Possibility of using concentration of suspended solids as an indicator to measure microbial quality of plants wastewater effluent

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Abstract: Given the shortages of available water, specially for agricultural purposes, wastewater reuse prevents contamination of water as well as partially solving the current water shortage problems.This study aimed to determine the quality of wastewater effluent from the wastewater treatment plants (WTP) at Kashan University of Medical Sciences using the relationship between Total Suspended Solids (TSS) with Total Coliform (TC), and Fecal Coliform (FC) for agricultural use. All samples were taken from the sanitary WTP effluent at Kashan University of Medical Sciences. Standard methode were used for physiochemical and biological analysis of TSS, TC and FC. Results indicated that the value of R2 between TSS –FC and TSS – TC, regressions were; 0.78 and 0.79, respectively also, P-value was found less than 0.001 for the regressions in both cases. Therefore values of TC and FC could be estimated based on TSS parameter.Based on the results of present study a significant correlation between TSS, TC and FC parameters was observed in WTP effluent.

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1. Introduction

Increasing population growth and development of urbanization, as well as living standards have increased the amount of consumed water and finally wastewater. Sewerages are one of the factors which pollute the environment, so they should be collected, treated and , if possible, returned in the water circulation of nature (Quadir et al., 2004). The aims of wastewater treatment are to protect public health, reuse it and remove the problem of sewage disposal of urban and rural residents (Song et al., 2006) .Wastewater must be treated in such a way that the produced effluent can safely be used for agricultural purposes, or other reuse aims (Üstün et al., 2011). Several processes for wastewater treatment are used in which a very high percentage of microbial pollution in sewage effluent has been removed for favorable reuse (Vera et al., 2012). Microbial contaminants identified by World Health Organization as indicators include total coliforms (TC) and fecal coliform (FC) (WHO., 2002). One of the wastewater treatment plants (WTP) is the activated sludge process that can be effective in the removal of more than 99% of pathogens and coliforms (Bitton, 2005). Because of the fixed amount of water in nature, the modified waters by domestic WTP can be considered as a reliable alternative source (Hochstrat et al., 2008, Jamwal and Mittal, 2010). The relationship between the key components of wastewater such as total suspended solid (TSS) and coliforms (TC and FC) can be used to evaluate the efficacy of WTP (Kazmi et al., 2008). Quality indicators for the use of limited and unlimited irrigation are usually TC, FC and TSS; so the control of these parameters is important in the plants output (Agrafioti and Diamadopoulos, 2012). In addition, some studies show certain relationships between physiochemical and biological parameters in WTP (Kazmi et al., 2008, Williams et al., 1995). Due to the increasing wastewater reuse in dry and semi dry areas, effluent compliance with global standards is extremely important. Therefore, wastewater microbial indicators must be tested frequently. Meanwhile such tests are time-consuming and

expensive. The TSS test on the other hand costs less and takes less time. Thus, this study aimed to investigate the logical relationship between wastewater quality parameters such as TSS, TC, and FC for the easier achievement of wastewater microbial quality for reuse. The novel finding of the present study is the evaluating of relationship between the TSS, TC, and FC parameters for the dry area.

2. Material and Methods

This descriptive study was conducted, aiming to determine the relationship between physicochemical parameters (TSS) and microbiological parameters (FC and TC) in the wastewater effluent of activated sludge system from Kashan University of Medical Sciences (KUMS). This treatment plant is ASP in type of extended aeration, and its divisions include manual bar screen, aeration tank, secondary sedimentation, and disinfection, in which for the disinfection the chlorine dosage was 3±0.5 mgL-1 with 13 minutes retention time. a total number of 130 samples were randomly taken on different days of the week over a 4-month period from effluent. For TSS test, 2 liter-polyethylene bottles and for FC and TC tests, sterilized glass bottles with 300-ml capacity were used. All the taken samples were immediately transferred to the water and wastewater laboratory for analysis. All the studied TSS, TC, and FC parameters were examined according to the latest edition of "Standard Methods" (book) (2012). Finally, SPSS software and regression test was applied to analyze obtained data.

3. Results

Table 1 shows that the highest and lowest values for TSS values were 98 and 7 mgL-1, respectively, and also The highest and lowest values of FC were (log 2.28 or 190 MPN/100ml) and (log 0.85 or 7 MPN/100 ml), respectively, and for TC these values were (log 2.43 or 269 MPN/100ml) and (log 1.18 or 15 MPN/100ml), respectively. Figure. 1 illustrates the linear relation between the dependent variable TC and independent variable TSS. moreover Figure. 2 a linear relation is seen between the variable TSS and dependent variable FC. It deserves special attention that the high positive correlation seen between the values are strong statistically.

Table 1. Values of Total Suspended Solids (TSS),Total Coliform(TC), and Fecal Coliform (FC), parameters in the WTP Effluent at KUMS

Parameter	Minimum	X±SD	Maximum
TC (in log)	1.18	1.62±0.32	2.43
FC (in log)	0.85	1.42±0.31	2.28
TSS (mgL^{-1})	7	32±21	98

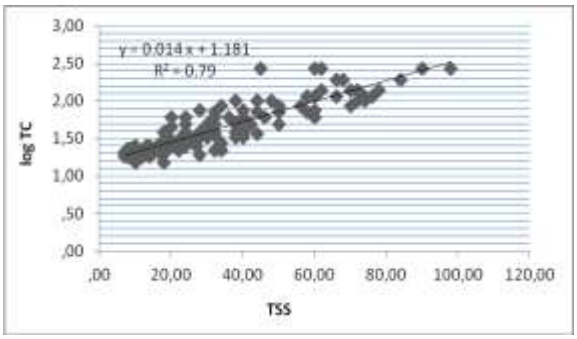

Fig.1. Relationship between Total Suspended Solids (TSS) and Total Coliforms (TC) in the WTP effluent of KUMS

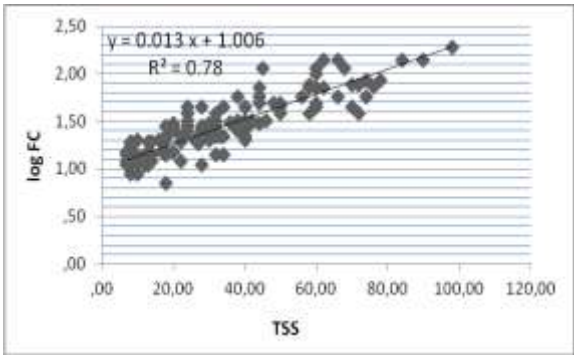

Fig. 2. Relationship between Total Suspended Solids (TSS) and Fecal Coliforms (FC) in the WTP effluent of KUMS

As table 2 shows the highest correlation coefficient (R^2) value was the TSS – TC and the lowest was TSS -FC. The regression analysis of dependent parameter TC and independent parameter TSS showed the following values; F=492.9 and P<0.001 and Also, regression analysis between the dependent FC and independent TSS parameters showed F=467.3 and P<0.001. According to the information obtained, the constant and value of **β** were calculated for all for equations with P<0.001.

Table 2. Linear equations of parameters Total Suspended Solids (TSS) with Total Coliform(TC), and Fecal Coliform (FC), in the WTP Effluent at KUMS.

Parameter (in log)	Equation	R^2
TC	y = 0.014 TSS + 1.181	0.79
FC	y = 0.013 TSS + 1.006	0.78

4. Discussions

Results of the study showed values of R2 between TSS -FC and TSS – TC, were; 0.78 and 0.79, respectively. Therefore, in total of cases R2 had a value in excess of 0.75, which indicates a significant correlation between these parameters of the wastewater. In other words, based on results obtained in relation to the wastewater effluent from ASP, the microbial quality of the wastewater, especially TC and FC can be assessed according to TSS parameter. Results of similar studies conducted by Kazmi et al.(2008) on activated sludge system in various cities in India showed that value of R2 between TSS - TC and TSS -FC were 0.72 and 0.75 respectively. Compared with the present study, despite lower values of R2, the correlation between these parameters was significant.which is in agreement with results of the present study (Kazmi et al., 2008). In addition, a few studies have been conducted showing relationships between physiochemical and biological parameters in WTP (Williams et al., 1995, Wu et al., 2009).

Further to study on the relationships between TSS, TC, and FC parameters in wastewater treatment systems, the direct relationship between these parameters in surface waters (rivers and floods) in many other studies have been demonstrated, which is in line with results of the present study (Characklis et al., 2005, Crim et al., 2012). Mumtaz et al. (2011) in a study on surface waters in Pakistan found that there was a significant correlation between coliform (CFU) and values of TSS, with correlation coefficients 0.873 (Mumtaz et al., 2011). The results of the present study showed mean values of TSS was 32 mgL^{-1}, and mean values of MPN for FC and TC were 26 and 41 per100 ml, respectively. These values are lower than the permitted standards of the Iranian Environmental Protection Agency for reuse in irrigation and agriculture (TSS<100mgL^{-1}, TC<1000-MPN/100ml, and FC<400MPN/100ml) (Nasseri et al., 2008). Also, review of studies, showed that the wastewater effluent from wastewater treatment plants can be reused according to international standards (Carr, 2005, Jiménez, 2005, Sharafi K, 2012).

According to the WHO standards, the permitted limit of fecal coliforms for irrigation and agricultural use is less than 1000 (log 3) per 100 ml of effluent, and compliance with international standards wastewater reuse is compulsory (Jiménez, 2005, Jamwal and Mittal, 2010, Kamizoulis, 2008). Kashan is considered a semi-arid region of Iran, with average annual rain fall less than 140 mm (Modarres and de Paulo Rodrigues da Silva, 2007). Thus, given the low mean values of TSS, FC, and TC parameters in the study wastewater, and also the severe water source shortages in this region, it seems necessary that, with right strategies, wastewaters effluent should be used for non-drinking applications like limited and unlimited irrigation. Results of the present study on effluent of WTP in KUMS showed that values of R2 between TSS - FC and TSS – TC were; 0.78 and 0.79, respectively. Therefore, using the results obtained in this study, with TSS parameters known, Total and Fecal Coliforms can be predicted and the wastewater quality can be found.

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