in April whereas at August in the effluent were equal to 84 NTU.

It should be underlined that households where high organic matter and soaps were used led to higher turbidity values. As this parameter characterize pollution, the efficiency of any treatment would much depend on cooking style and dishwashing products used rather than on the family composition.

Chloride (Cl): The concentration of chloride with time is shown in Fig. 7. The concentration decreases from (309.9-194.9) mg/L as the operation time increased from March to August. The very high concentration sources are normally related to either clothes washing operations such as washing machines or hand washing or kitchen sinks probably due to a higher detergent concentration.

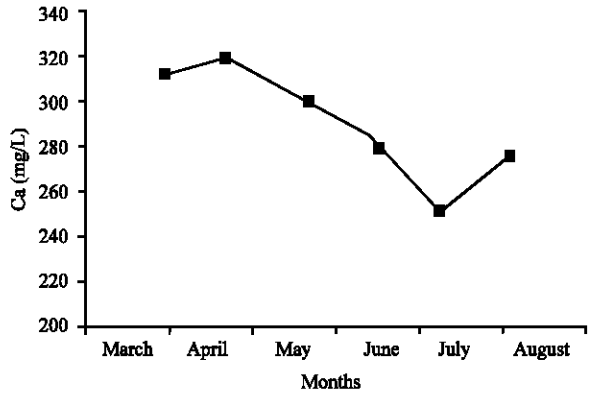

Fig. 8: Variation of Ca with month

Calcium (Ca): According to Fig. 8, it was found that the maximum value of calcium concentration was 320 mg/L occurred in April. Furthermore, the minimum was 240 mg/L in July.

Figuer 8 shows that calcium concentration was high during April. This attributed to calcium concentration was stable in grey water when carbon dioxide was present but calcium concentration can fall when calcium carbonate precipitates due to increased grey water temperature.

Total Hardness (T.H): Total hardness is mainly associated with calcium and magnesium ion concentrations regardless of their association with any negative ions.

The variation of hardness with time is showing in Fig. 9. From Fig. 9 the concentration of total hardness decreased slightly from 630 mg/L in March to 480 mg/L August.

The problem that hardness occurs was that the calcium and magnesium salts react with the surfactant (the surface-active agent) and reduce it was effectiveness. The problem with soaps in hard water was that the

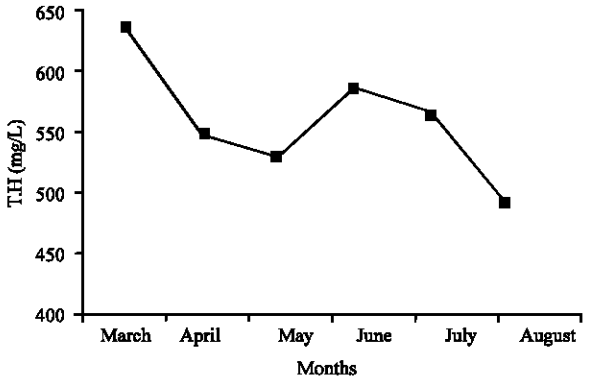

Fig. 9: Variation of T.H with month

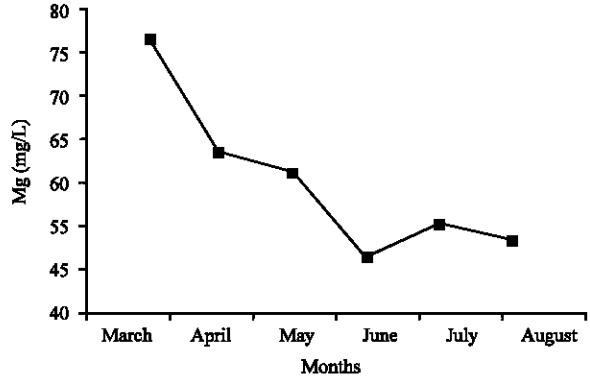

Fig. 10: Variation of Mg with month

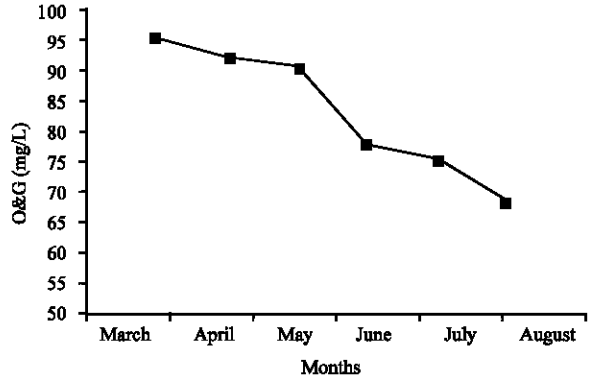

Fig. 10: Variation of Mg with month

compounds formed with the soap result in a greasy curd that is insoluble in water and difficult to wash out.

Magnesium (Mg): Magnesium comes after calcium as one of the most important positive ions found in water. The concentration of Mg variation with time is showing in Fig. 10. The highest value of Mg was 75.33 mg/L in March and the lowest value was 43.74 mg/L in June.

Based on above results, this variation could be attributed to the release of exchangeable cations during the mineralization of organic matter. In addition, elevated Mg level in the grey water could therefore be associated with a buildup of 'hard' water deposits in pipes, fixtures.

Oil and Grease (O&G): The oil and grease variation with time are shown in Fig. 11. It was found that the grey water has the lowest value (59.3 mg/L) of oil and grease due to low quantity of kitchen wastewater. While it has the highest value (94.6 mg/L) during March in which the raw kitchen wastewater contains food particles, oils, fats and that producted of our eating habit and food preparation.

CONCLUSION

The study shows that the quantity of grey water produced from different sources in a chosen household in Karbala city was 170 L/c.d which was account about 37.8% of the proposed quantity of drinking water supplied by the municipality for urban areas (450 L/c.d).

The results show that the lowest concentrations were observed in August which were (84 NTU), (194.9 mg/L), (480 mg/L) and (59.3 mg/L) for Tur., Cl, T.H and O and G, respectively. While for TDS and Ca were (749 mg/L) and (240 mg/L) in July. Also, the lowest value of COD, BOD and Mg were (179 mg/L), (117 mg/L) and (43.74 mg/L), respectively, in June and the pH was 7.1 in March.

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