A Study on Quality of Drinking Water in Hotels at Mysuru, INDIA

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Abstract - *Water is a vital compound to human which is used for oral consumption to regulate body temperature and other metabolic activities. It is also very much used for cooking, personal, and home hygiene at the residential level. The tourists relay on the city restaurants for food and water. If water supplied is potentially unsafe for consumption it may lead to water borne diseases like cholera, dysentery, salmonellosis, and typhoid. Hence, the present study was aimed in studying drinking water quality at selected restaurants in city of Mysuru. The water samples were collected at the point of use from sources like water purifier, Bottled water and Municipal supply and analyzed for significant water quality parameters. From analysis it was evident that, all the essential parameters were well within the permissible limits with respect to water purifier and Bottled water. Around 39% and 75% of municipal samples were having hardness and Iron above the desirable limits respectively. 100% of municipal samples were found positive with microbial contamination. Therefore, supplying good water after suitable purification may be made as regulatory requirement to run hotel or restaurants. Otherwise, depending on branded bottled water becomes inevitable for the tourists for safeguarding their health.*

Key Words: Water; Hotel; Restaurants; Purifiers; Tourists; Municipal; Bottled; E-Coli

1. INTRODUCTION

Water is a vital compound for existence, survival and metabolic activities of all living micro or macro organisms including human beings. It constitutes one of the most important physical environments and has a direct influence on human health. Water, being the life nourishing component, is necessary not only for humans but also for other organisms [1]. Nevertheless, the quality of water is being deteriorated by various anthropogenic activities, which directly or indirectly affecting the normal health conditions. Rapid industrialization and urbanization has caused the entry of wide array of complex organic and inorganic compounds to the water. These pollutants may also include suspended solids, bacteria, and toxic chemicals including volatile organics, acid/base, and heavy metals. These compounds may cause impact on public health and pose health risk to humans due to its microbial contamination.

The Cities like Mysuru, attracts tourists from different parts of the world and they mainly rely on Restaurants or Hotels for healthy food and safe drinking water. And also Mysuru is considered to be one of the best study center and students from different parts of the country stay in rented rooms and rely on hotels and restaurants for their daily food and water. Mysuru has also emerged as one of the major IT hubs in India as it served to be an extension of the Silicon Valley of India. Employees who are from other districts or state and travel daily, may also rely on the hotels and restaurants. Further, the local population may also visit hotels or restaurants occasionally.

Therefore, poor water quality in restaurants can be considered as a possible point source for spreading water borne disease. Hence, there is a need to study the quality of drinking water offered in Restaurants or Hotels. Studies have shown that the diseases occur predominantly due poor quality of drinking water [2]. In addition, it is imperative that investigation to be made to improve our knowledge about the importance of pathways of transmission and relationship between quality of water and disease burden. This information is necessary to construct the greatest improvement of public health status [3]. Considering all the above facts and views present investigations were contemplated in determining various significant water quality parameters from different sources at selected Hotels and restaurants.

2. METHODOLOGY

2.1 Study Area

Mysuru is located at 12 °18' N 76°39 E / 12.30° N 76.65°E and has an average altitude of 700m. It is situated in the southern region of the states of Karnataka, INDIA, at the base of the Chamundi Hill and spreads across an area of 128.42 sq.km. Ambient temperature of Mysuru varies from a minimum of 9°C to Maximum of 39 °C and the city receives an average annual rainfall received by the city is 798.2 mm. According to the census of 2011, Mysuru city's total population is 951,487 with 480,123 males and 471,364 females, making it the second largest city in Karnataka. The gender ratio of the city is 981 females to every 1000 males and the population density is 6223.55 persons per sq.km. Mysuru City is considered to be perfect place general tourist or business visitor or casual visitor.

2.2 Sampling Points

From the available survey data of Health Department, Mysuru City Corporation, wide range of Hotels and Resorts of different classes are cited in the Mysuru city, which are good option for tourists' accommodation (Table 1) out of which Twelve Hotels of different classes were considered for the present study (Table 2). Figure 1 provides the global positioning of all the selected hotels. These hotels have been selected depending upon the population and location area, like residential area, floating population, less populated etc. (refer Table 3).

The water samples were collected at the point of use from different sources (Table 3) and analyzed for significant water parameters which are listed in Table 4. Samples were collected and analyzed in the month of October, December and February. Municipal water from tap source was collected and analyzed with respect to all the sampling locations. The tap and outlet (purifier) at the sampling point was full opened for two minutes before water was collected in sample bottles. 8H, 10H and 12H did not have any type of purifier or bottled water facility. They supplied water for drinking which was directly collected from municipal source (Tap). The branded bottled water were taken directly to the lab for analysis.

2.3 Water Analysis

All the sample procured from different sources were analyzed in Environmental Engineering Research Center, Sri Jayachamarajendra College of Engineering, Mysuru, 570006. The water analysis was carried out to determine the concentration of various test parameter (pH, TDS, Turbidity, Conductivity, Total Hardness, EC, Sulfate, Nitrate, Calcium, Fluoride, Chlorine, and E coli) according to Standard Procedures given in Standard Methods for Examination of Water and Wastewater [4]. For Nitrate determination, Phenol di Sulfonic Acid (PDA) method was adopted.

3. RESULTS AND DISCUSSION

The quality of drinking water sources such as municipal, water purifiers and bottled, at different hotels is furnished in Table 5, 6 & 7 respectively. The results not shown in Table 6 and 7 for sampling locations 8H, 10H and 12H because the facility of purifier or bottled water was absent.

3.1. Total Hardness

From Table 5, the total hardness (TH) of water is slightly above the desirable limit of 300mg/L in 39% of all the municipal water samples. Samples from locations 9H and 12H showed concentration of 334 and 330mg/L respectively i.e. 10% higher than the desirable limits. 58%, 25% and 33% of the samples collected and analyzed in the month of October, December and February respectively, had concentration more than desirable limits. Samples from 1H, 3H and 8H had the concentration below the desirable limit in all three months. Therefore, Installation of Water softener or adopting suitable softening method is essential at the locations where total hardness is more than the desirable limits. From Table 6 it is evident that the water purifiers were able to reduce the total hardness to very much less than 10% of the desirable concentration (<30mg/L). Even though 8H was not having water purifier the water supplied is safe for drinking with respect to total hardness.

3.2. EC and TDS

The total dissolved solids (TDS) may be measured by standard gravimetric method or using TDS meter/ EC [7]. The EC measured can be converted to TDS using formula deduced using cell constant of the electrode.

$$TDS\ (mg/L) = EC*K*1000 \quad (1)$$

Where, K is the cell constant and EC is Electrical Conductivity

From Table 5 it can be observed that the TDS is almost nearly 500 times the EC. Which means the cell constant K is almost near to 0.5 (commonly 0.64). About 17% of all the samples had TDS value more than the desirable limits. The average value of the TDS was more than the desirable limit at 11H. Therefore, desalination becomes very much essential in these places to avoid its impacts on human health and hotel facilities

3.3. Cations

The cations such as Iron and Calcium were monitored in all the three months. Whereas concentration of calcium and Iron was found exceeding in 25% and 78% of municipal water samples. This may be due to effects of old distribution system of the city and also corroded pipes in the water conveyance system within the hotel premises. More than 90% of the Iron and Calcium were removed through various water purifiers.

3.4. Anions

The concentration of residual chlorine in the distribution system is essential in order to avoid contamination during conveyance of water. Hence, desirable concentration prescribed is 0.2mg/L. From Table 5 it is evident that residual chlorine level is very much less than the desirable concentration which indicates that it was consumed for destruction of contaminants in the distribution system. However, after purifying the water the residual chlorine level was found to be above the desirable limits (Table 6). This may be due to chlorine impregnated materials used in the purifiers to destroy the pathogens. Nitrate was found to be very much less than the threshold limit of 45mg/L. Three municipal samples were found having Fluoride concentration more than 1mg/L. Sulfate was found to be within the desired prescribed limit of 200mg/L in all the municipal samples.

3.5. pH, e-coli and Turbidity

The pH of municipal, purifier and bottled water was well within the prescribed range for drinking water. Turbidity and e-coli was not detected in all the samples of purifier and bottled water. Whereas, Turbidity and e-coli was found in municipal water samples in all the locations (Table 8). Therefore, direct consumption municipal water renders unsafe in health perspectives due to microbial contamination. This may due to presence of turbid particles in water which acts as house for microbes and thereby reducing the action of disinfectants. Contamination may occur during the conveyance of water through distribution system or due to lack of residual chlorine in the municipal waters (Table 5).

3.6. Purifier & Bottled Water

From Table 6 and 7 it is evident that the purifiers and bottled water very much comply with the drinking water quality standards. Except residual chlorine all the others parameters are well below the desirable limits. Hence, it can be said that consumption of purifier or bottled water is highly recommended than to rely on the municipal water while travelling different places. Travelling may not be constrained only for tourists.

The performance of each water purifiers was found excellent in removal of all the test parameters. Even the microbial contamination which was detected in the municipal water was 100% removed. However, chlorine and Nitrate concentration was found to be high in purified water compared to municipal waters. This may be due to adsorption or ion exchange materials used in the water purifiers. Even though the concentration of chlorine and nitrate in purified water was found to be higher than the municipal water it was well within the prescribed limits. Hence, rendering the water safe for drinking, cooking and other purposes.

4. Conclusions

From the study, locations 8H, 10H and 12H were found to be unsafe places to consume water, because they supply direct municipal source water. And the municipal water found was positive for e-coli tests. Therefore, installing water purifiers to provide safe drinking water is ideal option if the hotels mainly rely on municipal water. Compared to water quality of purifier, bottled water was found to be superior in quality. However, the studies recommend not to consume demineralized water because it will be lacking essential ions required for metabolism. Since, City like Mysuru, attracts very large number of tourists who mainly depend on the local restaurants or hotels for food and water, providing safe drinking water becomes challenging. Supplying municipal water directly may have adverse health impacts depending upon individual immune. Hence, hotels or restaurants can be recommended or enforced to have water purifiers or disinfection units and other means of supplying safe drinking water. It may be recommended for tourists or travelers to rely on bottled water to safeguarding health.

Scope for Future Study

Study can be further continued to for evaluating drinking water quality in hotels in Bus stand, railway stations, hospitals, canteens, fast food corners etc. Contaminants other than e-coli can be monitored to understand the level of risk on human health. Water Quality Index can be developed for various water sources in order to identify for its best use.

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Table – 1: Classification of Hotels in Mysuru City According to Health Department

Sl. No.	Class	No. of Hotels	Description
1	A	7	Star Hotels
2	B	22	Hotel with food and accommodation with plinth area of >1000Sq Ft
3	C	31	Hotel with food of plinth area <1000Sq Ft
4	D	35	Hotel with only food facility

Fig – 1. Global Position of the Selected Hotels

Table - 2: Different Classes of Hotels Considered in Present Study

Sl. No.	A	B	C	D
1	1H	4H	7H	10H
2	2H	5H	8H	11H
3	3H	6H	9H	12H

Table-3: Water Sampling Points and Details of Type of Drinking Water Source and Area

Sampling Locations	Month	Drinking Water Source		Type of Area
		Water Purifier Brand	Bottled Brand	
1H	Oct	Eureka	Kingfisher	Less floating population
	Dec	Eureka	Kingfisher	
	Feb	Eureka	Bisleri	
2H	Oct	Forbes Aqua Ultra	Aquafina	Residential Area
	Dec	Forbes Aqua Ultra	Aquafina	
	Feb	Forbes Aqua Ultra	Aquafina	
3H	Oct	Aquagaurd Reviva	Kingfisher	Floating population
	Dec	Aquagaurd Reviva	Aquafina	

	Feb	Aquagaurd Reviva	Aquafina	
4H	Oct	Aqua Sure	Cauvery	Residential Area
	Dec	Aqua Sure	Bisleri	
	Feb	Aqua Sure	Bisleri	
5H	Oct	Aquagaurd Total Sensa	Aquafina	Floating population
	Dec	Aquagaurd Total Sensa	Cool Rich	
	Feb	Aquagaurd Total Sensa	Cool Rich	
6H	Oct	Aquagaurd Compact	Aquaozone	Less floating population
	Dec	Aquagaurd Compact	Aquaozone	
	Feb	Aquagaurd Compact	Brindavan	
7H	Oct	Aqua Sure	Aquafina	Residential Area
	Dec	Aqua Sure	Aquafina	
	Feb	Aqua Sure	Aquafina	
8H	Oct	-	-	Less floating population
	Dec	-	-	
	Feb	-	-	
9H	Oct	Aqua FOB	Brindavan	Floating population
	Dec	Aqua FOB	Aquaozone	
	Feb	Aqua FOB	Aquaozone	
10H	Oct	-	-	Floating population
	Dec	-	-	
	Feb	-	-	
11H	Oct	Aqua pure	Cool Rich	Less floating population
	Dec	Aqua pure	Cauvery	
	Feb	Aqua pure	Cool Rich	
12H	Oct	-	-	Residential area
	Dec	-	-	
	Feb	-	-	

Table – 4: Drinking Water Standard of Study Parameters

SI No.	Parameter	IS10500: 2012 [5]		Effects observed beyond Desirable Limit
		Desirable	Permissible	
1	pH	6.5 – 8.5	-	Affect the mucous membrane and corrosion of distribution system, risk of dissolved metal content in water
2	TDS, mg/L	500	2000	Palatability decreases and may also cause gastro intestinal irritation
3	Sulfate, mg/L	200	400	Gastro intestinal irritation [6]
4	Iron, mg/L	0.3	1.0	Imparts taste and color, risk of iron bacteria and corrosion of distribution system
5	Nitrate, mg/L	0	45	Methemoglobinemia (blue baby syndrome)
6	Calcium, mg/L	75	200	Encrustation in distribution system and formation of scales
7	Fluoride, mg/L	1	1.5	Concentration may be kept < 1. High fluoride i.e. >1 may cause many skeletal or dental disorders
8	Turbidity, NTU	1	5	Turbidity in water reduces the

				acceptability of water and uncertain about contamination
9	Conductivity, mS	-	-	Same as TDS
10	Residual Chlorine, mg/L	0.2	1.0	Imparts taste and Normally chlorine odor is experienced
11	Total Hardness, mg/L	300	600	Encrustation in water supply structure and adverse effects on domestic use
12	E- Coli, cfu/100mL	Shall not be detectable in any 100 ml sample		Anemia, Kidney Failure, Headache, Nausea, Vomiting, Hemolytic Uremic Syndrome (HUS), Diarrhea, Abdominal cramp, Fever

Table – 5: Municipal Water Quality at Different Hotels

Location	Month	TDS	SO_4	Fe	NO_3	Ca	F^-	EC	Cl	TH
1H	Oct	428	136	0.37	0.60	52.4	0.80	0.88	0.03	285
	Dec	399	108	0.28	0.35	61.3	0.71	0.89	0.02	299
	Feb	398	131	0.28	0.58	62.4	0.45	0.62	0.04	275
2H	Oct	476	142	0.34	1.80	64.0	0.70	0.91	0.05	281
	Dec	501	126	0.36	0.85	50.2	0.58	0.95	0.03	302
	Feb	450	104	0.31	1.90	75.0	0.52	0.77	0.04	265
3H	Oct	482	128	0.42	1.20	74.0	0.82	0.57	0.04	299
	Dec	485	135	0.21	1.02	45.5	0.62	0.98	0.05	285
	Feb	432	121	0.45	0.34	79.0	0.62	0.91	0.04	290
4H	Oct	466	148	0.60	1.40	63.9	0.69	0.68	0.03	306
	Dec	495	142	0.35	0.46	60.2	0.54	0.82	0.03	264
	Feb	395	142	0.58	1.25	69.5	0.57	0.52	0.02	285
5H	Oct	452	144	0.23	3.20	65.4	0.54	0.66	0.03	315
	Dec	487	175	0.47	0.71	57.4	0.39	0.74	0.04	287
	Feb	489	138	0.32	3.90	63.2	0.46	0.66	0.03	302
6H	Oct	439	134	0.78	1.20	51.0	0.93	0.88	0.02	311
	Dec	438	133	0.41	2.57	48.2	0.54	0.77	0.02	248
	Feb	486	108	0.62	1.95	49.5	0.62	0.94	0.01	288
7H	Oct	465	124	0.35	1.60	71.4	1.08	0.52	0.05	308
	Dec	492	124	0.38	0.62	63.9	0.69	0.86	0.03	265
	Feb	470	126	0.35	2.40	77.2	0.72	0.64	0.02	276
8H	Oct	420	122	0.52	2.60	69.7	1.26	0.67	0.08	286
	Dec	508	128	0.31	0.71	45.8	0.74	0.85	0.02	238
	Feb	450	139	0.28	2.20	65.2	0.63	0.57	0.07	238
9H	Oct	400	129	0.45	2.60	77.4	0.66	0.38	0.01	291
	Dec	547	154	0.47	0.78	39.6	0.70	0.66	0.05	302
	Feb	385	141	0.47	3.10	58.5	0.54	0.56	0.02	334
10H	Oct	481	130	0.24	2.10	73.0	0.74	0.39	0.04	304
	Dec	538	178	0.40	1.56	78.5	0.86	0.8	0.04	312
	Feb	442	125	0.38	2.80	68.0	0.48	0.67	0.03	315
11H	Oct	500	152	0.42	2.80	61.0	0.85	0.45	0.04	310
	Dec	547	162	0.29	0.87	77.2	0.45	1.02	0.04	257
	Feb	471	132	0.51	2.45	58.0	0.57	0.78	0.02	318
12H	Oct	486	141	0.55	2.90	63.3	1.27	0.85	0.02	330
	Dec	481	108	0.31	1.02	74.1	0.68	1.06	0.03	265
	Feb	421	116	0.22	2.50	68.0	0.40	0.97	0.03	257

Table – 6: Purifier Water Quality at Different Hotels

Location	Month	TDS	SO_4	Fe	NO_3	Ca	F	EC	Cl	TH
1H	Oct	52	1.45	0.04	2.13	4.56	0.02	0.34	0.38	18
	Dec	49	1.39	0.04	2.08	4.33	0.02	0.31	0.21	15
	Feb	43	1.28	0.05	2.12	4.12	0.02	0.42	0.27	18
2H	Oct	48	1.67	0.03	3.22	2.70	0.10	0.52	0.31	16
	Dec	45	1.58	0.03	3.02	2.51	0.08	0.48	0.23	16.5
	Feb	48	1.48	0.03	3.14	2.38	0.06	0.52	0.18	15.5
3H	Oct	43	1.62	0.02	1.98	3.49	0.06	0.44	0.42	17
	Dec	42	1.61	0.02	1.93	3.34	0.07	0.41	0.35	12.7
	Feb	39	1.51	0.02	2.04	2.34	0.05	0.34	0.33	10.7
4H	Oct	56	1.50	0.01	2.10	4.33	0.03	0.62	0.37	18.2
	Dec	52	1.42	0.01	1.85	4.12	0.03	0.54	0.27	14.8
	Feb	45	1.25	0.01	2.40	4.57	0.02	0.54	0.31	15.2
5H	Oct	66	1.39	0.06	3.30	5.12	0.05	0.33	0.28	19.2
	Dec	54	1.25	0.05	2.82	4.95	0.05	0.35	0.21	16.5
	Feb	52	1.33	0.06	2.80	5.40	0.04	0.25	0.23	22.8
6H	Oct	38	1.47	0.08	4.12	4.67	0.06	0.29	0.43	18.6
	Dec	44	1.28	0.07	4.01	4.52	0.07	0.24	0.39	14.8
	Feb	33	1.25	0.06	3.50	4.12	0.05	0.32	0.39	17.5
7H	Oct	59	1.61	0.04	2.37	5.55	0.02	0.32	0.36	16.3
	Dec	52	1.28	0.03	2.68	5.32	0.02	0.24	0.28	17.2
	Feb	45	1.45	0.05	2.41	4.35	0.03	0.41	0.33	15.2
9H	Oct	40	1.51	0.07	1.88	3.96	0.04	0.48	0.29	15.2
	Dec	35	1.41	0.05	2.41	3.58	0.04	0.35	0.21	16.2
	Feb	38	1.38	0.07	1.52	3.08	0.05	0.35	0.24	16.2
11H	Oct	47	1.32	0.05	3.45	4.88	0.03	0.55	0.30	17.9
	Dec	49	1.32	0.03	2.99	5.01	0.02	0.51	0.25	18.2
	Feb	36	1.4.0	0.04	3.20	4.12	0.04	0.61	0.27	14.2

Table – 8: pH, Turbidity and E coli in Municipal Water at different Hotels

Location	Month	pH	Turbidity	E coli	Location	Month	pH	Turbidity	E coli
1H	Oct	7.4	0.45	6	7H	Oct	7.6	0.28	3
	Dec	7.5	0.32	10		Dec	7.7	0.21	8
	Feb	7.7	0.32	7		Feb	7.4	0.21	5
2H	Oct	7.4	0.35	5	8H	Oct	7.3	0.41	4
	Dec	7.7	0.56	2		Dec	7.4	0.26	7
	Feb	7.6	0.21	6		Feb	6.9	0.41	5
3H	Oct	7.5	0.81	10	9H	Oct	7.6	0.83	16
	Dec	6.9	0.62	6		Dec	7.7	0.62	6
	Feb	7.6	0.28	9		Feb	7.1	0.24	7
4H	Oct	7.2	0.91	15	10H	Oct	7.2	0.98	7
	Dec	7.9	0.84	9		Dec	7.8	0.31	8
	Feb	7.5	0.21	7		Feb	7.7	0.29	6
5H	Oct	7.6	0.38	8	11H	Oct	7.5	1.36	5
	Dec	7.8	0.34	1		Dec	7.7	0.11	5
	Feb	7.7	0.13	6		Feb	7.9	0.38	8
6H	Oct	7.3	0.66	11	12H	Oct	7.6	0.84	8
	Dec	7.2	0.28	5		Dec	7.6	0.18	6
	Feb	7.6	0.29	8		Feb	8.0	0.42	9

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