

## Acidic and Alcoholic Beverages and Teeth, with Clinical Advisories

Louis ZG Touyz<sup>1\*</sup>, Sarah JJTouyz<sup>2</sup> and Leonardo M Nassani<sup>1</sup>

<sup>1</sup>Faculty of Dentistry, McGill University, Montreal, PQ, Canada

<sup>2</sup>Pennine Acute NHS Trust, Manchester, UK

**\*Corresponding Author:** Louis ZG Touyz, Professor, Faculty of Dentistry, McGill University, Montreal, PQ, Canada.

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### Abstract

Consumption of many acidic drinks is assumed by many to be harmless. This applies to fruit juices, all pop-sodas and alcoholic beverages. This appraisal examines some health advantages and disadvantages of beverages, discusses fundamental principles dictating policies, and lays out clear guidelines for health care workers to provide patients.

**Keywords:** Alcohol; Diet; Drinking; Ethanol; Fruit-Juices; Pop-Sodas

### Background

People need at least 1.5 liters of daily liquid intake to survive and retain health. To provide pleasure, nutrition and enjoyment of liquid intake, daily beverages are now ubiquitously consumed. This intake embraces non-alcoholic and alcoholic beverages [1-3]. Non-alcoholic beverages include water, tea, coffee, all pop-sodas, fruit-juices and soups, while alcoholic drinks embrace low alcoholic drinks like apple-ciders, beers, wines and tonics, (alcohol vol/vol from 2% →11%) medium alcoholic drinks, like ports, sherries, fortified wines champagne and others (alcohol content vol/vol 15 → 30%), with higher alcoholic drinks including vodkas, whiskies, brandies, fruit-derived aqua-vites (alcohol content 30 → 45%), among others. For ethanol, 50%vol/vol is sometimes referred to as 100% proof [4,5]. For taste buds to work, the stimuli must be ionized. For example sucking insoluble marbles may stimulate saliva flow, but this activity is tasteless. Consequently all gustatory stimuli must be-, and are enhanced, when sapid. With all beverages and drinks, this implies the drink-contents act as solvents with dissolved constituents ionizing in solution, and consequently intensify subjective taste sensations. Any flavorant molecule which augments ionization, improves its' flavor. This applies both to alcoholic and acid beverages. Increased ionization intensifies and boosts the taste sensations [5-7]. Fruit juices in general are acidic, deriving their acid from carboxylic fruit acids like malic (in apples), citric (in citrus) and tartaric (in grapes) [7,8]. Most alcoholic beverages are also acid in spite of their ethanol content, and with many other ionizing additives, the mix gives them unique flavors. Alcohol alone enhances flavors by ionization [7-10]. The critical pH at which all hydroxyapatite in biological calcified material dissolves, is pH 6.5 - > 5.5. Tooth material (as enamel, dentine and cementum) all are decalcified at this pH; decalcification softens the tooth and makes it vulnerable to physical destruction, through attrition, abrasion and erosion [11-13]. Also the decalcified dental loci when attacked by microbes from biofilm and creates cavitation, is referred to as dental caries [7]. Chronic frequent imbibing of acidified, synthetically-sweetened, sugared, pop, fruit and alcoholic-beverages may affect health in general [8-10], and while the damaging effects of these on teeth are well known [10-11] and clinical methods of alleviating the pain are established [42,43], precise instructions, of what advice health-care workers may counsel their patients to avoid these damages are rare.

### Aim of the Study

This research examines 1) the known acidities of common alcoholic beverages and non-alcoholic beverages; 2) discusses effects on health in general and teeth in particular; and 3) summarizes sound advice for counseling health-care workers to provide patients to minimize deleterious effects on teeth.

## Methods and Material

Samples of 10 alcoholic drinks (white-wine, red-wine, sherry, port, apple cider, brandy, beer, whisky, rum and vodka) were placed in separate containers. Each sample had its pH and temperature measured using a calibrated high precision Preciva Digital pH Meter (0,00 - 14,00 pH). Temperature of liquids was recorded using a lab standard and calibrated non-contact infrared digital thermometer. For each sample, 3 measures were done by 2 operators to reduce inter and intra-operator bias, meaning that each sample's pH was measured 6 times by 2 different operators. An average of the measures was recorded with 0% statistical variation reported and a standard deviation of 0.01.

## Results and Statistical Analysis

Following the completion of measurements, averages of the measures were calculated along with the standard deviation. Numbers are classified from the lowest to the highest pH and grouped by 4 categories: common liquids, apple juice, grape juice and alcoholic beverages. All liquids have a pH below the acidic pH of 5.5 at the exception of milk, water and plain vodka (40% alcohol).

### Non-alcoholic acidic drinks

#### Acid Fruit juices:

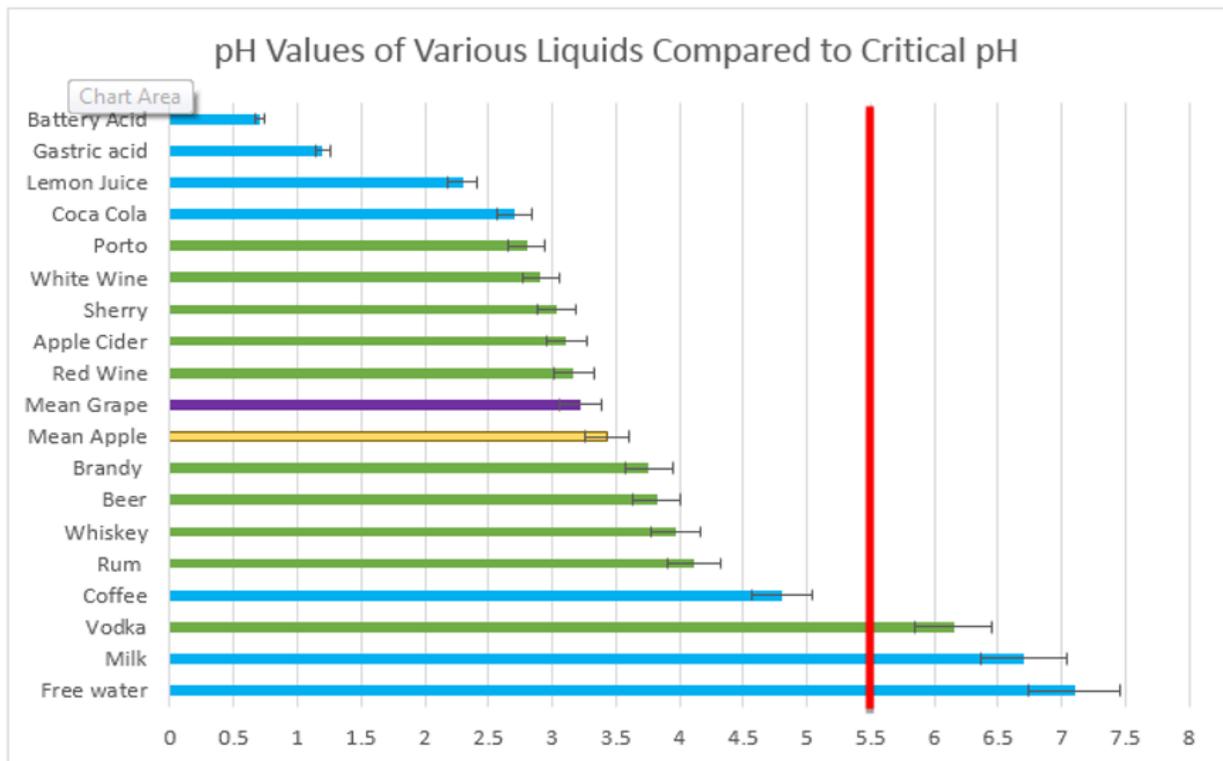
After World War II (1939 - 1945) many countries developed huge fruit orchards to provide global markets with fresh fruits. Often most of these crops are less than perfect with regard to size, flavor and appearance. Consequently these products are converted into other marketable products like jams, chutneys, concentrates, dried products and juices [12]. These products stress their natural origin, the nutritious content, the Vitamin content (mainly Vits C, A and E) and their health properties [13]. When marketing these products luscious perfect images of the ripe fruit are always linked by associative advertising to influence consumers' choice. The acidic nature is ignored in the promotions, but the acid content is retained. Consuming or imbibing acids over a period of time causes ravages on teeth [14]. After repeated, frequent chronic acid exposure, attrition, abrasion and erosion manifests. Once the decalcified areas are attacked by oral microbes and cavitation obtains, this is designated as caries, which is progressive to total destruction of the tooth [15]. Many fresh fruit juices are sold as frozen concentrates and water is added for the preparation. Freezing the prepared juice renders a supersaturated acid solution that takes much more alkali saliva to neutralize residual imbibed acids; the pH's of fruit juices are well recorded [7,12,16,21]. Eating acidic fresh fruits (like lemons, citrus, peach, pears, plumbs pineapple and melon among others) may also precipitate sensitivity, as the fleshy part of these fruits are also soft, semi-liquid and acid. Adding fruit and fruit flavors to sodas increases the acidity. Synthetic sweeteners added to soda water does not change the acidic nature of pop-soda [17].

### Pop-sodas and Colas

Most pop-colas have phosphoric acid as part of their contents [18-20]. All pop-sodas have CO<sub>2</sub> gas dissolved in the mixture. This adds to the acid nature of the drink. Soda water is a weak mixture of carbonic acid (H<sub>2</sub>CO<sub>3</sub>) which forms when the gas is mixed with water. This ionizes in the water and combined with the free water ions, makes the soda water acid:



Caffeine (as found in pop-Colas and Pop- Guarana drinks) when dissolved into the drink also contributes some acidity to the drink [19,20]. Most Cola mixtures are acid and will dissolve teeth [18]. All pop-sodas have a pH well below the critical pH, and when imbibed frequently and regularly will cause erosion of the teeth. Regular cola drinking also precipitates dental hyper-sensitivity, as does Guarana Pop-Sodas [17-21]. Besides the deleterious dental effects sugared drinks have been implicated in contributing to morbid obesity and the development of diabetes mellitus [18,22,23].



**Figure 1:** pH measures of ubiquitous acid liquids: All the acidities of the grape and apple juices measure pH3.5 (yellow and purple bars in this graph), and are significantly below the critical pH5.5 [red vertical line] at which pH most acids dissolve calcium hydroxyapatite in teeth. The blue bars are pH measures of other common liquids. pH measures of alcoholic drinks are in green [7,12,16,21].

### Alcoholic acid drinks

**Alcohol:** Alcoholic beverages are consumed globally. Globally many cultures have been deceived by promoters of drinks as a health beverage [24]. The motive is profit from commercialization of beverages, not health. For example Resveratrol in red wines has been shown to reduce the prevalence of coronary heart disease. Resveratrol is available in pill form without any alcohol [25]. But alcohol causes CNS nerve damage. Alcohol is toxic to metabolism, is causally related to liver disease and cancers [26-31]. Alcohol is addictive and has a direct inhibitory effect on cognitive abilities like smell, eyesight, neuro-muscular co-ordination, balance, proprioception, hearing and touch [26,27]. Alcohol damages DNA and predisposes development of cancer [29,31-35].

Alcohol is toxic to the liver which becomes prone to neoplastic change [32-35]. Oral cancers are more prevalent in alcohol drinkers than abstainers, and smoking more than doubles the risk of cancer for alcohol drinkers [36-38]. Almost every person who drinks alcohol does so for the neural effects. That alcohol enhances the taste of drinks is not disputed. Chronic excessive drinking of alcohol negatively affects the oral microbiome, those ecosystems of oral microbes. More potentially pathogenic oral bacteria such as Bacteroides, Actinomyces, and Neisseria are increased. Many Alcoholic drinks are acidic and highly erosive when consumed frequently, in large quantities over an extended period of time. High alcohol intake may cause acidic gastric emesis, that aggravates erosion to the teeth and exacerbates dental sensitivity [39]. Carbonated drinks, including sugar-free varieties, will have a similar effect on dentition [19,20].

### Discussion

Dietary acid intake through imbibing acidulated drink overwhelms the neutralizing effects of alkaline stimulated saliva; if the intake is frequent, the oral acid environment pervades all oral organs (tongue, teeth, gums, cheeks, palate etc.) and oral stagnation niches, and over a short period of time (less than an hour) acid damage may ensue. Alcohol and carbohydrates metabolize at the same rate: (1 Gram = 4 Cals) [40], but both alcoholic and non-alcoholic drinks remain acidic with the potential to damage teeth, unless neutralized by saliva. Intra-oral fermentable carbohydrate (including alcohol) are acidogenic and assist in oral acid production. Many acid drinks contain caffeine which is an antagonist on the neural effects of ethanol; this caffeine is added so that more alcohol can be consumed. But caffeine itself when dissolved adds to the acidity of drinks and aggravates the erosion [41]. Dental hypersensitivity manifests as subjectively experiencing pain. The stimuli vary from changes in temperature (hot and cold), to touch, or osmotic pain induces by eating soluble substances like sugary or salty foods. This is because the cervical or exposed dentinal become patent, and the extra-cellular fluid-flow in the dentinal tubules react to stimuli and cause pain. Most therapies are targeted at stopping or reducing this fluid flow in the tubules by interfering with the induction of stimuli [42,43].

After chronic repeated exposure to acidic alcohol beverages, occlusal tooth material diminishes with consequent loss of cusps and reduction in height. Exposed cervical dentine becomes exposed to the oral environment and the terminal openings of the dentinal tubules are easily affected by temperature, osmotic or tactile stimuli.

Because fluoride forms Fluor-hydroxyapatite, the critical pH at which tooth material dissolves is lowered; this means that a stronger acid is needed to decalcify enamel, dentine and cementum. Accordingly using a fluoridated mouth-rinse used daily at a different time to tooth-brushing, will be effective against decalcification induced by imbibing alcohol drinks. The fluoride also will precipitate any available Calcium ions in the openings of the dentinal tubules and block fluid-flow, and so reduce pain induction.

Acidified drinks may induce cervical dentinal sensitivity [38]. A desensitizing toothpaste and/or prescription tooth-paste with fluoride will assist in alleviating sensitivity. Also addition of calcium phosphate in the paste helps in relieving severe pain. Addition of calcium to acid drinks may moderate the erosive effect, but this addition tends to affect the organoleptic properties of the drink. Off flavors, like "It tastes chalky" tend to constrain this practice.

The use of pit and fissure sealants as a protective covering over restorations and the clinical crown, and using potassium nitrate (KNO<sub>3</sub>) are also among therapies used to assist eliminating acute sensitivity and to reduce further wear [41-43].

From the appraisal [1-43] laid out above, the following suggested counseling advice could be of sound benefit for health care workers.

### Advice and counseling for patients

- Decrease the amount of acid drinks consumed. The less acid liquid drunk the less the chances of tooth damage.
- Reduce the frequency of drinking acidic beverages. Reduced frequency allows for oral stabilization out of an acid milieu.
- Don't drink a beverage just before going to sleep. Saliva (as alkali) all but stops flowing during sleep; it takes longer to neutralize oral acid when asleep.;
- Choose less acidic drinks like black tea, soups, milk or cacao. These have minimal acid and induce minimal damage.
- Eschew horizontal scrub method of brushing; use techniques (Smith Physiological, or Modified Bass) by stroking one way the gums towards the occlusal surface. Correct brushing technique encourages gum to cover vulnerable cervical recession that exposes dentine.

- Select a tooth-paste with low abrasivity and avoid those not approved by recognized Dental Authorities (like ADA, FDA, BDA, SADA, CDA etc). Most approve dentifrices do not contain abrasive powders which damage teeth: some smokers pastes are highly abrasive and damage teeth.
- Do not swish drinks before swallowing. Use a straw if available. This minimizes fluid tooth contact and tooth destruction.
- To avoid tooth-brush abrasion of softened decalcified tooth material, do not brush for at least one hour after consuming acid drinks. Allow at least half an hour for saliva to neutralize oral acid, and a further thirty minutes for re-calcification,
- Rinse your mouth before and/or after acid drink consumption with a fluoride mouthwash. Fluoride links immediately with decalcified active calcium, precipitates in situ, prevents and stops softening and loss of hard tissue.
- Use plain water as a rinse, if a fluoridated mouth wash is not available. Diluting the acid allows faster salivary action to neutralize the acid.
- Eating a piece of cheese after a drink assists in slowing down decalcification. Cheese provides extra calcium ions, and makes for oral alkali changes; this constrains the effects of acid.
- Increase the flow of alkaline saliva to hasten its' neutralizing effect on residual acid action, by chewing a sugar-free, synthetically sweetened (with xylitol, sucralose or sorbitol) chewing-gum.

### Concluding Remarks

The frequency, amount, timing type of beverage and personal drinking habits all moderate the ravages induced by drinking acidic drinks. Home care and behavior modification could strongly assist in minimizing the onset, duration and re-occurrence of dentinal sensitivity.

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### Ethics

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