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Study on Physicochemical Status, Bacterial Analysis and its Correlation

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Abstract:
Swimming pool, as a recreational facility is now a part of current lifestyle that offers social and health benefits. More demand for hotels with swimming pool facility and are highly used during peak seasons. However swimming pool could become a pooling medium of various bacteria came from the bathers, air and soils thus risk of water-borne disease and impose hazard to human health. Therefore, a well disinfected swimming pool that meets the minimum standard requirement must be reached. This study aimed to assess the status of physicochemical parameters including free chlorine, pH, and temperature and to assess status of bacteria analysis of swimming pool water samples. 11 swimming pool water samples were taken from hotels in Klang valley, Malaysia. The physicochemical parameters were tested using colorimetric method using N,N-diethyl-1,4-phenylenediamine and bacteria analysis were obtained by standard plate count (SPC) method. Results are presented in mean and standard deviation. Correlation coefficient is obtained by Pearson's correlation statistical test. Results showed mean of temperature 29.64±1.430C, pH 7.56±0.40, free chlorine 1.22±1.16 ppm and bacterial SPC 4,825.64±8,409.16cfu/ml. Correlation-coefficient between temperature and SPC r: 0.71. The findings showed current physicochemical status of hotel swimming pool water samples met the minimum standard requirement. However, the bacterial SPC is highly above acceptable range and positively correlated to temperature. This indicates bacterial count increase with temperature rise despite of acceptable chlorine level. The acceptable level of chlorine as disinfectant is insufficient to oxidize bacteria thus may put the swimming pool water at risk of spreading water borne diseases. This finding suggests increase dosage of chlorine is required to maintain swimming pool sanitation during hot season in order to provide a safe water recreational facility. However, larger sample size is required to confirm the findings website.

Index Terms: Swimming pool; Bacteria; pH; physicochemical parameters

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I. INTRODUCTION

Swimming pool, as a recreational facility is now a part of current lifestyle that offers social and health benefits. More demand for hotels with swimming pool facility and are highly used during peak seasons. However swimming pool could become a pooling medium of various bacteria came from the bathers, thus risk of water-borne disease and impose hazard to human health (Drasko Pekovic., et al., 2015).

Contaminated water due to body shedding of bathers includes body fluid such as urine, saliva, vomit, hair, breathing (release of respiratory), digestive, genital bacteria and also other harmful bacteria from skin (Karami, et al, 2015). Apart from that, chemicals that is used for maintenance and balance of the water quality and environmental contaminants also contribute as part of health risk for human (Drasko Pekovic., et al., 2015).

In order to ensure a safe water recreation facility, World Health Organization has published a guideline to maintain water recreational facilities (2006) that emphasis on optimum swimming pool water quality that covers physicochemical, water disinfection, safety, water quality evaluation and microbial assessment.

Evaluation of physicochemical status and bacteria analysis is crucial in swimming pools water to provide a safe facility for the bathers. Physical and chemical factors such as adjusted pH, chlorine residual, turbidity, total alkalinity and temperature may affect biological factor or neutralize to each other and later increasing microbial activity in the pool water (Karami et al, 2015). If there is no control over swimming pools water quality, it may risk serious bacterial contamination (Hoseinzadeh et al, 2013).

This study aimed to assess the status of physicochemical parameters and to assess status of bacteria analysis of swimming pool water samples and its correlation from hotels in Klang Valley, Malaysia.

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II. METHODOLOGY

A. Sample collections

Swimming pool water samples were used in this study collected from 11 different hotels in Klang Valley, Malaysia. Samples were collected not less than1 feet below the water surface using a sterile 500ml scotch bottle and away from water return inlet. Duplicate sample were taken.

B. Physiochemical Analysis

The samples were tested using a Pentair Rainbow pool and spa test kit to measure pH, free chlorine, total alkalinity using N,N-diethyl-1,4-phenylenediamine colorimetric method. The tests were directly done after sampling. Temperature of the swimming pool water has been determined by dipping the thermometer 1 feet depth into the swimming pools water and the reading will be taken in one minute.

Table 1: Physicochemical Analysis

Sample no	1	2	3	4	5	6	7	8	9	10	11	Mean ± SD	Standard range for swimming pool water
pH	8.2	7.8	7.8	7.6	7.8	7.6	7.6	6.8	6.8	7.6	7.6	7.56± 0.40	7.2 – 7.6
Free chlorine /ppm	0.5	1.5	0.3	0.3	0	3	3	3	1	0.5	0.3	1.22± 1.16	1.0 – 3.0 ppm
Total alkalinity / ppm	30	30	30	30	30	30	30	40	30	30	40	31.82± 3.86	80 – 120 ppm
Temperature /^{0}C	31	28	31	32	31	29	30	28	28	28	30	29.64± 1.43	No standard

Table 2: Bacterial analysis

Sample no	1	2	3	4	5	6	7	8	9	10	11	Mean ± SD	Standard for swimming pool water
SPC / cfu/ml	452	364	8,288	27,894	13,626	152	188	704	572	388	454	4,825.64± 8,409.16	<200 cfu/ml

A. Bacteriological Analysis.

Samples were diluted by serial dilution and bacteria colony counted using standard plate count method as described by Standard Methods for examination of water (American Public Health Association, 1985). Diluted samples were inoculated on nutrient agar plate before incubated for 24 hours in 37^{0}C. Average colony count were then obtain and calculated to gain colony forming unit per ml sample.

III. RESULT

Use The physicochemical analysis (pH, free chlorine, total alkalinity and temperature) is presented in Table 1 below while the bacterial analysis presented in Table 2

The results showed that pH range from 7.6 to 8.2 with mean 7.56±0.40. Free Chlorine result from 0.3 to 3.0 ppm with mean 1.22±1.16 ppm. Total Alkalinity from 30 to 40 ppm with mean 31.82±3.86 ppm and temperature range from 28 to 31^{0}C with mean 29.64±1.43^{0}C.

Results of the bacteriological analysis of the water sample are presented in Table 2. The standard plate counts for all water samples spread from 152 to 27,894 cfu/ml with mean 4,825.64± 8,409.16 cfu/ml.

Correlation study between water temperature and bacterial colony count from sample as shown in Chart 1 revealed a strong positive correlation between the parameters with correlation coefficient r : 0.70.

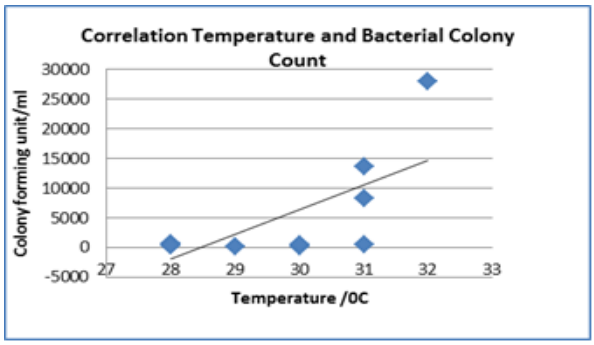

Chart 1 : Correlation between Bacterial colony count and Temperature

While correlation study between free chlorine and bacterial colony count as shown in Chart 2 result in a weak negative correlation between the parameters with correlation coefficient r : -0.46.

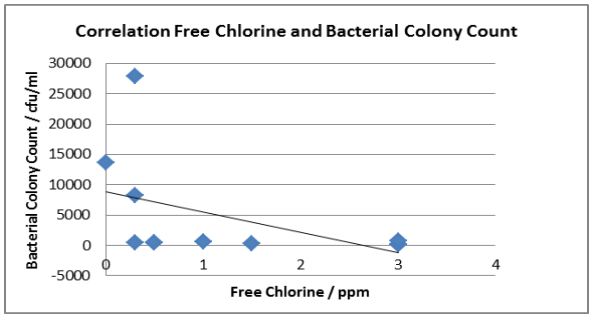

Chart 2 : Correlation between Bacterial colony count and Free Chlorine

Correlation test for Water pH and total alkalinity show weak correlation with correlation coeffision r : 0.36

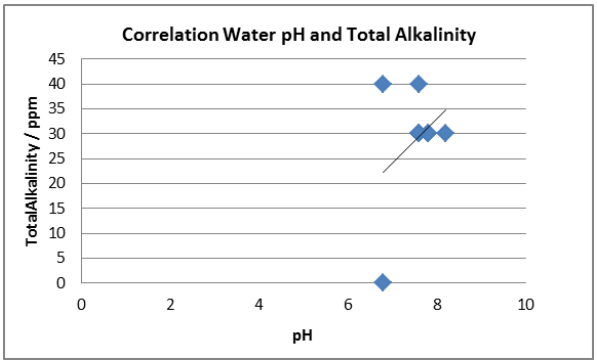

Chart 3 : Correlation water pH and Total Alkalinity

IV. Discussion

The findings showed current pH level and free chlorine concentration status of hotel swimming pool water samples met the minimum standard requirement for swimming pool water as published by International Standard Organization (BS EN ISO 7393-2:2000). The total alkalinity status was extremely below standard but do not influence the pH level of the water samples that falls in the standard range. The bacterial analysis revealed high number of bacterial colony count from the sample with unacceptably high mean compared to safety standard for swimming pool by Guidelines for Safe Recreational Water Environments (WHO, 2006). The bacterial colony count showed parallel pattern with increase temperature of swimming pool water despite of sufficient concentration of free chlorine. Since standard plate count were reliable and practical indicators for the efficiency of the disinfection process and safety of swimming pools (Nikaeen et al, 2009), this current finding indicates acceptable level of chlorine as disinfectant is insufficient to oxidize bacteria in the swimming pool water thus may put the swimming pool at risk of spreading water borne diseases (Leoni et al, 1999)

V. Conclusion

This finding suggests the increase dosage of chlorine is required to maintain swimming pool sanitation during hot season in order to provide a safe water recreational facility. However, larger sample size is required to confirm the findings.

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