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BEVERAGES: HARMFUL EFFECT ON HUMAN HEALTH

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ABSTRACT

Beverages are the most consumable drinks worldwide although of their serious impact on human health, it affects many body systems such as loco motor system, gastrointestinal system, and cardiovascular system, central nervous system and even reproductive system, and simply it affects all the body structures. Diabetes, heart diseases, bones and teeth disorders are frequently induced due to excessive consumption of beverages particularly among children and aged persons. More importantly, the association between sugar sweetened beverage consumption and metabolic disorders was true irrespective of the existing adiposity. This ill effect of consuming sugar sweetened beverages is primarily a consequence of adverse sugar metabolism that is triggered in the body. The purpose of this article is to present what is known about the effect of beverage consumption on longer term harmful effects on human health. Specific beverages addressed include water, other energy-free beverages (diet soft drinks, coffee and tea), and energy-containing beverages (soft drinks, juices and juice drinks, milk and soy beverages, alcohol).

KEYWORDS: Beverages, Soft drinks, Diabetes mellitus, Dental disorders, Harmful effects on health, Toxicity.

INTRODUCTION

Beverages is the most consumable drinks worldwide although of their serious impact on human health, it affects many body systems such as locomotor system, gastrointestinal

system, circulatory, central nervous and even reproductive system, simply it affects all the body structures. Diabetes, heart diseases, bones and teeth disorders are frequently induced due to excessive consumption of soft drinks particularly among children and aged persons. Some beverages have been suggested to have a harmful effect on the dental and general health of people including children and adolescents.[1] The high content of sugar and acids, which have cariogenic and acid genic potential, can contribute to dental caries, tooth erosion, as well as contributing to health effects such as overweight and obesity and may be associated with an increased risk of type 2 diabetes, liver diseases, kidney diseases, heart problems.[2] A soft drinks (also called soda, pop, fizze drink, tonic, mineral or carbonated beverage) is a beverage that typically contains water (often, but not always carbonated water), a sweetener, and a flavoring agent. The sweetener may be sugar, high-fructose corn syrup, or a sugar substitute (in the case of diet drinks).[3] Having appropriate recommendations that would help cut down the consumption of sugar sweetened beverages is thus the need of the hour. Just like on a cigarette pack; there should be a warning printed on beverages “IT IS INJURIOUS TO HEALTH".

TYPES OF BEVERAGES

According to Roethenbaugh[4], there are four primary sectors of the global commercial beverage market (Figure 1): hot drinks, milk drinks, soft drinks and alcoholic drinks. Hot drinks, include tea and coffee. Soft drinks have five main subcategories: bottled water; carbonated soft drinks; dilutables, (squash, powders, cordials and syrups); fruit juices (100% fruit juice and nectars (25–99% juice content); still drinks, including ready-to-drink (RTD) teas, sports drinks and other noncarbonated products with less than 25% fruit juice). Alcoholic drinks, including beer, wine, spirits, cider, sake and flavored alcoholic beverages. Amongst the different types of beverages, milk, soft drinks, and fruit juices are the most important and they are consumed in high amounts.[5,6] Beverages could be also classified into alcoholic and non alcoholic drinks. An alcoholic beverage is a drink that contains ethanol. A non-alcoholic beverage is a drink that contains little or no alcohol. This category includes low-alcohol beer, non alcoholic wine, and apple cider if they contain less than 0.5% alcohol by volume and they are called soft drinks.[4]

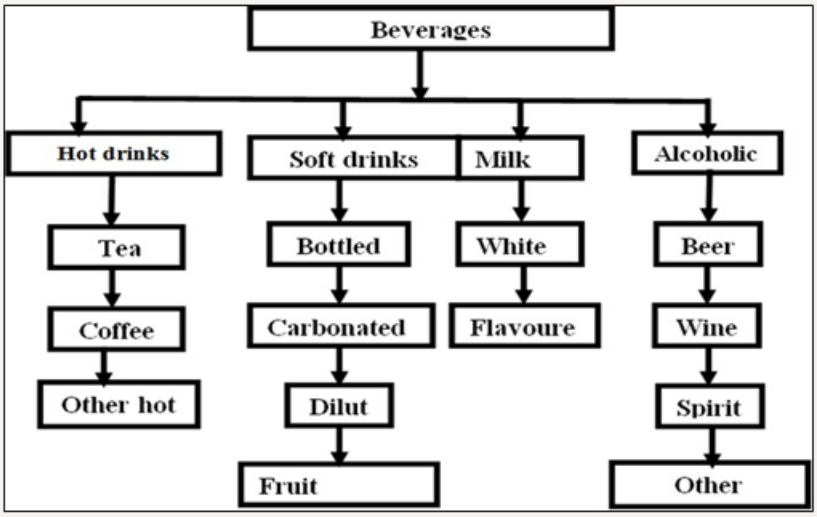

Figure 1: Beverage sectors and segments. Source: Soft drinks world, (2003).

Ingredients of Soft Carbonated Beverages[7]

Ingredients	Usage level	Functions
Water	Approx. 90% of a regular product and 98% in a low calorie beverage (http://www.britishsoft-drinks.com)	Tasteless; odourless; acts as solvent for other ingredients; provides hydration
Sweeteners	8-12% w/v	Taste; Balances flavour
Flavourings	0.1-0.5% w/v	Give flavour; Provide uniqueness to the drink
Carbon dioxide	0.3-0.6% w/v	Sparkling effect to the drink; Gives rise to fizz and effervescence; Sharpen the flavour and taste; Preservative effect
Acidulants	0.05-0.3% w/v	Improve beverage flavour profile; Provides sourness to modify taste of sugar; Imparts tart taste; Preservative effect
Colours	0-70 ppm	Delivers colour; Make product aesthetically appealing; Physiological impact; Helps to adjust natural variations in colour during storage or processing
Preservatives	As per standards	Maintain safety; To protect flavour; To retain freshness
Stabilizers	01-0.2% per GMP	To sustain emulsions; Avoid disintegration on storage; Enhance mouthfeel
Emulsifiers		Hold fatty flavours suspended in beverage; Avoid formation of rings and layers
Fruit Juices	Usually up to 10%	Reduces the amount of sugar usage; Add flavour and acidity
Other Ingredients (saponins, antioxidants etc)		Saponins help in producing stable foams; Antioxidants prevent deterioration caused due to oxidation of flavours and colour

Toxicity of additives

Caffeine

Caffeine in carbonated drink is more readily absorbed than any other drink (like coffee, chocolate etc.). Caffeine disturbs sleep by stimulating nervous system. It also makes premenstrual syndrome worse, causes dehydration and induces stomach to produce acids,

aggravating hyperacidity. Since caffeine disturbs sleep, the body is more likely to produce C - reactive protein, which plays an importantrole in heart disease. Caffeine has been linked to birth defects, some forms of cancer, insomnia, irregular heartbeat, high blood pressure, high cholesterol, breast lumps, and depletion of some nutrients.[8]

Carbon dioxide

The gas used to make soda bubbly is the same poison we eject out of our bodies through our lungs. This gas is great for plants but it is bad news for human beings.[8]

Harmful sweeteners

Whether it is high fructose corn syrup or unnecessarily-high amounts of sucrose, carbonated sodas provide more calories than are generally needed by the average drinker. All this sugar can cause people to gain weight, to develop a high number of cavities, and, in the case of people with ADD or ADHD, to exhibit out-of-control behavior.[9]

Acid: In addition to the acids formed by bacteria in the mouth when they feed on sugar, the Pediatric Dental Health site advises most carbonated beverages contain phosphoric acid, citric acid or carbonic acid. Any of these can erode tooth enamel. According to Delta Dental, the calcium in saliva works to remineralize teeth after exposure to small amounts of eroding acid, but with the increased consumption of carbonated beverages, it's not enough. Even diet soft drinks contain damaging acids. People often consume many soft drinks over the course of a day, which means tooth enamel is exposed to the acids over several hours.[8]

Contaminated water: The carbonated-drink-producing industry uses huge amounts of water; like all other industries, they use product ingredient sources that are least expensive.

SPOILAGE AND SAFETY CONCERNS

Soft carbonated beverages represent an important market segment of the food industry. These beverages are nutrient deficient and hence are spoiled by very few organisms. Carbonated beverages may get microbiologically contaminated during the production process. Factors mainly responsible for microbiological contamination are: ingredients, production equipments, packaging materials, workers and premises. Yeasts are accounted to be the chief spoilage microorganism in soft carbonated beverages, primarily due to their capability to resist low pH and high carbonation. Several yeasts can even tolerate low temperature and medium high carbonation. Spoilage in soft carbonated beverages is thus mainly due to

facultative anaerobes which can grow in the presence or absence of oxygen. Spoilage due to moulds and bacteria is very uncommon in carbonated beverages as these are sensitive to carbon dioxide.

Increase in the population of yeast in the soft carbonated beverage plant may be attributed to insufficient heat treatment during clean in place system, personal hygiene of the handlers, poor quality raw materials and overall hygiene of the plant.

Davenport (1996) gave classification of yeasts responsible for spoilage in soft carbonated beverages. He divided various spoilage causing yeasts into four groups (1-4) Table 9. Group 1 comprises yeasts which can adapt to the carbonated beverage environment and are potent to cause spoilage in less numbers also. These are preservative resistant, osmotolerant and require vitamins to grow. Group 2 involves the organism which can cause spoilage only if something goes wrong during the manufacturing process. Group 3 implies to class of organism which are indicators of poor hygiene. Group 4 are called aliens that are those which are out of their indigenous environment.

Moulds grow as white, delicate, fluffy, cottony masses suspended in soft drinks. Fungal spores or conidia and mycelium fragments can contaminate beverages at any stage of the production process.[10]

Groups of yeast	Species of yeast
Group 1	*Dekkera anomala, Saccharomyces cerevisae, Zygosaccharomyces bisporus, Z. lentus*
Group 2	*Candida parapsilopsis, Pichia anomala, S. cerevisae*
Group 3	*Candida sake, C. saloni, Rhodotorula glutinis, Aureobasidium pullulans*
Group 4	*Kluyveromyces marxianus, K. lactis* (both are dairy yeast)

Source: Davenport, 1996

HARMFUL EFFECTS OF BEVERAGES ON HEALTH

Soft carbonated beverages are gaining popularity day by day. Unfortunately, carbonated beverages are frequently used as a replacement for water and other healthy beverages. These have many disadvantages like obesity, dental caries, dentine erosion, loss of calcium, heart burn, belching, metabolic disorders like diabetes and dehydration.

Obesity and weight-related diseases

Generally beverages have high concentration of sugars. Imbalance in energy levels which may be because of endocrinal, genetic or idiopathic reason. Soft carbonated beverages overloaded with sweeteners seem to be a contributory factor to childhood obesity. These beverages are energy dense and also have a high glycaemic index. Intake of one carbonated beverage drink leads to 10% higher intake as compared to others (James *et al*. 2004).

In a meta-analysis of 88 studies, we examined the association between soft drink consumption and nutrition and health outcomes. We found clear associations of soft drink intake with increased energy intake and body weight. Soft drink intake also was associated with lower intakes of milk, calcium, and other nutrients and with an increased risk of several medical problems (Vartanian *et al*. 2007).

Many of these experiments examined the influence of sugar-sweetened soft drinks on weight gain in children and adolescents.[11]

In one experiment, adolescents replaced sugar-sweetened soft drinks in their diet with artificially sweetened soft drinks that were sent to their homes over 25 weeks. Compared with children in a control group, children who received the artificially sweetened drinks saw a smaller increase in their BMI (by −.14 kg/m^2), but this effect was only statistically significant among the heaviest children.[8]

Oral health problems

Oral health has shown to be affected with regard to sugar sweetened beverage consumption. Acid erosion and dental caries have been the main health concerns to sugar sweetened beverages.

Acid erosion is defined as the loss of tooth enamel caused by acid attack.[12] When consuming carbonated sugar sweetened beverages, acid deposits on the teeth, attacking the enamel. Over a gradual period, the enamel is worn down, which can lead to dental caries. Erosion of tooth enamel begins at a pH of 5.5,[13] and ingredients found in sugar sweetened beverages such as phosphoric acid and citric acid significantly contribute to the demineralization of the enamel. Citric acid in various sugar sweetened beverages can cause chelation.[14]

Consumption of sports and energy drinks have been linked to irreversible tooth damage.[15] This is especially common in adolescents who consume about 30-50% of the beverages that

are on the market.[16] Studies have shown that energy drinks have caused twice as much damage on teeth than sports drinks. Citric acid, the preservative found in many sugar sweetened beverages causes stripping of the enamel.[17]

Fruit juices generally contain lower amounts of sugar than carbonated sugar sweetened beverages.[17] The acidity levels found in fruit juices vary, with citrus based juices having the lowest pH levels. The low acidity found in fruit juices cause higher risk of cavities with enamel exposure.[18]

Frequency of sugar sweetened beverages results in dental caries, which are caused by Streptococcus bacteria. Dental caries is an infectious oral disease and is the breakdown of the teeth due to the bacteria in the mouth. It occurs when bacteria within the plaque metabolize the sugarrele,[19] asing various acids as waste compounds. As the acids are released, they form holes in the teeth which dissolve the enamel. The sugars, therefore provide a passageway for the activities of the oral bacteria, lowering salivary pH. The bacteria alone are not the sole cause of tooth decay, as it is the presence of these sugars that inhibit the production of acid.

Effect on Blood Potassium Levels

Hypokalemia is a potassium deficiency. It is defined by the level of potassium in the blood; levels 3.5 and 5.0 mmoL are considered to be normal while levels below 3.5 mmol/L are defined as hypokalemia.

There are many case reports on the relationship between hypokalemia and sugar sweetened beverages such as colabased drinks. Based on reports published,[20][21] patients' potassium levels decreased because of an increase in cola consumption; and as the consumption was reduced potassium levels rose back to normal levels.[21] Oral supplements and other methods did not help raise potassium levels. And so it was concluded that extreme cola consumption can lead to hypokalemia. Symptoms caused by an increased consumption of cola that lead to hypokalemia include muscle weakness, leg cramps, and fatigue.[21]

There are three mechanisms that lead to potassium deficiency due to cola drinks. They are as follows: (1) a large intake of glucose which leads to an intracellular redistribution of potassium; (2) potassium wasting due to large masses of indigestible fructose in the gastrointestinal tract; (3) the caffeine in cola drinks lead to diuresis, an increase in the

sodium-potassium pumps via cellular phosphodiesterase inhibition, increased renin levels, and also produced metabolic alkalosis which all lead to hypokalemia.[21]

The consumption of sugar sweetened beverages has increased over the years; this includes caffeinated and uncaffeinated drinks. The rise in consumption of soft drinks is due to the current convenience, availability, and accessibility of sugar sweetened beverages today. Over these years an increase in concern and action towards the accessibility of sugar sweetened beverages have been taken through policy. Government officials and doctors alike have responded to the increase in sugar sweetened beverages and its health effects.[21] Internists have further discussed adding extreme sugar sweetened beverages consumption to the list of usual questions about alcohol, tobacco, and illicit drugs that lead to hypokalemia. Although low potassium levels are tolerated in healthy adults, as cola consumption increases things like obesity, hypertension, and diabetes can be developed from hypokalemia.[21]

Effect on Bone Health

Phosphoric acid (phosphate) which is used as an acidulant and flavour enhancer in soft carbonated beverages can interfere with absorption of calcium hence causing loss of calcium from bones.

Phosphoric acid, present in carbonated drinks is violently poisonous, it de-oxidizes blood. In detergent manufacturing industries, phosphoric acid is used to produce water softener. Water softener removes Ca^{2+} and Mg^{2+} ion from hard water. In human body, the function remains the same by removing Ca^{2+} from bones causing osteoporosis (porous bones).

A research study indicated that in adolescent girls carbonated beverages cause low bone density and fractures. Researchers at Tufts University examined data from 2,500 women and men (ages 49 to 69) involved in the Framingham Osteoporosis Study. They assessed dietary intake and measured bone mineral density (BMD) at the spine and hip. Non-cola carbonated drinks were not associated with low BMD, but cola intake was associated with lower BMD at the hip (though not the spine) in the women, but not in the men.[22]

Effect on Kidneys

Kidneys are less able to excrete phosphoric acid when it is in excess. Thus, there is extra work for kidney. Soft drinks remove Calcium from the body, causing an excess amount of Calcium that tend to be deposited in kidney, resulting in nephrolithiasis (kidney stones).[8]

Effect on Skin

Acidic blood affects the action of glutathione, which is an antioxidant enzyme. In addition, these drinks lack vitamins and minerals. By taking these drinks, people cut their intake of fresh juices, milk and even water and deprive themselves from essential vitamins and minerals that are mandatory for skin. Thus, the skin becomes more prone to wrinkles and aging.[8]

Effect on Gastro-Intestinal System: When you open the bottle of a soft drink, bubbles and fizz are immediately emitted out. This is due to phosphoric acid and carbon dioxide (CO2) content, which make these drinks highly acidic. The pH of soft drink ranges from 2.5-3.4 which generates a highly acidic environment in the stomach. Throughout the digestive system, that starts from the mouth and ends up at the anus (liver, gallbladder and pancreas play the role of accessory organs) only the stomach can resist an acidic environment up to pH 2.0. But before the acidity of soft drink reaches the stomach it passes through all the other organs involved in the digestive system thus causing an abnormal acidic environment. Hence the linings of the mouth, pharynx and esophagus are highly sensitive to acids.[23]

Also there is a very common practice of taking soft drinks when a person suffers from acidity or after having a heavy meal. The phosphoric acid present in soft drink competes with the hydrochloric acid of the stomach and affects its functions. When the stomach becomes ineffective, food remains undigested causing indigestion, gassiness or bloating (swelling of stomach). Thus people who are suffering from acidity should not be drinking soft drinks because actually it increases acidity further.[8]

Heartburn and Belching

Carbon dioxide dissolved in soft carbonated beverages converts to gas at normal body temperature. On drinking carbonated beverage stomach expands to accommodate the carbon dioxide dissolved in beverage. This process is also known as belching. As a result acid present in stomach may enter the food pipe causing heartburn and bitter taste in mouth Johnson *et al.* 2010).

Metabolic Syndrome and Diabetes

In recent years, consumption of carbonated beverages has augmented manifolds. These beverages contain energy rich sweetening agents like HFCS, cane sugar, or beet sugar. Consumption of these beverages increases the blood sugar level and also the weight of the

person. Regular intake of these beverages may cause diabetes and other metabolic disorders (Nettleton *et al.* 2009).

Risk of Type II Diabetes

There is a strong link between sugar-sweetened beverage consumption and risk of type 2 diabetes.[24] However, the high risk of type 2 diabetes is unlikely to be caused directly by sugar, with a 2016 *British Medical Bulletin* article stating the evidence is unconvincing.[25] It is likely that weight gain caused by sugar-sweetened beverage consumption is what increases the risk of type 2 diabetes.[25]

Type II diabetes pathogenesis

The hallmarks of type II diabetes (T2DM) pathogenesis are insulin resistance and impaired insulin secretion. In the earlier stages of disease development, cells throughout the body become resistant to the effects of insulin. Therefore, insulin is unable to cause cells to take up glucose (among other impairments) and glucose builds up in the blood. As a result, insulin secretion is ramped up, to try to compensate for this lack of response. For a while this may work, but eventually, the body's ability to secrete insulin from the pancreatic beta cells gets burnt out. In later stages of T2DM, patient cells are both resistant to insulin effects and the pancreas has lost its ability to produce adequate insulin in response to glucose. Type II diabetes is a progressive disease which eventually can lead to patients becoming dependent on exogenous insulin to lower their blood glucose levels.[26]

Consumption of high fructose and sucrose-containing diets have been previously associated with increased risk of T2DM through animal studies linking increased sugar consumption to decreased insulin sensitivity.[27][28] However, a definitive conclusion on this association is still controversial, owing to a lack of data and trials on the direct effect of high-sugar diets in T2DM development.[29] Current evidence suggests that the danger of high-sugar diets in increasing T2DM risk comes not from the direct effects of sugar on insulin resistance, but more so from the imbalance of energy intake-use that high-sugar diets can contribute to.[30]

Dehydration

Human body is mainly composed of water. For proper functioning of body regular hydration is required. It is often observed that instead of water people consumes soft carbonated beverages. Some soft carbonated beverages may contain caffeine acts like a diuretic, increase urination hence deplete body of water and also affect the salivary flow (Hildebrandt *et al.*

2013). Some carbonated beverages also contain sodium which leads to removal of water from body cells and thus causing dehydration.

Pregnancy

Dietary improvements in expecting mothers are important for the future health of the mother and child. Sugar sweetened beverages among other beverages like coffee and alcohol are recommended to be reduced in intake. A study, showed that pregnant woman minimized their intake of sugar-sweetened beverages, alcohol, and coffee, when educated about the negative effects these beverages can have on their unborn child.[31] The statistics for each beverage showed that among alcohol, coffee, and sugar-sweetened beverages, sugar-sweetened beverages were still consumed more despite there being a minimized intake. The minimized intake of coffee and alcohol is due to the less harmful effects sugar-sweetened beverages have compared to coffee and alcohol.[31][32] The report declares that the minimized intake may be due to alcohol and coffee being a part of socializing and therefore becomes substituted by sugar-sweetened beverages at social events.[31]

DISCUSSION AND CONCLUSION

The additives of beverages and sports drinks were found to have adverse effects. Both drinks are most favorable in summer season but regular usage may degrade the health. Soft drinks are more harmful in comparison to sports drinks. The carbonated beverages were found to show more toxic effects on health status. Natural local drinks are very healthy, cheap and easy to obtain in comparison to beverages which are expensive and harmful. Using of natural resources usually protect the community from health and economical problems, culturing of community and learning of young students to save and promote their own resources especially fruits and other vegetables and seeds which used as natural drinks will overcome many health disorders and allow them to enjoy with healthy life and healthy mind. The present article offers the understanding of beverages and their harmful effects on the human health.

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