Page 332 to 338

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Analysis of Heavy Metals and Some Constituents in Soft Drinks

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Abstract

In this study five brands of Soft drinks were qualitatively analyzed for the presence of Sugar, Reducing sugar, Carbon dioxide, Alcohol and Phosphate while the acidity, pH, and heavy metals concentration were quantified. Qualitative analysis showed the presence of Sugar, Reducing Sugar, Phosphate, Alcohol, and Carbon dioxide in the soft drinks. All the soft drinks were acidic with low pH ranging from 2 to 5 and the acid concentration was relatively low between 4 and 14.8 g/L. Heavy metal analysis showed the presence of lead and mercury in all the soft drinks.

Keywords: *Soft drinks; Sugar; Reducing Sugar; Alcohol; Heavy Metals*

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Introduction

"An ounce of prevention is worth a pound of cure" is a well known proverb. Today, man is continuously exposed to a variety of toxic chemicals mainly due to changes in life style. The food we eat, the water we drink, the air we breathe, and the environment we live in are contaminated with toxic xenobiotics (manmade compounds) (Xavier., *et al*. 2004). Eating habits and food consumption have a direct relation with obesity, diabetes, cancer, hypertension and coronary heart disease (Amas, 2006). A soft drink is a drink that typically contains carbonated water, a sweetener, and a natural or artificial flavoring. The sweetener may be sugar, high-fructose corn syrup, fruit juice, sugar substitutes, or some combination of these. Soft drinks may also contain caffeine, colorings, preservatives, and other ingredients. In Kerala today, soft drink is one of the most consumed beverages.

These drinks are readily consumed on daily bases especially when undergoing tedious activities like hard work and sport (EFSA, 2006). Also, with the relatively affordable prices, they are highly consumed during leisure and relaxation outings and serve the general public in celebrations such as traditional marriages, weddings, funerals, etc (Dharmasena, 2010). The high consumption rate of soft drink is attributed to the characteristic taste and flavor as well as their thirst quenching potential (Phillip., *et al*. 2013).

These characteristics are defined by the constituents present such as sugar which is responsible for its sweetness, carbonated water which is water compressed with carbon dioxide to make it an ultimate thirst quencher and flavoring agents to add flavor to the drinks

(Kirk,1991. Consumption of soft drinks leads to severe health disorders like dental decay, heart diseases, neurological diseases etc (Arun., *et al*. 2009). Research has proved that a glass of fizzy soft drink is nothing less than a killer beat up on the body (Lall, 2009). There is a positive link between overweight and soft drink consumption (Ludwig., *et al*. 2001). Over the past 2 decades, various changes in lifestyle have brought about an alarming increase in the prevalence of overweight, obesity and type II diabetes all over the world (Botero and Wolfsdorf, 2005). India is no exception; it has a population of 35 million persons with diabetes and, according to WHO estimates, this figure will climb to 73.5 million by 2025. (www.diabetes.co.uk). Thus, this study was aimed to evaluate some constituents of selected soft drinks in Kerala which may be characteristic of their taste and consumption and also assessed two heavy metals Lead and Mercury for possible contamination.

Materials and Methods

Five brands of Soft drinks were purchased from local grocery stores in the Kollam district of Kerala State and were qualitatively analyzed for the presence of Sugar, Reducing sugar, Carbon dioxide, Alcohol and Phosphate while the acidity, pH, and heavy metals concentration were quantified. The presence of sugar, Reducing Sugar, Carbon dioxide, Phosphates, Alcohol and acidity were determined according to the procedures of AOAC (2005). The acidity of the soft drinks was done by the acid titration method. pH was done by the dipstick method. Heavy metals analysis were done using Atomic absorption spectrophotometer.

Results

Qualitative analysis showed the presence of Sugar, Reducing Sugar, Phosphate, Alcohol, and Carbon dioxide in the soft drinks (Table-1). High Sugar content was seen in Can Pepsi, whereas Bottled Miranda, Can 7 up and Bottled Frooti showed moderate quantity of Sugar. Bottled Neeta showed Low sugar content. Reduced sugar was abundantly seen in Bottled Miranda and Bottled Frooti whereas Can Pepsi, Can 7 up and Bottled Neera contain moderate amount of reducing sugar. Phosphate was found to be absent in Bottled Miranda and Can 7 up where as Bottled Neera and Can Pepsi contain moderate amount of phosphate.

In Bottled Frooti low level of Phosphate was determined. Alcohol was present in small quantities in all the samples except Bottled Frooti. Carbon dioxide was present abundantly in Can Pepsi, Bottled Miranda and Can 7up, where as it was absent in Bottled Neera and Bottled Frooti. All the soft drinks were acidic with low pH ranging from 2 to 5 and the acid concentration was relatively low between 4 and 14.8 g/L (Table-2). Heavy metal analysis showed the presence of lead and mercury (Table-3). Highest concentration of Lead was found in the sample Miranda (5.34 mg/L) where as lowest value was shown in bottled Frooti (0.30 mg/l). Can Pepsi showed a value of 1.12 mg/L, whereas Can 7 up and Bottled Neera showed value of 0.51 mg/l and 0.40 mg/l respectively. Highest value of Mercury was found in Bottled Miranda (0.020 mg/l) followed by Can 7 up (0.019 mg/l). Bottled Frooti and Can Pepsi showed a value of 0.015 mg/l and 0.09 mg/l respectively. Neera showed lowest value of Mercury (0.008 mg/l).

Samples	Benedict test	Fehling's solution test	Test for phosphate	Test for alcohol	Test for Co_2
Can Pepsi	+++	++	++	++	+++
Bottled Miranda	++	+++	_	++	+++
Can 7 up	++	++	_	++	+++
Bottled Neera	+	++	++	++	_
Bottled Frooti	+++	+++	+	_	_

'+++' - High level: '++' - Moderate level: '+' - Low level: '_' – absent

Table 1: *The Presence of Sugar, Reducing Sugar, Phosphate, Alcohol and Carbon dioxide in Soft drinks.*

Samples	pH	Acid Level (g/L)
Can Pepsi	4	4.0
Bottled Miranda	2	6.0
Can 7 up	3	6.8
Bottled Neera	5	5.6
Bottled Frooti	2	14.8

Table 2: *pH and acid concentration in Soft drink Samples.*

Samples	Lead (Mg/L)	Mercury (mg/L)
Can Pepsi	1.12	0.009
Bottled Miranda	5.34	0.020
Can 7 up	0.51	0.019
Bottled Neera	0.40	0.008
Bottled Frooti	0.30	0.015

Table 3: *Concentration of heavy metals Mercury and lead in soft drink samples.*

Discussion

The most liable reasons for soft drink consumption are usually its sweetness due to the presence of sugar as well as the thirst quenching nature of carbonated water used (Banumathy and Hemameena, 2006). From this study, all the soft drinks showed the presence of sugar; both reducing and non-reducing sugars which are responsible for its sweetness. But the sugar content seemed to vary in different samples. High fructose corn syrup (HFCS) is now the preferred sweetener (instead of cane sugar) in soft drinks as it is cheaper and sweeter. The liver is the organ that must metabolize the fructose in HFCS and researchers have found that animals on high-fructose diets develop liver disease and metabolic disorders.

Despite loud disclaimers from corn syrup manufacturers, many experts strongly believe HFCS consumption to be a major promoter of diabetes. HFCS is associated with poor development of collagen, a very important structural protein, found in all body tissues especially in the circulatory system, the muscles and skeleton. The ingredient in fizzy drinks causing the damage is fructose, which is highly absorbable in the liver. It does not affect insulin production and goes straight to the liver where it is converted to fat. Aspartame is the main artificial sweetener used in diet sodas is a potent neurotoxin (nerve poison) and hormonal disrupter and thus harmful to human health.

Carbon dioxide which gives soft drink the frizzy effect as an ultimate taste quencher was present in most of the drinks except for the Frooti and Neera which are not usually carbonated. Phosphorous is an important element for the body. It forms a major constituent of the DNA, cell membrane layer and channels and is also vital for teeth and bone formation (EFSA, 2006). Phosphate was found to be present in three samples. Phosphates used in fizzy drinks, as well as many other processed foods, has been found to speed up the ageing process. This is not bad just in terms of wrinkles, but also health complications that some with age, such as, chronic kidney disease and cardiovascular calcification.

Although low acid concentration could be of importance in killing gastrointestinal bacteria in the body, low pH could cause teeth erosion (Panich and Poolthong, 2009). The effect of low pH has been shown in so many studies to be responsible for tooth decay especially when the acidity (acid concentration per liter) of the soft drink is high (Larsen and Nyvad, 1999). In this study, most of the soft drinks had a relatively low pH which indicating the harmful effect of Soft drink on human body.

Industrial processes require good sterilization procedures and quality control to ensure the safety of soft drinks. In this study alcohol content was present in all the four samples and found to be absent in the bottled Frooti. Poor sterilization during production may lead to microbial contamination which may ferment sugar to alcohol (Juvonen., *et al*. 2011) Results from this study showed the presence of alcohol in soft drinks. Though the level of alcohol was not quantified, previous studies have shown alcohol level in soft drinks to be present in very minute amounts less than 0.05% which is very in significant to cause related alcohol intoxication problems such as drunkenness (Juvonen., *et al*. 2011). In case of Neera the alcohol content may be due to the natural fermentation at ambient temperature within a few hours of extraction.

Most important result of this study was the presence of heavy metal Lead and Mercury in all the samples. Water, if not purified during the production process of soft drink may be the source of contamination by heavy metals which constitute a major threat to public health. As such, certain standards and guidelines on the tolerable levels of heavy metal contaminants in water have been defined by World health Organization, and United States Environmental Protection Agency (2011). In this study lead was present in all the soft drinks and the level was above the WHO tolerable limits. Lead was shown to be detectable in all the soft drinks and the concentrations were also found to be beyond the accepted MCLG (0.00) and MCL (0.015) limits.

Mercury was also detected in most samples and the values were far above the recommended acceptable MCL limit of NIS (0.001 mg/L) and EPA (0.002 mg/L) as well as their MCLG limit of 0.002 mg/L. A long-term consumption of foods containing heavy metals above the tolerance levels, has a hazardous impact on human health. Because soft drinks are widely consumed, they contribute a large fraction to the heavy metals intake and, therefore, strict control of these elements is advisable (Bingol, 2010).

Analysis of the toxic metals in these soft drinks in our society is very important because of the health hazards emanating from drinking them. Toxic metal ions even in small quantities present in the system are not easily eliminated from the system and could accumulate over the years causing diseases like skin cancer, lung cancer, liver cancer, heart diseases, brain damage, lymphatic cancer, lung diseases, kidney failure, memory loss and mental retardation in children.

Due to the wide consumption of soft drinks, they contribute a large fraction to heavy metals intake and therefore strict control of these elements is advisable. For this purpose, the steps in all processes must be monitored to prevent contamination by heavy metals. Application of agricultural wastes should be made at a rate which exceeds their levels in water. Heavy metal contamination in food and drinks has been an important factor; therefore, facility modernization and quality manufacturing are required to prevent heavy metal contamination in drinks and thus the possible health hazards to the consumer.

Atmospheric contamination, the excessive use of fertilizers and pesticides and sewage sludge or irrigation with residual water is among the source of contamination of foodstuffs and beverages. As a result of soil, atmosphere, underground and surface water pollution, foods and beverages are contaminated with heavy metals (Adepoju-Bello., *et al*. 2009; Bingol., *et al*. 2010). Lead and cadmium toxicity is well documented and is recognized as a major environmental health risk throughout the globe (Bingol., *et al*. 2010). Lead is known to affect humans and animals of all ages; however, the effects of lead are most serious in young children. Due to the high toxicity of lead and Mercury, it is of public health interest that these metals are quantified in beverages and foodstuffs.

Conclusion

The presence of sugar, carbon dioxide, phosphate and acidity in soft drinks gives it the characteristic taste which justifies its frequent consumption. But drinking just two sugary soft drinks a week increases the amount of insulin the pancreas produces and can double the risk of developing pancreatic cancer. Drinking just one fizzy drink a day could increase a man's chance of developing prostate cancer by around 40 per cent. Drinking just one-and-a-half cans a day can increase a girl's breast cancer risk by per cent. Some chemicals that are used to colour soft drinks can cause cancer. Caramel the common artificial coloring agent used in soft drinks, especially kola drinks has been linked to genetic defects and cancer.

The high consumption of soft drinks gives room for the risk of heavy metal contamination and intoxication as lead and mercury were found to be present in most of the soft drinks and the values were above the accepted limits for consumption. As such, soft drink consumption may constitute a major public health concern for heavy metal contamination and thus, there is need for regulatory bodies to monitor and control the quality of the soft drinks in order to ensure safe consumption and minimize the possible underlying risk. Quality control should be ensured during production and the quality of sugar and water used for soft drink production be evaluated for the presence of heavy metals at the level of purification and sterilization to reduce or prevent subsequent health effects of intoxication.

Though soft drinks give plenty of calories to consumers, these hardly have any nutritional value nor do they satisfy hunger. Thus, most consumers of the soft drinks do not cut down on their normal calorie consumption and thus end up being obese. The 'diet' soft drinks are no better. Though there is little evidence to support that diet soft drinks lead to obesity and diabetes, yet chemicals such aspartame, saccharin, sucralose, acesulfame potassium that are used to sweeten those have been alleged to be carcinogenic.

Increased prevalence of diabetes in India can be largely attributed to changes in the lifestyle and an increasing preference for a western diet. The consumption of soft drinks has also increased at an alarming rate in India. This study clearly indicated the presence of harmful substances in the Soft drinks and also the presence of heavy metals like Mercury and Lead. Considering the adverse health effects of soft drinks, more state governments should join hands in the crusade against soft drinks to safeguard the health of the people. The Central and state governments together with healthcare professionals should educate people about the harmful effects of soft drinks rather than thwarting the good initiatives being taken by a few states.

References

1. AOAC. Official Methods of Analysis of AOAC International (18th ed.) AOAC International, Gaithersburg, MD, USA (2005).
2. Adepoju Bello AA., *et al*. "Analysis of selected metallic impurities in soft drinks marketed in Lagos, Nigeria." *African Journal of Biotechnology* 11.20 (2012): 4676-4680.
3. Arun Raj., *et al*. "Biochemical effects of feeding Soft drinks and ethanol." *Indian journal of Experimental biology* 47.5 (2009): 333-337.
4. Amas AY. "The effect of television food advertisement on children's food purchasing requests". *Pediatrics International* 48.2 (2006):138-145.
5. Anderson GH. "Much ado about high-fructose corn syrup in beverages: the meat of the matter." *The American Journal of Clinical Nutrition* 86.6 (2007): 1557-1558.
6. Banumathy and Hemameena. "Customer satisfaction and customer preferences towards Soft drinksTotal Qual". *Management Business Excel* 19.7 (2006): 843-853.
7. Bingol M., *et al*. "Determination of some heavy metal levels in soft drinks from Turkey using ICP-OES method." *Czech Journal of Food Sciences* 28.3 (2010):213-216.
8. Ballew C., *et al*. "Beverage choices affect adequacy of children's nutrient intakes." *Archives of Pediatrics & Adolescent Medicine* 265.22 (2000): 1148-1152.
9. Botero D and Wolfsdorf J I. "Diabetes mellitus in children and adolescents". *Archives of Medical Research* 36.3 (2005): 281-290.
10. Dharmasena K A. The Non-Alcoholic Beverage Market in the United States: Demand Interrelationships, Dynamics, Nutrition Issues and Probability Forecast Evaluation (PhD thesis) Texas A&M University (2010).
11. Diabetes amongst children soaring in India. (2006).
12. Engwa Azeh Godwill., *et al*. "Determination of some soft drink constituents and contamination by some heavy metals in Nigeria." *Toxicology Reports* 2 (2015): 384-390.
13. EPA (United States Environmental Protection Agency). Edition of the Drinking Water Standards and Health Advisories Office of Water U.S. Environmental Protection Agency, Washington, DC. 8, 719-726, 731-732. (2011).
14. EFSA (European Food Safety Authority). The setting of nutrient profiles for foods bearing nutrition and health claims pursuant to Article 4 of the Regulation (EC) No 1924/2006: Scientific Opinion of the Panel on Dietetic Products, Nutrition and Allergies (2006).

15. Forshee R A., *et al*. "A critical examination of the evidence relating high fructose corn syrup and weight gain." *Critical Reviews in Food Science and Nutrition* 47.6 (2007): 561-582.
16. Girma W., *et al*. "Determination of the level of some trace and heavy metals in some soft drinks of Ethiopia." *Journal of Chemical, Biological and Physical Sciences* 2.3 (2015): 84-88.
17. Harnack L., et al. "Soft drink consumption among US children and adolescents: nutritional consequences." *Journal of the American Dietetic Association* 99.4 (1999): 436-441.
18. Hector D., *et al*. "Soft drinks, weight status and health: a review." *NSW Centre for Public Health Nutrition, Sydney, Australia* (2009).
19. Ibrahim D., *et al*. "Heavy metal poisoning: clinical presentations and pathophysiology." *Clinics in Laboratory Medicine* 26.1 (2006): 67-97.
20. Juvonen R., *et al*. "Microbiological spoilage and safety risks in non-beer beverages." (2011).
21. Kirk R S. Pearson's Composition and Analysis of Foods (9th ed.) Longman (1991).
22. Larsen M J and B Nyvad B. "Enamel erosion by some soft drinks and orange juices relative to their pH, buffering effect and contents of calcium phosphate". *Caries Research* 33.1 (1999): 81-87.
23. Lall Meeta. "Cut out the Killer colas", The Hindu Daily, July 26. 6 (2009).
24. Ludwig David S., *et al*. "Relation between consumption of sugar sweetened drinks and childhood obesity: a perspective observational and analysis". *Lancet* 357.9255 (2001): 505-508.
25. Monsivais P., *et al*. "Sugars and satiety: does the type of sweetener make a difference?" *The American Journal of Clinical Nutrition* 86.1 (2007): 116-123.
26. Panich M and Poolthong S. "The effect of casein phosphopeptide–amorphous calcium phosphate and a cola soft drink on *in vitro* enamel hardness." The Journal of the American Dental Association 140.4 (2009): 455-460.
27. Petridou E., *et al*. "The role of dairy products and non-alcoholic beverages in bone fractures among school age children." *Scandinavian Journal of Social Medicine* 25.2 (1997): 119-125.
28. Phillip B B., *et al*. "Demand for non-alcoholic beverages among urban households in SouthWest, Nigeria." *African Journal of Food, Agriculture, Nutrition and Development* 13.3 (2013): 7853-7869.
29. Sanjita Das and Sunita Singh Rajput. "Toxic Level of Soft Drinks and Sports Drink on Health Statu." *IJAPBC* 2.4 (2013).
30. Tahmassebi JF., *et al*. "Soft drinks and dental health: a review of the current literature." *Journal of Dentistry* 34.1(2006): 2-11.
31. Taylor E D., *et al*. "Orthopedic complications of overweight in children and adolescents". *Pediatrics* 117.6 (2006): 2167-2174.
32. Vaux B. "105 What is your generic term for a sweetened carbonated beverage?" *Harvard Dialect Survey accessed* (2011).
33. WHO. Guidelines for Drinking Water Quality (4th ed.) Geneva (2011): 72-475.
34. WHO/FAO Expert Consultation. "Diet, Nutrition and the Prevention of Chronic Diseases". *Geneva*, WHO (2003).
35. Wallace H A. "Principles and Methods of Toxicology, 4th ed". Taylor and Francis Publishing Inc. Philadelphia. (2001): 50-55.
36. Xavier R., *et al*. "Farmers and formulations - Rural health perspective". *Medical Journal of Malaysia* 60.1 2004): 118-124.
37. Xavier R., *et al*. "Soft Drinks and Hard Facts: A Health Perspective." *ASEAN Food Journal* 14.2 (2007): 69-81.