



Demystifying Apples in Health and Dentistry

Louis ZG Touyz*

Abstract

Apples are frequently associated with chewing and teeth. Anecdotal folklore ascribes magical powers to apples. Besides growing fresh fruit harvests for consumption, universally apple industries include ciders, fruit juices, dried fruits jellies and confection products. Large varieties of apples exist worldwide, but apple consumption does not prevent or cure tooth decay. Apples contain fermentable carbohydrates that overwhelm any protective plaque-biofilm removal apple fibre may impart after rigorous chewing. Malic acid in apple decalcifies enamel and allows for initiation of caries. Apples may be a good source of fibre and nutrients, but apples are not a benevolent detergent health chew.

Keywords

Attrition; Abrasion; Apples; Erosion; Frangible

Introduction

The Apple (*Malus domestica*), embraced by many dentists as an unofficial symbol for desirable attractive teeth [1] is a fascinating fruit with curiously interesting roles in society. The apple retains many health and nutritional benefits, but may not always be an ideal representation for dental or oral health when examining evidence from recent research [2-4]. These traditional associations between teeth and apples, derives from the realization that apples cannot be bitten or successfully chewed without functioning teeth. Besides organoleptic satieties of flavour, taste, texture, aroma and mastication, crispness of apples produce a pleasurable overall subjective experience when eaten. Teeth, good food and health are closely related with each other, and consequently in the publics' eye, teeth and apples become indivisible and symbolically associated with each other. Throughout world cultures and traditions apples have been attributed various qualities, some verified as food for health advantages, but many others are false.

Aim

This appraisal from a dentists' point of view, hopefully provides fresh clarifying insights, with focus on apples in general, and its' health benefits and dental implications in particular.

The Apple

Apple legends, folklore and traditions

Since 1990, Apple Day is celebrated across the United Kingdom

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on October 21. In the Scandinavian countries and USA a polished apple is a traditional gift by pupils for teachers. This stems from days when inadequate teachers' salaries were supplemented with bushels from the apple crop as wages. As pay increased, the quantity of apples diminished to a single fruit. 'Johnny Appleseed' was John Chapman (1774-1845) an American pioneer orchardist; he earned his nickname and place in American folklore by planting apple trees across Ohio, Indiana and Illinois. According to popular legend Isaac Newton contemplated the forces of gravity and laws of energy after an apple fell on his head. Swiss folklore holds that William Tell split an apple on his sons head with an arrow from his crossbow [5]. In ancient Greece, tossing an apple to a girl was a traditional proposal of marriage. Catching and consuming it meant she accepted. Eating apples were a source of eternal youth, beauty, and forever looking young with smiles to match [6].

Apple commerce and sources

Apples as commercial harvests have been traded since time immemorial; by the Twenty First Century 45 000 000 tons of apples are grown worldwide with monetary value approximating UK £ 3 000 000 000 (about US \$ 10 billion) [7].

Apples are the most widely cultivated fruit of temperate climates. They thrive most in well-drained soil but are susceptible to frost and a large number of pests. The apple is a firm fleshy edible fruit of the rosaceous tree of genus *Malus*.

Original apple and modern varieties

The *Malus sieversii*, found in the Ili Valley of the Tien-Shan Mountains bordering China, is universally considered the original wild ancestor of all apples, as it has DNA sequences similar to the common apple *Malus Domestica* [5]. Many varieties are sustained in cultivation, others have long disappeared [5,8]. For example, by the end of the 1800's 7,000 named apple varieties were grown in the USA, but most are lost and hardly 200 survive [7]. Globally over 2000 known varieties of apple are cultivated, and among the universally traded apples, the 36 most common popular varieties include: Ambrosia, Antonovka, Baldwin, Ben-Davis, Blenheim-Orange, Braeburn (firm, tasty, fragrant and easy chew, the authors favourite), Bramley, Cameo, Cortland, Cornish-Gilliflower, Cox's-Orange Pippin, Cripp- Pink, Egremont- Russett, Elstar, Flower-of-Kent, Fuji, Gala, Ginger-Gold, Golden-Delicious (sweet aromatic and crisp, a favorite among women), Granny-Smith (traditionally green colour, acidic, crisp with a unique aroma and flavour), Gravenstein, Haralson, Honey-Crisp, Idared, James-Grieve, Jazz, Jonagold, Jonathan, Knobbed-Russet, Macoun, McIntosh (Popular in Canada and Northern USA), Northern-Spy, Paula-Red, Pink-Pearl, Pinove, Red-Delicious and Rome. One of the youngest apple varieties is the Aurora Golden Gala (2003) a sweet Canadian apple, while one of the oldest surviving apple still cropped in the USA may be the Roxbury Russet (1640). Colour, size, shape, texture, fragrance, flavour, sugar and acid content vary among these, while personal tastes, expectations and choices determines individuals' preference.

Apple constituents

The major constituent of apples is water, about 80% w/w (as 100

gram edible portion); the major solids include carbohydrates (11%) as sucrose (3.5%), glucose (1.7%) and fructose 6.1%), fibre, and traces of other nutritional substances and malic acid (0.41%). With all the other contents, 100grams of apple with skin has a nutritional value of 50 kcal (equivalent to 220 KJ) [9].

Apples are not a complete food as they contain no “first class” protein with minimal traces of 14 amino acids, and only a miniscule fraction of Recommended Daily Allowances of the micro-nutrients cited above [10].

Other contents per 100-Grams edible portion of Apple are:

(USDA Nutrient Database 2007)

Carbohydrates 13.81 g

Sugars: 10.39 g

Fiber: 2.4 g

Fat:0.17 g **Protein:**0.26 g

Trace Nutrients: (Measured in milligrams–mg, or micro grams–µg)

Thiamine: (Vitamin B1) 0.017 mg

Riboflavin: (Vitamin B2) 0.26 mg

Niacin: (Vitamin B3) 0.091 mg

Pantothenic Acid: (Vitamin B5) 0.061 mg

Vitamin B6: 0.041 mg

Folate: (Vitamin B9) 3 µg

Vitamin C:4.6 mg

Calcium: 6 mg

Iron: 0.12 mg

Phosphorous:11 mg

Potassium:107 mg

Zinc:0.04 mg

Apples contain over 21 organic acids, malic acid being the main one (a dicarboxylic acid, constituting 80-90% of the total acid content) and is the major contributor to making apple juice acidic with a pH=3.0 ± 0.5 [11]. The combination of acids and sapid carbohydrate contributes to the pleasant organoleptic experience of eating apples. Other carboxylic fruit acids like citric acid (found in citrus) and tartaric acid (found in grapes) are also found in apples, but in low concentrations when compared to malic acid [11].

Apple flavour and aroma

A rich qualitative mixture of a wide range (over 160) of volatile chemical substances give apples their singular fragrance and taste (deriving from some 20 acids, 30 alcohols, 75 esters, 27 Carbonyls, 9 esters and acetyls, and 5 other hydrocarbons). Combinations of these aromatic substances, renders apple varieties unique in smell and taste [12]. The main aromatic contribution is from ethyl 2-methylbutyrate with a threshold of 0.0001 ppm which provides a ripe note, while hexanal and 2-hexanal (thresholds of 0.005 and 0.017 ppm respectively) imparts a green and unripe odour [13]. Ethyl 2-methylbutyrate is used in artificial food flavourings as well as enhancing fragrances for cosmetics, soaps, shampoos, ointments and creams.

General health benefits

Many serious claims are made attributing health benefits to eating apples.

“There’s a consistent inverse association between apples and risk of various cancers”; these health promoting properties of apples derive from regular consumption of apples and claim reduction on the risk of colon, lung and prostate cancers [14]. Apples contribute to the total fibre intake which assists in sustaining bowel motility without stagnation and so may help prevention of colon cancer [15-17]. Apples contain sparse lipids and don’t contribute directly to raising blood lipids or cholesterol, but consuming apples with their pectin content, does reduce serum cholesterol levels [18-19]. Apple phenolic, as naturally occurring antioxidants in fresh apples, protects neural cells from oxidative stress [20]. Phyto-chemicals like quercetin, epicatechin, and procyanidin B2 (PMID 14558772) are cited as being present in ripe fresh apples, especially the skins, and are proven to protect nerves and nerve cells from oxidative stress cytotoxicity. These phyto-chemicals and are named as protectors against triggers that start Alzheimer’s or Parkinson’s Diseases [2-4,21,22].

Apples contain some Vitamin C and other anti-oxidants which prevent DNA damage and consequently reduce the risk of cancer [24,25]. Multiple biological properties are attributed to apples which contribute to overall health.

Pesticide use in mass apple production controls infestations from insects or microbes, like the Apple Sucker (*Psyllia mali*), fungal Black Spot, Apple Scab, Gymnosporangium rust fungus, and Fire blight, a bacterial disease [5]. For this reason it is always desirable to wash or peel apples to remove residues of these chemicals before eating. An apple a day certainly enriches variety, taste and texture of a balanced diet and provides heightened enjoyment to eating from the fruit and vegetable food-groups [4].

Apples and oro-dental health implications

Apples are associated with chewing, perfect dentitions and natural pristine smiles. This may stem from mythology, but a reality check of apples and oro-dental health provides a different point of view (Figure 1).

Chewing apples

Edentulous people don’t enjoy eating apples as much as dentate people, even with full replacement prostheses [25]. Dentate people bite off portions of apple; chew them easily and with great gusto.

The apple juice from fresh fruit is ionized with sugars that elicit strong gustatory stimuli: this taste rush combined with dental proprioceptive neural inputs from fresh fibre crunching renders a uniquely pleasant experience from eating and chewing apples [26].

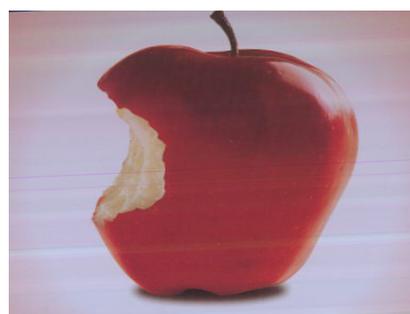


Figure 1: Biting into apples and the crunching chew which follows, with natural or prosthetic teeth, is among the many pleasures of eating.

Apples' acids and teeth

The range of acidity of Apple Juice is pH=2.5-3.5, is erosive and cariogenic [11,27]. Apple products whether dried apple [28], carbonated, juiced or fermented as cider [pH of Apple Cider in the lower range pH 2.5-3.00] all have a pH below a pH=5.5 which is universally considered the threshold pH at which acid decalcification occurs of calcified dental tissues [11,20,26,27].

Fresh fruit juices, (including apple juice and apple-juice blends), are promoted as good source of Vitamin C, which in many cases they are; for example guava juice often mixed with apple and grape juices, has high concentrations of Vitamin C, but dentally is very erosive [25,28-30].

Vitamin-C in apples

While apples are considered as beneficial as part of a general diet, apples not the best source of Vitamin C when compared to Citrus, Guava, or Parsley, or other fruits and vegetables like the Acerola West Indian Cherry and Broccoli. At 4.6 mg/100 gram edible portion in apple, apples have low Vitamin C content compared to 30-50 mg for citrus, 200mg for guava, or 300 mg/gram in parsley. Also the Acerola cherry and broccoli have much more Vitamin C/100 gram than apples [29] (Figure 2).

Frangible and mucosal burn

Ascorbic acid added to fruit juice mixtures and blends boosts the Vitamin C content, but also contributes to the overall acidification of fruit and vegetable based drinks. Abusive high acid juice intakes not only can induce cervical sensitivity [felt as pain], decalcification and tooth frangible [erosion, attrition and abrasion] [29,31,32], but can also cause keratin changes of the mucosa that resembles a chemical burn [mucosa appears opaque white and does not rub off] [33].

Apples and scurvy

Both oral scurvy (chronic avitaminosis C) and periodontal disease present with bleeding on probing of the gingiva. While often dietary deficiency of Vitamin C may contribute to the severity of periodontal disease, without improved Oral Hygiene coupled with mechano-therapy (scaling and root planning), periodontitis will not resolve [29] Whereas avitaminosis C as gomphiasis (gum disease in Scurvy) resolves with high doses of Vitamin C (1000 mg Vitamin C/day for 7 days) or with citrus, or high dietary Vitamin C Foods (for example Parsley, Broccoli or Guava), natural cures advocating eating only apples as cures for periodontitis or oral scurvy are spurious. Apples with their low Vitamin C concentration (4-8 mg Vitamin C/100 g edible portion), as a cure for bleeding gums are palliative at best and not optimally effective [29,34].

Apple allergy

Allergies to apples are not unknown, but are rare. Usually the first contact is when apple is placed in the mouth, and it is not surprising that an oral contact allergy manifests. A gingival blister develops quickly where the apple is in contact with the mucosa. An itchiness, discomfort or low grade pain may occur in the tongue followed by glossal swelling. If ingested a mild gastritis with emesis, and pruritus may develop. The skin and possibly insecticide residues are blamed for this reaction [35].

Apples as natures' toothbrush

Apples have been long touted as a "detergent chew" implying

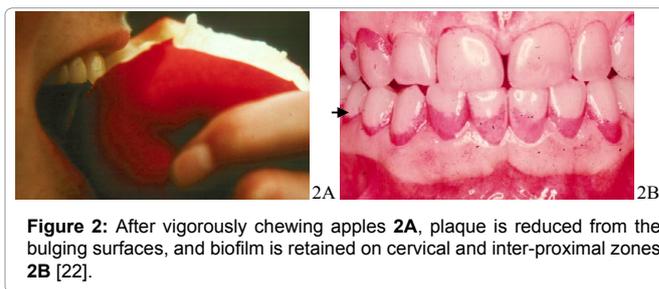


Figure 2: After vigorously chewing apples 2A, plaque is reduced from the bulging surfaces, and biofilm is retained on cervical and inter-proximal zones 2B [22].

that by chewing an apple dental biofilm plaque is removed. Exhorting people to eat an apple, instead of brushing and flossing teeth, is not desirable or well-founded advice. When examining mouths after chewing both fresh and/or dried apple, plaque is removed but only from the bulging surfaces of the teeth, and plaque remains on the cervical and inter-dental areas, sites which are notoriously vulnerable to decay and gum disease from plaque stagnation [25]. Chewing apples, no matter how frequently, is not a substitute for good oral hygiene with inter-dental flossing and brushing.

Discussion

Periodontitis will not resolve or arrest without mechano therapy. Apples, as part of a balanced diet, add immense enjoyment to the quality of life. Apples in legend, folklore, myth and history have enriched the lives of Mankind from time immemorial. The health properties of apples derive from anti-oxidant, anti-inflammatory anti-allergic, anti-thrombosis and antimicrobial activities; apples also have been associated with anti-viral properties and inhibiting sub-endothelial triglyceride deposits [36,37]. Modern preventive strategies (like efluoridation of water and oral hygiene education programs embracing prevention of decay and gum disease)and operative dentistry (replacing lost teeth with sustainable ideal forms functioning as prostheses), ensures benefit for all by conserving the dentition to chew apples as part of daily life. In the twenty first century-reality apple products remain popular, and apple consumption keeps rising as the demand for pristine quality fruit and apple products increase. However the success of modern dentistry evolves with evidence gleaned from experience, research, training and education. Moderation of apple consumption or acid apple products, with excellent oral hygiene practices, is mandatory to avoid oro-dental morbidity. Frequency of apple consumption, the amount, timing, type of acid food and method of chewing and swallowing all impact the morbidity outcomes of oral health [32].

Conclusion

Oral health care workers should not blindly sustain spurious traditions and false paradigms and myths [38]. Advantageous claims for apples derive mainly from nutritional health benefits and are routinely, without thinking, transferred to oral health. 'An apple a day may keep the doctor away' but not the dentist. If anything 'Apple abuse puts your teeth in a noose' [38]. And acid foods from apples may not be as beneficial as the lay public believe.

Declaration

The author has no conflict of interests.

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