CHEWING GUM: THE GOOD, THE BAD & THE UGLY

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The global market for chewing gum is approximately 13 lac tonnes per year representing almost a US 19 billion dollar industry, meriting heavy media and print promotion by the gum manufacturing industry. Chewing gum has almost as long a history as the mankind itself. Chewing gums have been marketed for a variety of benefits such as an adjunctive oral hygiene aid, for smoking cessation and as a preventive option for various dental problems like plaque accumulation, gingivitis, caries etc. The medicinal uses of chewing gum have also been realised in the last thirty years. The ease of administration and control of dosage makes it a potent drug delivery system. Consequently, chewing gums have seen changes in their components over a period of time with many active ingredients being added to exploit this potential. Effects of various therapeutic substances in chewing gums have been studied over the last few decades. This review aims to compare the benefits and drawbacks of chewing gum to provide an objective insight from a neutral perspective.

Key Words: Chewing gum, anti-cariogenic, anti-gingivitis, saliva flow, pH level, drug delivery, remineralisation.

Introduction

Results of a study conducted by Andrew Scholey[1] in University of Northumbria in Newcastle, UK provided evidence that chewing gum can improve long-term and working memory. Yes, chewing gums have been claimed to provide strange benefits to the mankind. But how good is gum chewing for our oral health? And can it have any adverse effects?

This article aims to answer such questions by reviewing the published work on effects of chewing gum and compare the benefits and drawbacks of chewing gum to provide an objective insight to the readers. People might wonder why chewing gums are such a constant subject of debate and research? But when we are told that we spend billions of hours every year in gum chewing, we are compelled to imagine the effects this might be having on the oral and general health of millions of gum chewers worldwide.

History

The chewing of non-food items for pleasure has a long history. The history of the evolution of gum is a fascinating subject and has a great story to it. Chewing Gum, in fact is a resin obtained from the bark of a shrub like mastic tree found mainly in Greece and Turkey. Interestingly, the Grecian women especially, favoured chewing mastic gum to clean their teeth and sweeten their breath. But the Mayans weren't too far behind the Greeks - they simply got their gap (chicle) from a different tree (the Sapodilla tree) which now chiefly supplies the ever growing US market. Modern history of chewing gum dates back to 1848 when John Curtis manufactured and sold the first commercial chewing gum called Maine Pure Spruce Gum. Over the mid 1800's, Spruce gum was gradually replaced by paraffin wax gum to which sweeteners were added. However, one drawback of paraffin wax gum was that it required heat and moisture from the mouth in order to render it suitable for chewing. Around 1870, Thomas Adams, a resident of New York, accidentally rediscovered the chewing capability of 'chicle' and opened the first chewing gum factory. Since then chewing gums have been launched with various flavours and additives to enhance their benefits and marketability. The introduction and subsequent success of nicotine chewing gum in 1980s paved a way for a more general acceptance of chewing gum for medicinal use.

Composition of Chewing Gum

Grossly the Chewing gums are made of a gum base incorporated with sweetening, flavouring and

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aromatic agents. The gum base is a mixture of elastomers, natural and/or synthetic resins, fats, emulsifiers, waxes, anti-oxidants and fillers. Now-a-days natural elastomers have been replaced by synthetic ones, such as polyisobutylene rubber and butyl rubber. Each gum has its own specific formulation that makes it unique. The exact combinations of ingredients are therefore, carefully guarded company secrets.

Table 1. Ingredients of chewing gums

SUGAR BASED		SUGAR FREE	
Ingredients	**%**	**Ingredients**	**%**
Gum Base	19.4	Gum Base	25.0
Corn Syrup	19.8	70% Sorbitol	15.0
Sugar	59.7	Glycerine	6.5
Glycerine	0.5	Sorbitol	52.3
Flavour	0.6	Flavour	1.2

Benefits of Chewing Gum: THE GOOD

Chewing gums have been marketed for a variety of benefits viz. maintenance of oral health, psychological well being and an effective method for local drug delivery among others. In this section we will primarily delve into various benefits attached to the oral health.

Do chewing gums stimulate salivary flow?

Chewing gums help in increasing the stimulated and unstimulated salivary flow. People with low resting flow levels also benefit from prolonged gum chewing.

Dawes et al.[2,3] suggested that sugar-free and sugar containing chewing gums stimulate salivary flow equally well. In case of flavoured vs. unflavoured gums, it was observed that the initial stimulated flow rate with flavoured gums was about 10-12 times greater than the unstimulated rate (0.47 ml/minutes). After 20 minutes of chewing, it was still about 2.7 times that rate and about the same as the flow rate elicited by chewing-gum base alone.

As the chewing starts, the saliva secretion rate increases due to the activation of both mechanoreceptors and taste receptors that are afferent sensory pathways to the central nervous system[4]. Dodds et al.[5] found that increased masticatory effort by frequent consumption of sugar-free chewing gum over a two week time period resulted in a functional increase in the output of stimulated parotid saliva, as well as increases in pH and buffer capacity of whole and parotid saliva.

Polland et al.[6] further clarified that the saliva flow rate and salivary pH increased for the chewing period of up to 55 minutes for mint flavoured sugar-free gum, *irrespective* of the rate and style of chewing. Both salivary flow rate and pH were increased above resting levels for the entire 90 minutes. When the experiment was repeated with the gum pellets replaced at 30 and 60 minutes, similar increases in salivary flow rate and pH were found.

Do chewing gums raise plaque pH levels?

Low plaque pH values after the intake of fermentable carbohydrates can be elevated by gum chewing due to their salivary flow rate stimulating action.

In general, sugar-free chewing gums have been found to be more effective than sugar-containing chewing gum in raising plaque pH[7-20].

Shu et al.[21] tested the effect of two types of chewing gums (sugar-free and tea polyphenol gum) on plaque-pH against a 10% sucrose rinsing challenge. Both gums could increase the plaque pH recovery, which had dropped due to the sucrose rinsing challenge and they could maintain the dental plaque pH above the resting value.

Infact chewing sugar-free gum at 5 minutes after sucrose rinsing challenge, as observed by Dong et al.[22], dental plaque pH was raised from 5.59 (measured at 5 minutes after sucrose challenge) to 6.98 (measured at 10 minutes after sucrose challenge).

Holgerson et al.[23] in his study discovered that the plaque-pH was significantly greater in a group of

subjects given a high single dose (6gm) of xylitol chewing gum compared to a low dose (2gm) and control groups (paraffin, no xylitol) during the first 5 min after chewing. After a 10% sucrose rinse, the interdental plaque-pH dropped in all groups but the high-dose group displayed significantly less reduction 0-5 minutes after chewing.

Imfeld et al.[19] measured the effect of sugar-free chewing gums containing various amounts of urea on the pH recovery in dental plaque. The subjects who had refrained from toothbrushing for 3-7 days rinsed with either 10 or 50% (w/v) sucrose solutions and then chewed for 10 minutes on various concentrations of urea containing chewing gums. A quick rise in plaque pH was found with all urea-containing chewing gums within the first minute of chewing, and neutralization continued during the whole 10-minutes chewing periods. Higher concentrations of urea resulted in more pronounced pH recovery. Slightly higher plaque pH values were found when chewing on two pieces at a time of a 20-mg urea gum was compared with only one piece.

Do chewing gums remove plaque & food debris?

Takahashi et al.[24] assessed the antiplaque effect of mastic chewing gum through two double-blinded, randomized clinical trials. In the first trial, after mechanical tooth brushing, the inhibitory effect of mastic gum on *H. pylori* in saliva was compared to a placebo gum. Saliva samples were collected at the end of 1, 2, 3, and 4 hours; diluted; inoculated onto 10% horse blood chocolate agar plates; and cultured anaerobically at 37 degrees C for 48 hours. The total numbers of bacterial colonies on each plate were then calculated. In the second trial, the effects of mastic gum on *de novo* plaque formation on tooth surfaces and gingival inflammation were evaluated over a 7-day period without mechanical oral hygiene, following random use of either mastic or placebo chewing gum. The degree of plaque accumulation and gingival inflammation were compared between the two groups. Results showed that, the total numbers of bacterial colonies were significantly reduced during the 4 hours of chewing mastic gum compared to the placebo gum. The mastic group showed a significantly reduced Plaque Index (2.69 ± 0.29 versus 3.15±0.24) and Gingival Index (0.44 ± 0.15 versus 0.66 ± 0.23) compared to the placebo group. It was concluded that mastic chewing gum is a useful antiplaque agent in reducing the bacterial growth in saliva and plaque formation on teeth.

Tellefsen et al.[25] evaluated the effect of use of chlorhexidine chewing gum in reduction of plaque formation as compared to the use of similar xylitol and sorbitol products & suggested that regular use of chlorhexidine chewing gums appears significantly more effective to control dental plaque formation possibly due to their anti-bacterial effect. Moreover, the xylitol-containing chewing gum was found to be significantly better than sorbitol products.

This observation was, however, negated by Ainamo et al.[26] who found that Xylitol, Sorbitol or Sucrose containing chewing gums do not result in any plaque reduction which was supported further by observations of Riethe et al.[27].

On the contrary, recent studies suggest that the chewing gums containing lactoperoxidase (LP), micro granules of silicon dioxide (SD), and zinc gluconate (ZG) provide no plaque inhibitory effects on smooth surfaces[28]. Addy et al[29] also concluded that gum chewing removed established plaque to some extent but not interdentally or along the gingival margin. Infact, McCall[30] went on to state that gum chewing was the least effective method of plaque removal compared to toothbrush and floss.

Do chewing gums have anticariogenic effects?

By altering the chief medicinal ingredient, the chewing gums have been known to exert an anticariogenic effect viz.

1. by increasing the enamel resistance to breakdown (Table 3)
2. by decreasing the amount of plaque accumulation (Table 3)
3. by accelerating the plaque acid neutralization (Table 3)

Steffen et al.[31] reported that chewing sugar-free gum immediately after meals, reduces caries which may be ascribed to numerous factors viz. saliva stimulation throughout the chewing process, the lack of sucrose and the inability of bacteria to metabolise polyols into acids.

Morgan et al.[32] discovered that 54 mg CPP-ACP (Calcium phosphopeptide-amorphous calcium phosphate) sugar-free gum significantly slowed progression by 18% and enhanced regression of approximal caries relative to a control sugar-free gum without CPP-ACP as assessed using digital bite wing radiography.

Supplementation of chitosan to gum was found to be an effective method for controlling the number of cariogenic bacteria, by Hayashi et al.[33] particularly in situations where it is difficult to brush one's teeth, such as when an individual is away from home all day or participating in outdoor training.

Significant increases were found[34] in pH, free calcium, and phosphate concentrations in plaque and saliva when an alpha-tricalcium-phosphate-containing gum was chewed. The results of this study suggested that the experimental gum may be more effective than conventional gum in reducing the cavity causing effects of sugar.

Table 2. Medicinal Chewing Gum Sold Worldwide[35]

Trademark™	Active Substance	Aim	Commercially Available In
Aspergum	Aspirin	Pain Relief	North America
Nicorette	Nicotine	Smoking Cessation	Worldwide
Nicotinelle	Nicotine	Smoking Cessation	Australia, New Zealand, Western Europe
Trawell	Dimenhydrinate	Travel Illness	Italy, Switzerland
Superpep	Dimenhydrinate	Travel Illness	Switzerland, Germany
Chooz	Calcium Carbonate	Stomach Acid Neutralization	USA
Endkey Vitamin C	Vitamin C	General Health	Middle East, United Kingdom
Stamil Vitamin C	Vitamin C	General Health	Australia
Source Vitamin C	Vitamin C	General Health	USA
Brain	DHA & CCE	Enhanced Brain Activity	Japan
Stay Alert	Caffeine	Alertness	USA
Café Coffee	Caffeine	Alertness	Japan
Buzz Gum	Guarana	Alertness	United Kingdom
Go Gum	Guarana	Alertness	Australia
Chroma Slim	CR	Diet	USA

Chewing Gum in Drug Delivery

Aspergum, a medicated chewing gum containing acetylsalicylic acid, was introduced in 1928, but it was during the 1970s that the first nicotine-containing gums were introduced and the potential of chewing gum as a drug delivery system was realised.

Chewing Gum as drug delivery method has various advantages: Easy administration without need of water, absorption via buccal mucosa thereby avoiding first-pass metabolism; lower dosage requirement due to higher bioavailability, and easier drug delivery method for those who find it difficult to swallow medicines in tablet or capsule form.

Do chewing gums promote remineralization?

Stimulated saliva is known to promote remineralization of early carious lesions due to its mineral supersaturation with respect to dental hard tissue. Several studies have shown that the chewing of sugar-substituted gum after meals and snacks promoted in situ remineralization of experimental caries-like lesions in human and bovine enamel specimens which were mounted in the oral cavities of volunteers[36-38].

Chewing gums containing xylitol and calcium lactate have been found to enhance remineralization of enamel surface compared to chewing gum containing xylitol[39] alone. Calcium lactate actually acts as an antacid and can be absorbed at various pH levels, hence preventing tooth decay.

When sucrose-containing chewing gum was used, however, remineralization was either not significant[38] or was found only when these gums were chewed for more than 20 minutes after meals[40,41].

Do chewing gums reduce gingivitis?

Chewing gums can help reduce gingivitis via mechanical removal of plaque, prevention of growth of harmful bacteria and reduction of bleeding.

Significant reduction in gingivitis along with the dental plaque was found in a 4-week study on pre-existing gingivitis patients with sugar free chewing gums by Sharma et al[42]. It was supported further by a clinical study conducted by Krasse[43] in 2005 which showed that patients who chew gum containing *Lactobacillus reuteri prodentis* have significantly reduced bleeding of the gums after two weeks of use. Around 85% of the patients in the study reacted positively to this treatment which may be due to a substance named **reuterin** produced by *L .reuteri* known to combat harmful bacteria and prevents growth of harmful microorganisms.

Kleber et al. (2001) found that regular use of a chewing gum containing 5% sodium bicarbonate appeared safe and effective for the removal of dental plaque and reduction of gingivitis when used in conjunction with daily tooth brushing[44]. Infact Smith et al. (1996) concluded that a significant reduction in bleeding was seen in patients using Chlorhexidine chewing gum for 4 to 8 weeks[45].

Effect of manuka honey on plaque and gingivitis was extensively researched by English et al.[46] who discovered its superior antimicrobial properties which may be used with success in the treatment of gingivitis and periodontal disease. Analysis of the results in the present study indicated that there was a statistically highly significant reduction in the mean plaque scores (0.99 reduced to 0.65), and the percentage of bleeding sites (48% reduced to 17%), in the manuka honey group, with no significant changes in the control group.

Do chewing gums reduce stain and whiten teeth?

Increase commercialization of teeth whitening chewing gums often make us wonder about their credibility.

Chewing gums containing sodium hexametaphosphate[47,48] while on one hand may help in physically removing extrinsic stains, on the other hand they[49,50] may also inhibit stain formation.

Other General Benefits of Chewing Gum

Chewing Gums have also been claimed to have achieved following general benefits -

- Improves concentration
- Freshens your breath

Table 3. Dental Chewing Gum Sold Worldwide[35]

Trademark™	Active Substance	Aim	Commercially Available In
Fludent/Flux	NaF	Caries Reduction (Enamel Resistance)	Sweden, Norway, Finland
Flugum	NaF	Caries Reduction (Enamel Resistance)	Switzerland, Belgium, France, Spain
Flourette	NaF	Caries Reduction (Enamel Resistance)	Denmark, Norway, Spain
Sensodyne Flour	NaF	Caries Reduction	Germany, Austria
		(Enamel Resistance)	
Lacalut Flour	NaF	Caries Reduction (Enamel Resistance)	Germany, Switzerland
Biotene	Lactose peroxidase, Glucose oxidase	Caries Reduction (Enamel Resistance)	Switzerland, Belgium, USA
V6	Carbamide	Caries Reduction (Enamel Resistance)	Western Europe, USA, Australia, New Zealand
Dirol	Carbamide	Caries Reduction (Enamel Resistance)	Central East Europe
Endekay	Carbamide	Caries Reduction (Enamel Resistance)	United Kingdom, Middle East
Boots Dental Gum	Dicalcium phosphate	Caries Reduction (Enamel Resistance)	United Kingdom
SorBits/ BenBits	Bicarbonate	Caries Reduction (Enamel Resistance)	Denmark, Sweden, Belgium, Norway, Netherlands
Candida	Calcium monophosphate	Caries Reduction (Enamel Resistance)	Switzerland
Dental Care	Bicarbonate, Calcium Carbonate	Caries Reduction (Enamel Resistance)	USA
Oral B	Bicarbonate	Caries Reduction (Enamel Resistance)	United Kingdom, Germany, Denmark
Arm & Hammer Dental	Bicarbonate	Caries Reduction (Enamel Resistance)	USA
Trident Advantage	Bicarbonate	Caries Reduction (Enamel Resistance)	USA

Yotuel	Papin	Tooth Whitening	South America, Spain, Greece, Finland, United Kingdom, Middle East
Ice White	Bicarbonate	Tooth Whitening	Solvenia, Ireland
Zenser	Zinc Acetate, Zinc, Q10, Bicarbonate	Fresh Breath	Latvia, Estonia
Dental Health	Chlorophyll	Fresh Breath/ Gum Health	USA
Discus Health	Zinc	Fresh Breath	USA
Breath RX	Zinc Chloride	Fresh Breath	USA, Canada
Vitaflo CHX	Chlorhexidine	Antimicrobial	Denmark
Chlorets	Copper chlorophyllin	Fresh Breath	Orient
ChewX	Chlorhexidine	Antimicrobial	Switzerland

- Relaxes and eases tension
- Moistens the mouth
- Helps staying alert and awake
- Resists urge to smoke
- Reduces ear discomfort while flying
- Satisfies snack craving
- Prevents heartburn after meals
- Improves long term memory1

Drawbacks of Chewing Gum: THE BAD

There have been claims of adverse effects of chewing gum but the growing market of gums proves that the benefits have prevailed over them. We will glimpse at some of the potential harmful issues associated with gum chewing.

Do chewing gums cause TMJ problems?

One drawback of chewing gum is the potential for TMJ (temporomandibular joint) problems. Gum chewing may result in muscle fatigue and pain, especially if it is done frequently and/or for long periods of time. In a study by Christensen et al.[51] involving 323 girls, aged 15-16 years a questionnaire on oral habits and TMD symptoms was given to gain some insight into the relationship between gum chewing and TMJ disorders. Results revealed that gum chewing was a very prevalent habit (62·4%), performed daily (mean chewing time 3·95 hr/day). Girls who chewed intensively (more than 4 hr/day) showed associations with pain in the ear area during function and at rest, as well as joint noises.

However, Sallsten et al[52] contradicted these findings by negating any possible association between chewing gum and fatigue and pains of the jaw muscles in his study on adult volunteers.

Research has not really established a direct causal relationship between gum chewing and development of structural changes within the jaw joint, which could lead to fatigue and/or pain though it is still a debatable topic.

Can chewing gums release mercury from dental fillings?

Sallsten et al.[52] concluded that heavy gum chewers, chewing 10 pieces per day on an average for 27 months, risk the break down of amalgam in their dental fillings and having dangerously high levels(twice the normal) of mercury in their blood and three times their normal concentration in urine & exhaled breath as compared to the infrequent chewers.

Similarly, Gebel et al.[53] demonstrated that the consumption of chewing gum resulted in significantly higher mean urinary mercury content in people with amalgam fillings in comparison to non gum-chewing people with similar fillings.

Chewing Gum as a Menace: THE UGLY

Chewing gums are non-biodegradable and can prove to be public hazard if not disposed properly. Most of us are familiar with the negative aspects of chewing gum, when we find it on chairs, stuck under desks or contaminating pavements and therefore our shoes. Dropping chewing gum is a common littering problem. A single piece of gum might seem insignificant but the combined visual impact of all the gum on any city's streets is clear. Apart from looking unpleasant, gum is costly to clean up. Removing it from the pavement requires high impact cleansing which is expensive, whereas a gum itself costs little to purchase. Some countries have restricted the use of chewing gums and others have provision of huge fines for littering.

Conclusions

During the course of our review we found some very interesting studies on variable effects of chewing gums. We were able to understand why chewing gum, apart from keeping millions of gum chewers busy, motivates thousands of researchers and dental professionals every year to explore new facts about it. Chewing gums certainly have considerably beneficial effects on our oral health – both short-term as well as long lasting, viz.

- *chewing gums, both sugar-free and sugar-containing, significantly increases both stimulated & unstimulated salivary flow rate,*
- *are effective in raising the plaque-pH levels,*
- *may prevent or remove plaque to some extent, but are in no way a substitute to traditional mechanical oral hygiene (toothbrush, floss etc.) measures,*
- *have been found to exert significant anti-cariogenic effects,*
- *may help prevent stain formation and reduce extrinsic stains significantly hence resulting in desired whitening of teeth,*
- *chewing of sugar-free gums after meals and snacks can promote remineralization of enamel,*
- *may reduce gingivitis significantly if taken along with traditional mechanical oral hygiene measures,*

yet their glaring though debatable degenerative effects viz.,

- *pathosis like MPDS on long term gum chewing*
- *considerable impact of excessive chewing on mercury levels on serum, urinary and exhaled breath*

cannot be ignored thereby warranting gum chewing as an important parameter to be considered in patients with long term gum chewing history.

We thereby implore upon the rationalism of our readers alike to responsibly dispense such products to their patients

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A man saw a child weeping
'Why are you weeping', he asked
'A snake bit me' was the reply
'That is nothing', was the reply
'I thought you had a toothache' and went on his way!