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PUBLIC HEALTH QUALITY OF STREET-VENDED FRESH FRUIT JUICES SOLD IN SADDAR TOWN, KARACHI

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ABSTRACT

Street vended fresh fruit juices are generally available under unhygienic conditions and cost-effective nutritional food source in Karachi. Heavy metal contamination of food products including fresh fruit juices is of high concern worldwide. Alarming levels of heavy metals in fresh fruit juices is likely to cause deleterious health effects in public due to extensive consumption among tropical countries. For this purpose, 80 samples (60 street vended juice samples of Sugarcane, Mango, Banana, Orange, Apple and Watermelon, 10 water samples and 10 milk samples used in the preparation of theses juices) were collected from Saddar town, Karachi to determine heavy metals (Arsenic, Cadmium, Chromium, Iron, Lead, Nickel and Zinc). The mean level of heavy metals in Sugarcane juices were in the order of Pb > Ni > Fe > Zn >Cr > As > Cd, while in Mango and Banana juices were Ni > Fe > Pb > Zn > Cr > As > Cd and Pb >Ni >Fe >Zn > Cr > As >Cd. Similarly, the order of mean levels of heavy metals in Orange, apple and watermelon juices were Ni > Pb > Fe > Zn > Cr > As >Cd, Ni > Fe > Zn > Pb >As > Cr >Cd and Pb > Ni > Cr > As > Fe > Zn > Cd. Furthermore, mean concentration of heavy metals in water and milk samples were in the order of Ni > Pb > Fe > Zn > Cr > Cd >As and Pb > Ni > Fe >Zn > Cr > As > Cd. The present study also focused on microbiological investigation for the detection of Total Coliforms Count (TCC) and Total Fecal Coliforms Count (TFC) by MPN method in street vended fresh fruit juices. All fruit juices, water and milk samples from all stations have shown contamination with total coliform count and fecal coliforms. Water and milk along with their not sufficiently clean utensils were the major sources of heavy metals and pathogenic microorganisms which may cause detrimental health problems in the consumers..

Keywords: Street vended, Fruit juices, Heavy metals, Coliforms, Saddar

INTRODUCTION

Globally, increased consumption of contaminated food products with toxic heavy metals is threatening the quality of life (Krejpcio *et al*., 2005; Dehelean and Magdas, 2013). Nutritionally important heavy metals including iron (Fe), Copper (Cu) and zinc (Zn) are naturally found in fruits and vegetables in trace concentrations (Anastácio *et al*., 2018); however, human exposure to increase levels of heavy metals pose deleterious effect on global food security (Dehelean and Magdas, 2013) and issue of public health concern (Radwan and Salama, 2006; Harmankaya et *al*., 2012; Akhtar *et al*., 2015). Over the last two decades (Anastácio *et al*., 2018), fresh fruit juices and beverages are widely consumed in developing countries, particularly the tropical countries (Franke *et al*., 2005; Braganca *et al*., 2012; Salma *et al*., 2015).

Fruit juices are enormously nourished with vital minerals, vitamins, phytochemicals **(**Anastácio *et al*., 2018) and antioxidants (Akhtar *et al*., 2015). Fresh juices help to regulate the metabolism potential of body and fulfill several deficiencies of essential trace nutrients (Dehelean and Magdas, 2013). As compared to supplementary beverages, fresh fruit juices ensure healthy diet with protection from certain malignancies and cardiovascular disorders (Oguntibeju *et al*., 2013).

Street-vended fresh fruit juices prepared by dilution of fruit pulp with water (Akhtar *et al*., 2015) without heat application with the addition of several preservatives (Salma *et al*., 2015) solvents, artificial flavors and non-food grade colors to increase the volume, enhance the visible quality and shelf life of the juice. The main sources of heavy metals in agricultural activities are contaminated water (Arora *et al*., 2008), applying mineral fertilizers (Lugon-Moulin *et al*., 2006), transportation and industrial discharge (Gratani *et al*., 2008).

Karachi is the largest, most populous and the industrialized city of Pakistan. Climate of Karachi is comparatively mild due to its position at the coast. Throughout summer the temperature ranges from 26-40^{0}C, whereas, the winter temperature usually varies between 16 and 26 ^{0}C. Street vended fresh juices are commonly available under unhygienic condition and at low price in different parts of the city. The people have no choice but to consume these juices in order to quench their thirst. Although, heavy metal concentrations have been determined in different fruit juices in Multan city, Pakistan (Akhtar *et al*., 2015), none of the study with this purpose has been conducted in Karachi. Moreover, in Karachi city, fruits and vegetable are grown in highly polluted areas which have contaminated soil and receive polluted irrigation water from industrial units (Zahir *et al*., 2009). Furthermore, the additives used in juices may already be contaminated and serve as a source of heavy metal upon exposure (Akhtar *et al*., 2015). Consequently, cumulative effects of heavy metals in fruit juices accelerate more exposure and health risks.

Consumption of fruit juices potentially contaminated with heavy metals may cause serious health consequences as a result of heavy metal accumulation in human body (Krejpcio *et al*., 2005). Children are more vulnerable to heavy metal toxicity due to weaker immune system and their juice intake per unit body weight is more than adults (Anastácio *et al*., 2018). Exposure to elevated heavy metal concentrations in diet resulted in acute and chronic health effects including carcinogenesis, mutagenesis, teratogenesis, neurotoxic effects and malfunctioning of reproductive system (Galal-Gorchev, 1991; IARC, 1993; WHO, 2003; Giaccio *et al*., 2012). The awareness to heavy metal toxicity in general public particularly in developing countries is very low and they have been taken toxic heavy metals and other pollutants in their food products unknowingly.

World Health Organization (WHO) and Food and Agricultural organization (FAO) have set the maximum permissible limits for toxic and essential heavy metals in the form of Acceptable Daily Intake (ADI). Therefore, it is necessary to monitor the food quality and ensure food safety as per the nutritional requirements. Therefore, this study aims to assess the presence of toxic heavy metals and microbiological contamination in street-vended fresh fruit juices including *Sugarcane, Mango, Banana, Orange, Apple and Watermelon* being sold in Saddar Town, Karachi, and to compare the results with national and international guidelines to evaluate their public health quality.

MATERIALS AND METHOD

Study Area

Saddar Town is situated at 24°51'11.46"N 67° 1'0.02"E in the colonial heart of Karachi. It is surrounded by Clifton Cantonment and Jamshed Town to the east, Lyari town to the west while Kemari Town and the Arabian Sea to the south. It was a Karachi borough in the central part of the city that formed much of the historic colonial core of Karachi. It was formed in 2001 as part of The Local Government Ordinance 2001, and was sectioned into 11 union councils. The town system was disbanded in 2011 and it was re-organized as part of Karachi South District in 2015. This part of the city is the major hub of economic activity.

Sampling

In all, 80 samples (n = 60 street vended juice samples of Sugarcane, Mango, Banana, Orange, Apple and Watermelon, n=10 water samples and n =10 milk samples used in the preparation of theses juices) were collected from Empress Market (J-1), Jahangir Park (J-2), Bambino Cinema (J-3), Regal Chowk(J-4), Zainab market(J-5), Jama Cloth market (J-6), Urdu Bazar (J-7), Pakistan Chowk(J-8), Light house(J-9) and Tower(J-10) situated in Saddar Town, Karachi during 2018. At least three vending stalls in each zone were selected for sample collection. Sterile glass containers were used for the collection of samples, which were sustained at 4ºC in an ice box during its carriage to the laboratory.

Sample Digestion and Heavy metal Analysis

Juices and milk samples were wet digested by the method as defined in AOAC (2000). One mL sample and 10 mL HNO_3 were taken in 100mL conical flask. The contents were heated for 20 min at 70°C and then cooled followed by addition of 5mL perchloric acid. The contents were heated to 190 °C until less than 1mL residues were retained in a flask. They were cooled and diluted with deionized water up to 50 mL final volume. The digested sample was properly labeled prior to the analysis. The heavy metals were examined in all the digested samples and water samples by using appropriate kits with Merck Nova 60. Each experiment was repeated three times and the results were reported in the form of mean and standard deviation.

Microbiological Examination

Microbiological analysis was performed by MPN technique (APHA 2005). The samples were investigated for the detection of Total Coliforms Count (TCC) and Total Fecal Coliforms Count (TFC). Sterility was maintained throughout the analysis by using laminar flow hood. TCC was estimated by lactose broth (Merck, Germany) of single and double strength. TFC were examined through EC broth (Merck, Germany) by using positive single and double strength lactose broth tube.

RESULTS AND DISCUSSION

Heavy Metals Examination

a) Fruit Juices

The concentration of heavy metals found in fruit juices have been summarized in Tables 1 and Table 2 while the concentrations of heavy metals in milk and water used in fruit juices are shown in **Table 3** with their maximum permissible limits. The mean level of heavy metals in Sugarcane juices were in the order of Pb > Ni > Fe > Zn > Cr >As > Cd, while in Mango and Banana juices were Ni > Fe > Pb > Zn > Cr > As > Cd and Pb > N > Fe > Zn > Cr > As > Cd. Similarly, the order of mean levels of heavy metals in Orange, apple and watermelon juices were Ni > Pb > Fe > Zn > Cr > As > Cd, N > Fe > Zn > Pb > As > Cr > Cd and Pb > Ni > Cr > As > Fe > Zn > Cd.

Table 1. Mean Levels (±SD) of Heavy Metals in Fruit Juices of Saddar Town (ppm).

Juices	Heavy metals (ppm)						
	Arsenic (As)	Lead (Pb)	Cadmium (Cd)	Chromium (Cr)	Nickel (Ni)	Iron (Fe)	Zinc (Zn)
Guidelines	0.1	0.5	0.2	1.2	<1.0(0.5)	NA	1.5
Sugarcane (n=10)	0.058 ± 0.036	7.858 ± 1.075	BDL	0.213 ± 0.086	7.464 ± 0.403	2.670 ± 0.406	1.060 ± 0.180
Mango (n=10)	0.058 ± 0.029	3.172 ± 0.347	0.031 ± 0.020	0.860 ± 0.221	4.753 ± 0.465	3.227 ± 0.931	1.543 ± 0.325
Banana (n=10)	0.064 ± 0.030	5.370 ± 0.155	BDL	0.567 ± 0.184	3.213 ± 0.408	2.697 ± 1.113	1.400 ± 0.649
Orange (n=10)	0.090 ± 0.070	2.727 ± 0.486	BDL	0.128 ± 0.046	3.277 ± 0.260	0.820 ± 0.201	0.493 ± 0.382
Apple (n=10)	0.026 ± 0.037	1.713 ± 0.499	BDL	BDL	3.053 ± 0.339	2.817 ± 0.386	2.020 ± 0.393
Watermelon (n=10)	0.173 ± 0.040	6.057 ± 0.257	0.061 ± 0.060	0.187 ± 0.091	3.707 ± 0.363	0.141 ± 0.079	0.121 ± 0.038

*(WHO, 1999); NA=Not available; BDL = below detectable limit

Table 2. Range of Heavy Metals in Fruit Juices (ppm).

Juices	Heavy Metals (ppm)													
	As		Pb		Cd		Cr		Ni		Fe		Zn	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Sugarcane	0.023	0.095	6.64	8.652	BDL	BDL	0.12	0.29	7.03	7.824	2.31	3.11	0.86	1.21
Mango	0.031	0.088	2.85	3.54	0.02	0.05	0.69	1.11	4.28	5.21	2.36	4.21	1.22	1.87
Banana	0.042	0.099	5.21	5.52	BDL	BDL	0.41	0.77	2.86	3.66	1.86	3.96	0.89	2.13
Orange	0.012	0.146	2.18	3.11	BDL	BDL	0.09	0.18	3.05	3.56	0.59	0.96	0.22	0.93
Apple	0.004	0.069	1.16	2.13	BDL	BDL	BDL	BDL	2.69	3.36	2.45	3.22	1.59	2.36
Watermelon	0.130	0.210	5.82	6.33	0.02	0.13	0.12	0.29	3.44	4.12	0.06	0.22	0.08	0.16
Water	0.015	0.092	2.65	5.21	BDL	0.1	0.15	0.52	3.98	7.52	2.36	3.65	0.47	1.25
Milk	0.004	0.066	1.64	3.27	BDL	BDL	0.04	0.31	0.49	1.33	0.14	1.36	0.13	0.66

Table 3. Heavy Metals in Water and Milk of Fruit Juices (ppm).

Samples		As	Pb	Cd	Cr	Ni	Fe	Zn
Water		0.045 ± 0.027	4.150 ± 0.726	0.060 ± 0.031	0.314 ± 0.111	6.121 ± 1.232	3.030 ± 0.464	0.830 ± 0.303
Guidelines for water*	WHO	0.01	0.01	0.003	0.07	NA	0.05	3
	NSDWQ	≤ 0.05	≤ 0.05	0.01	≤0.02	NA	≤ 0.05	5
	US-EPA	0.01	0.015	0.1	0.005	NA	0.1	5
Milk		0.027 ± 0.026	2.533 ± 0.513	ND	0.140 ± 0.094	0.913 ± 0.314	0.717 ± 0.442	0.375 ± 0.202
Guidelines for milk**		NA	0.02	NA	NA	NA	NA	NA

*(WHO, 2011); (NSDWQ, 2008); (US-EPA, 2008) ** (EU, 2006*(WHO, 2011); (NSDWQ, 2008); (US-EPA, 2008) **, (EU, 2006)

Arsenic

In all the samples of fruit juices, arsenic is detected well below Maximum Permissible Limit (MPL) except in watermelon juice with a mean value of 0.173 ± 0.040 ppm (0.130-0.210 ppm). Anastácio *et al*., (2018) reported the maximum value of arsenic (0.01024 ppm) in orange juice, followed by 0.0098 ppm in mango juice and 0.008 ppm in apple juice. However, Dehelean and Magdas (2013) reported maximum arsenic level in apple juice (0.0036 ppm) collected from Romania market. In the present study, Orange juice has average arsenic concentration (0.090 ± 0.070 ppm) with a range of 0.012 -0.146 ppm at Empress Market and Regal chowk (J-1 and J-4). Although, the concentration of As found in the juices have no potential to cause any health effect in case of acute exposure, however, long term exposure to arsenic even in low concentrations may cause disruption in cell communication, diabetes, vascular and lung diseases and cancer (Järup, 2003).

Lead

In this study, alarming concentration of lead was found in sugarcane (mean= 7.858 ± 1.075 ppm) and watermelon juice (mean= 6.057 ± 0.257 ppm) with a range of 6.64-8.652 ppm at J-6 (Jama Cloth) and J-1 (Empress market) and 5.82-6.33 ppm at Regal chowk and Jahangir Park (J-4 and J-2) respectively as compared to other juices, absolutely crossing the maximum allowable limits. The concentration of lead in the fruits juices sold in Karachi city is extremely high as compared to the literature. Kılıç *et al*. (2015) and Krejpcio *et al*. (2005) determined a mean value of 0.0097 ppm and 0.125 ppm in orange juice which are within the guidelines as compared to the mean lead levels found in the orange juice in this study (2.727 ± 0.486). The lowest concentration of lead was detected (0.004 ppm) at Pakistan Chowk (J-8) in apple juice having mean concentration of 1.713 ± 0.499 ppm. The possible sources of Pb in sugarcane juice were lubricating oil used in machine to squeeze sugarcane, ice derived from contaminated water and water used for dilution. Contaminated soil could be another source where fruits were grown.

Cadmium

Though, cadmium is below detectable limit in the samples but a significant concentration (mean value) of 0.061 ± 0.060 ppm and 0.031 ± 0.020 ppm has been observed in the watermelon and mango juice collected from Regal Chowk and Pakistan Chowk (J-4 and J-8) respectively. However, cadmium is within the limits of the guidelines (WHO, 1999). These results are comparable with relatively lower concentrations of cadmium, 0.015 and 0.017 ppm determined by Krejpcio *et al*. (2005) and Kılıç *et al*. (2015) in orange and apple juice, respectively. In contrast, Harmankaya *et al*. (2012) and Kılıç *et al*. (2015) reported quite negligible cadmium concentration (0.0012 and 0.0092 ppm) in orange juice. Similarly, Khan *et al*., (2016) also reported low Cd contents in fruit juices collected from local markets of Lahore.

Lead and cadmium are the most hazardous heavy metals for human health if present in elevated concentrations. Moreover, cadmium has also been classified as a known human carcinogen by International Agency for Research in Cancer (IARC, 1993)**.** Several diseases are attributed to lead and cadmium toxicity including CNS and PNS problems, renal and GIT system disorders, bone diseases, and interference with the enzymatic processes of body through interaction with biological electron-donor groups (Rahman and Abdellsied, 2013). Therefore, lead and cadmium, both the heavy metals are considered as the most toxic environmental pollutants.

Chromium

Chromium seems to be present in extremely low concentrations in all the juice samples than maximum permissible limits. Throughout the study it has been investigated that highest concentration of 1.11 ppm is detected in mango juice collected at Light house (J-9) having mean concentration of 0.860 ± 0.221 ppm while minimum concentration was detected in the orange juice at Zainab market (J-5) having mean concentration of 0.128 ± 0.046 ppm while below detectable limit in apple juice. Anastácio *et al*. (2018) reported relatively lower concentrations of chromium ranging from 0.00583-0.0085 ppm in orange, 0.00913 ppm in apple and 0.0063-0.00673 ppm in mango juice. Major sources of Cr were water and milk used for the preparation of juices. Previous studies reveal that shortage of chromium in diet may cause metabolic disruption and diabetes while excess uptake may lead to skin irritation, liver, kidney and stomach problems and ultimately higher concentrations may cause cancer (Ogunkunle *et al*., 2014).

Nickel

The highest average concentration of nickel was found in sugarcane juice (7.464 ± 0.403 ppm) at J-1(Empress Market) followed by mango (4.753 ± 0.465 ppm) at J-8 (Pakistan Chowk) . Highest Ni concentration of 7.824 ppm was observed at J-1 (Empress Market) in sugarcane juice. Akhtar *et al*. (2015) reported 0.085±0.029 ppm of nickel in sugarcane and 0.161±0.046 ppm in orange juice collected from Multan city. Khan *et al*. (2016) indicated that 24

% fruit juice samples collected from local markets of Lahore have Ni level above the maximum permissible limit which may cause detrimental effects to human health. From Table 3, it is clear that Ni content in water and milk samples is quite high in this study and these were the major sources in fruit juices. Nickel contaminated soil may relocation Ni into the fruits which may then transfer to juices (Khan *et al*., 2016). Since Ni is necessary for human body, but it may cause several adverse health affects if exposed in significant doses for long term usage (Kasprzak *et al*., 2003).

Iron

There is no international or national guideline for iron uptake (WHO, 2011). But still there are some health hazards if this essential element may exceed in higher levels. Among the analyzed fruit juices, iron were found with mean maximum value in mango juice (3.227 ± 0.931 ppm) while the lowest mean concentration was observed in orange juice (0.820 ± 0.201 ppm). It was expected to get higher levels of iron in all the samples, as all are plant derived products **(**Onianwa *et al*., 1999**).** In this study, water and milk used for preparation of juices have high Fe level (Table 3) and confirms the major source of Fe in juice samples. Though, the range of iron in mango juice is found to be 2.36-4.21 ppm.

Zinc

Zinc is necessary for improved growth in human and as well as in plants in order to neutralize the toxic effect of cadmium in the living body, but its elevated levels may interfere with psychological processes of body (Radwan and Salama, 2006). In this study, mean maximum quantity of zinc was detected in apple juice (2.020 ± 0.393 ppm), whereas, in water melon the concentration was lowest (0.121 ± 0.038 ppm). In the study it has been found that zinc concentrations in apple and mango juices are not within the range of the allowable limits. Moreover, the range of zinc is found to be highest in mango juice (1.22-1.87 ppm).

b) Water and Milk

Water and milk are economical and widely used liquid products in fruit juice for dilution. In developing countries, mostly raw milk is used in street vended fresh fruit juices. Their addition is likely to increase the heavy metal contamination in juices if they are already contaminated with heavy metals. Generally, the level of heavy metals in drinking water is low but environmental factors may heavily contaminate the water sources. Drinking water guidelines are less restricted for developing countries as far as sanitary conditions are concerned (WHO, 2011). In this study, water used for the dilution was analyzed separately to assess their contamination levels. Except zinc, the concentrations of the selected heavy metals shown elevated concentration in water used in juices composition (Table 3). The mean level of heavy metals in water samples was in the order of Ni > Pb > Fe > Zn > Cr > Cd >As. The highest mean concentration found in Nickel (6.121 ± 1.232 ppm) followed by lead (4.150 ± 0.726 ppm). Highest Ni and Pb concentration were observed at Jama Cloth (J-6) and Empress Market (J-1). Pakistan chowk (J-8) have highest Fe concentration while Zainab market (J-5) receives low Fe contents in water.

In contrast, in milk samples, lead is alarmingly high (2.533 ± 0.513) as compared to the guideline (0.020 ppm) (EU, 2006) followed by Nickel (0.913 ± 0.314 ppm). The order of mean values of heavy metals was Pb > Ni >Fe > Zn > Cr> As > Cd. Favorably to human health, cadmium was below detectable and in minute quantity. Heavy metals are naturally present in water and raw milk but several studies have revealed the significant considerable concentrations recently (Younus, 2016; Javed *et al*., 2009). All the water samples showed a significantly increased value of essential and non-essential heavy metals above guidelines (WHO, 2011; NSDWQ, 2008; US-EPA, 2008) except that of zinc (0.830 ± 0.303 ppm) which is within maximum allowable limits.

Microbiological Profile:

a) Fruit Juices

In Saddar town, fruit juices from all stations have revealed contamination with total coliform count and fecal coliforms (Table 4). Minimum, maximum and mean values of TCC and TFC of all the fruit juices are presented in Table 4. The minimum TCC value of 43(Log10 1.633) MPN/100mL was observed in orange juice collected from empress market while maximum TCC value of ≥2400 (log10 3.38)MPN/100mL was observed in sugarcane, Banana and apple juice collected from Empress Market (J-1), Jehangir Park (J-2) and Bambino Cinema (J-3). These results corroborated with the findings of Alamgir *et al*. (2015a) (Karachi, Pakistan) and Ahmed *et al*. (2009) (Dhaka, Bangladesh).

TFC values ranged between 7(Log10 0.845) MPN/100mL to 1100 (Log10 3.041) MPN/100mL. interestingly Apple juice collected from Jama cloth (J-6) market having minimum TFC but apple juice collected from Bambino cinema (J-3) have highest TFC. Sugarcane and banana juice collected from J-1 (empress market) have also highest

TFC. According to Gulf Standards (2000) the acceptable limit for TFC is zero per mL of juice. All the samples failed to meet the guideline. Alamgir *et al.* (2015a) already reported high TFC in fruit juices available in Karachi. Higher prevalence of fecal coliforms in fruit juices indicates that ice, milk and water used for juice preparation and water used for washing of utensils may be of poor class (Lewis *et al.*, 2006; Tambekar *et al.*, 2009; Lateef *et al.*, 2006). Teeming houseflies in street vended stalls and absence of sanitary facilities are another sources of contamination (Sandeep *et al.*, 2001; Barro *et al.*, 2006).

Table 4. Microbiological investigation of street vended juices available in Saddar Town, Karachi.

Juices	TCC log $_{10}$ (MPN/100mL)		TFC log $_{10}$ (MPN/100mL)	
	Mean ± standard deviations	Range (Min-Max)	Mean ± standard deviation	Range (Min-Max)
Sugarcane	3.035±0.362	2.380-3.380	2.2437±0.490	1.322-3.041
Mango	2.789±0.288	2.322-3.041	2.2430±0.254	1.875-2.663
Banana	2.793±0.518	1.968-3.380	2.235±0.547	1.041-3.041
Orange	2.150±0.298	1.633-2.663	1.561±0.315	1.041-2.176
Apple	2.575±0.533	1.806-3.380	1.886±0.660	0.845-3.041
Water melon	2.269±0.174	2.079-2.663	1.754±0.282	1.447-2.176
Water	2.875±0.525	2.176-3.380	2.623±0.674	1.806-3.380
Milk	2.957±0.368	2.322-3.380	1.435±0.505	0.602-1.968

b) Water

In Karachi, 78 % tap water available in the city was contaminated with the organisms of public health and unfit for human use (Alamgir *et al.*, 2017). The studies point out heavy microbial and chemical effluence of water in different towns in Karachi (Amin *et al.*, 2019, Alamgir *et al.*, 2015b and c, Arain *et al.*, 2009; Hasnie and Qureshi, 2004). In this study, the coliforms and fecal coliforms were remarkably higher in all water samples (Table 4) which an indication of fecal contamination of water supplies. Mean TCC and TFC value of all water samples are 1258 (Log_{10} 2.874) MPN/100mL and 1048 (Log_{10} 2.623) MPN/100mL respectively. Minimum TCC and TFC value of 150 (Log_{10} 2.176) MPN/100mL) and 64 (Log_{10} 1.806) MPN/100mL) were observed at J-7 (Urdu Bazar) and J-1 (Empress Market) while Jehangir Park (J-2), Regal Chowk (J-4), Light house (J-9) and Tower (J-10) receive >2400 MPN/100mL in both TCC and TFC. The results of the present study are in accordance with the findings of Amin *et al.* (2019), Alamgir, *et al.* (2017), Hussain *et al.* (2007) and Shaikh *et al.* (2008) where they have reported that water supply in Karachi is contaminated with microorganisms and it is attributed to prevailing poor sanitation conditions, improper water distribution system, non-point sources of untreated domestic and industrial effluents, technical difficulties, leakage and seepages of old pipe lines.

c) Milk

Milk quality in Pakistan like India and Bangladesh is very poor due to unhygienic milking, storage in poor container, unsafe transportation and unhygienic condition of farms (Afzal *et al.*, 2011). Microorganisms have an ability to produce lactic acid which is liable for most of the physical, chemical and aromatic transformations in milk and milk based items (Ogier *et al.*, 2002). These microorganisms utilize milk sugars as a food and transform them into lactic acid which is responsible for low pH of milk, rendering milk proteins particularly casein and to denature into solid form (Aziz *et al.*, 2009). From Table 4, it is stated that milk samples collected from Jehangir Park, Regal Chowk and Urdu Bazar (J-2, J-4 and J-7) showed >2400 TCC MPN/100mL with a mean value of 1209 (Log_{10} 2.957) MPN/100mL. Minimum TCC of 210 (Log_{10} 2.322) MPN/100mL was monitored at Zainab market (J-5). Mean TFC in all the samples was 43.9 (Log_{10} 1.435) MPN/100mL and varied from 4 (Log_{10} 0.602) to 93 (Log_{10} 1.968) MPN/100mL. Light house (J-9) have lowest TFC while Jehangir Park and Jama cloth (J-2 and J-6) have highest TFC.

Conclusion

It is concluded that fresh fruit juices were grossly contaminated with heavy metals and organisms of public health importance. The consumption of these juices was cause of variety of ailments in humans. Water and milk used for the preparation of juices should be regularly monitored for the heavy metals and pathogenic microorganisms because they are major sources of contamination. Water should be properly treated before consumption. It is compulsory that the government must implement awareness programs among local peoples and street vendors along with the surveillance coordination which would monitor food safety permitting to the International Health Standards.

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