

Literature Review

CHEWING GUM: TRICK OR TREAT?

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تقدم هذه المراجعة التسلسل الزمني لتطور العلك منذ بداية استخدامه إلى اليوم الحاضر كما تذكر أيضاً مكوناته وطريقة تصنيعه واستخدام المحليات كبديل للسكر في صناعته .
 تم كذلك مراجعة تأثير العلك على صحة الأسنان من عدة أوجه كتأثيره على تسوس الأسنان وصحة اللثة وجفاف الفم واستخدامه كوسيلة لنقل الدواء كما تطرقت المراجعة باختصار للعلك العربي وفوائده والاستخدام العالمي للعلك وإنتاجه وتسويقه .
 مضمون هذه المقالة ليس فقط يدعم أن العلك الخالي من السكر لا يسبب التسوس بل أيضاً يدعم بقوة أن العلك المحتوي على مادة الزايلتول مضاد للتسوس ومفيد لصحة الأسنان ويمكن أيضاً التغلب على قابلية العلك المحتوي على السكر في تسبب التسوس بإضافة مكونات أخرى أو باستخدامه بطريقة صحية .
 إن مضغ العلك هو عادة عالمية وعلى الغالب فإنها ستدوم ما دام الإنسان يسكن على وجه الأرض .

This review presents a chronological account of chewing gum, from its early origins to its present day magnitude. The product's composition and manufacturing process are outlined in this paper. Sweeteners as substitutes for sugar are also discussed. The effect of chewing gum on dental health is reviewed from several aspects: dental caries, periodontal health, xerostomia and as a vehicle for medicaments. Gum of acacia arabica, world-wide gum usage, gum production and marketing are briefly mentioned. The literature not only supports the conclusion that "sugar-free" gums are non-cariogenic but strongly suggests that xylitol chewing gum is anticariogenic and benefit dental health while the potential cariogenicity of sucrose-sweetened gums can be modified by additives or selected pattern of use. Chewing gum is a world-wide phenomenon that will most likely persist as long as human beings inhabit the earth.

Introduction

Gum chewing is a common habit in many countries. Although gum chewing offers great pleasure to many individuals, it is also a nemesis for countless parents, school teachers and building custodians because this sticky intruder is often found in children's hair, on bed posts, and under tables, chairs, desks or sticks to the soles of passing shoes.

From the professional view, the role of gum chewing is more controversial. Some investigators believe that since most chewing gum is sweetened with sucrose, gum products may increase the cariogenic load to dietary carbohydrates. Others perceive that gum chewing, which occurs after eating, causes dental plaque pH levels to increase to a safe level and considers sugar-less gum as the least cariogenic. This single item of confectionery clearly has a considerable impact on the mouths of many of dental patients. It is important, therefore, that this new suggestion is viewed against a background of existing published evidence regarding the dental effects of chewing gum. Consequently, the objective

of this report is to review *the historical development of chewing gum, dental literatures related to this material and to answer the question: chewing gum: Trick or Treat?*

History of gum chewing

Chewing gum has an old & long history, In 50 AD, the Greeks sweetened their breath and cleansed their teeth by using mastiche, a resin from the bark of mastic tree.² (The English word "masticate" is derived from the root word mastiche.)

One thousand years ago, the ancient Mayan Indians of Yucatan chewed tree resin (chicle) from the Sapodilla tree.

Spruce gum, which was manufactured in 1848, became the first chewing gum product to be manufactured commercially Called "STATE OF MAINEPURE SPRUCE GUM." However, its use was eventually replaced by paraffin, which is still being chewed in some areas.²

During the 1860's, a new York photographer named Thomas Adams, realized

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the potential market for chewing gum products. He wrapped pieces of pure, flavorless chicle in colored tissue paper, packaged them in boxes, and left them on consignment with numerous drugstore owners. The gum was named ADAMS NEW YORK NO.1. Public response to the product was very favorable.²

The first patent for chewing gum, U.S. number 98,304 was filed on December 28, 1869 by Dr. William F. Sample, a dentist from Mount Vernon, Ohio. This product, consisting of licorice and rubber dissolved in alcohol and naphtha, was initially intended to be used as a dentifrice.²

In 1891, William Wrigley Jr., arrived in Chicago with \$32 in cash with a desire to market his special variety of soap. Eventually, he switched from soap to baking powder sales and offered chewing gum premiums to merchants who became his customers. By 1892, when the premiums had become more popular than the baking powder, Wrigley launched his first chewing gum products, LOTTA and VASSAR. A year later, he developed JUICY FRUIT, and shortly thereafter, WRIGLEY'S SPEARMINT gum.²

Sugarless gum made its debut in the early 1950s, generally used Sorbital as a sugar substitute. The first brand to be marketed was HARVEY's followed by TRIDENT and CAREFREE. In 1975, the Wm. Wrigley Jr. Company introduced the arrival of a new chewing gum product, FREEDENT, designed especially for denture wearers, which did not stick to most dentures as ordinary gum did.²

Since then, there has been intense competition among companies to produce greater varieties of chewing gums (Fig. 1).

Social history and cultural acceptance of gum chewing

At the beginning of its history this product was not so much accepted by the public. As Emily Post (1959) comments in her book that "it is still impossible to imagine a lady walking on a city street either chewing gum or smoking."³ There is also this anonymous American rhyme which says "The gum-chewing kid and the cud-chewing cow are somewhat alike, yet different somehow. And what is the difference? I think I know now it's the clear thoughtful look on the face of the cow."³

The social acceptance of gum chewing, however, has increased dramatically over the years.² As gum chewing has become more widely accepted and practiced, songwriters, film makers and authors have incorporated related themes into their works.²

Extent of usage

Chewing gum is used widely. A devoted gum chewer can confidently traverse the globe with the assurance that his/her masticatory needs will be met. These are some of the international terms which identify chewing gum (e.g. goma de mascara in Argentina; kaugummi in Austria; le chewing gum in France; elk in Arabian area; tsbles in Greece; gamu in Japan, tyggegummi in Norway and heung how chu in Taiwan).² So it can be considered as an international habit among all countries of the world (except in some countries and in some religious communities where gum chewing is still considered as bad manners or even forbidden [e.g. Singapore & UAE]).⁴

Production and marketing figures

The production and distribution of chewing gum is a multimillion dollar business which continues to expand. In 1987, gum products accounted for 550 million dollars in sales in the USA. Of this amount, 150 million dollars was brought in by the bubble gum market alone. Chewing gum sales rate second only to chocolate sold in the form of candy.²

In the Wm. Wrigley Jr. Company's 1986 Annual Stockholder's Report, net chewing gum sales were reported to be approximately 699 million dollars. In fact, Americans spend more on gum than on elementary school textbooks!²

Composition of a modern chewing gum

Twentieth century chewing gum is a combination of five main ingredients: powdered cane or beet sugar (50-65%), chewing gum base (18-30%), corn syrup (12-20%), color and flavoring agents (1-2%) and softeners (0.3-3.0%).²

Noticeably, more than half of its ingredient is sugar, which is responsible to enhance the flavor and enrich the texture of gum. Sugar in sugared gum is either sucrose.



Figure 1: A selection of some of the chewing gums currently sold in the Kingdom of Saudi Arabia.

fructose or hydrogenated glucose but sugar-free gum has also sugar substitute (using the term sugar-free or sugar-less is somewhat misleading because all carbohydrates provides about 4 Kcal/g; so the amount of calories provided is the same but the difference is the quantity which will depend on the sweetness).⁵ That is why sweeteners can be divided into two groups: *bulk sweeteners* and *intense sweeteners*. The formers are almost always carbohydrates and carbohydrate derivatives (sucrose, fructose, polyols, etc.). Intense sweeteners are either synthetic or natural substances (saccharin, cyclamate, aspartame, and acesulfame-K) where the sweetness is very high compared with sucrose, therefore, they are used at such low concentrations in order not to add to calories.⁶ Both types of sweetening agents are often included in sugar-free gums as aspartame, sorbitol, mannitol and xylitol .

Aspartame is a high intensity sweetener marketed as Nutrasweet\ it has the ability to reduce adherent plaque formed by streptococcus mutans and considered as non-cariogenic as well as anticariogenic.⁷ Sorbitol and Mannitol are polyols that are metabolized by oral bacteria so slowly that any acid produced is simultaneously neutralized, hence, these are considered non-cariogenic.⁸ Xylitol has been used for many years to replace sugar mostly in chewing gum. Several studies indicate the xylitol possesses an antibacterial property⁹

including the fact that it is not metabolized to acids either in pure cultures of oral microorganisms in vitro¹⁰ or in dental plaque *in vivo*."

Manufacturing

Chewing gum is typically processed in six steps:³

1. Base materials are placed in large kettles and ground thoroughly.
2. The mixture is purified by using a straining apparatus and high speed centrifuges.
3. The flavorings, softeners and sweeteners, mixed with the gum base in machines with strong rotating blades, produce a mass with the consistency of stiff bread dough.
4. The gum mass is sent through a series of rollers, formed into a thin, wide ribbon, lightly coated with powder sugar (to prevent sticking) and scored (cut and broken) into single sticks.
5. The gum is conditioned to increase shelf life.
6. The product is packaged and readied for distribution.

Benefits of gum chewing

Today, statements about the

therapeutic efficacy of chewing gum are more scientifically based than they were in the past.

In this review of the effects of chewing gum on dental health, the following aspects will be considered:

- Chewing gum and dental caries
- Chewing gum and periodontal health
- Chewing gum and xerostomia
- Chewing gum as a vehicle for medicaments
- Gum of acacia arabica

Chewing gum and dental caries

Although chewing gum is widely used in many countries, there is little information on the effect of chewing gum on salivary flow and how it changes during prolonged chewing or with different types of chewing gum, although any beneficial effects of chewing gum can be mostly be due to an increased salivary flow rate.¹²

Both sucrose containing and sugar-free gum stimulate salivary flow, due to a combined effect of gustatory stimulation from the sweetening and flavoring agents and mechanical stimulation of salivary flow from chewing (70-80 chews/min). The latter function is probably effective at the interproximal site due to physical pumping the saliva into this relatively inaccessible area.¹³ Increase in saliva flow lead to more frequent replenishment and greater supply of antibacterial factors, sialin, buffers, minerals and other beneficial constituents, reducing plaque acidogenicity and increase pH and buffer capacity of whole saliva.¹²

During gum chewing, there will be an increase in salivary film velocity to approximately tenfold higher than the highest unstimulated film velocity.¹⁴ In general, the flow rates with both types of gum peaks (5ml/min) in the first minute to become 10-12 times greater than the unstimulated flow rate (0.5-0.1 ml/min) and then lowers progressively to about (1.25 ml/min) by the end of 20 minutes of gum chewing. As chewing continues, there is a consequent rise in pH level which reaches a peak (7.6-7.8) after 3-5 minutes of chewing to a level above the critical pH.¹⁵ Such a pH is outside the accepted zone for demineralization of tooth enamel. The increase in salivary pH on stimulation is mostly due to an increase in bicarbonate concentration which is

proportional to flow rate. The pH falls very little with continued stimulation despite the reduction in flow rate.¹⁶

The use of sugar free or sugared gum as a plaque pH raising agent differs from their use as a snack item alone. The plaque pH response to sugared gum alone is likely to be affected by chewing time, since the carbohydrate is dissolved out of the gum very rapidly.¹⁷ *The use of gum chewed for 20 minutes, after plaque pH became already low, demonstrates that both sugared and sugar free gum effectively reverses the plaque pH which had dropped as a result of consumption of the meals*^{7,18} (Fig. 2). That is why the clinical field trials with sucrose containing gum have pointed to increased caries incidence levels with this type of chewing gum.¹⁹ These clinical studies^{19,21} were conducted without control of the time at which the gum was chewed and the period of chewing. On the other hand, chronic consumption of xylitol sweetened chewing gum resulted in reduction of dental plaque, suppression of mutans streptococci, and reduced adhesiveness of plaque.²² So far, four field studies with regimens including chewing gum and other xylitol containing products and four clinical trials have been carried out. All of the latter studies showed that a daily intake of two to three pieces of xylitol gum resulted in a definite reduction of caries.²² There are indications that regular and prolonged use of xylitol chewing gum may have a caries-preventive effect.²²

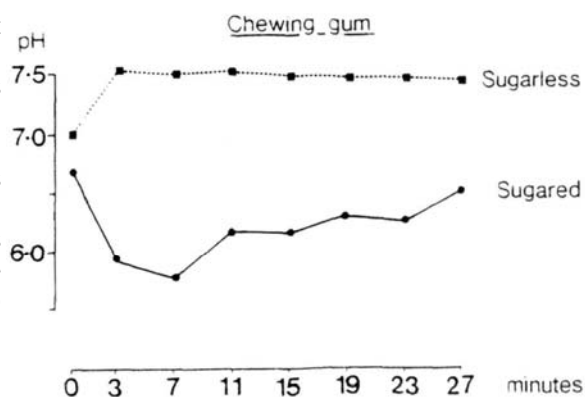


Figure 2. Plaque pH responses in human subjects chewing sucrose and sugar-free gum.

Chewing gum and periodontal health

Some short term advantages resulting from the mechanical removal of debris may be derived from gum chewing. These effects may include improvements in oral odor due to the use of the various flavoring agents in these preparations.²³⁻²⁴ Several studies have examined the effect on plaque, oral debris, calculus or gingivitis scores, in subjects who chewed gum compared with non gum chewing controls. The results are variable. Emslie et al.²⁵ found reductions in calculus, but not in debris or gingivitis, in gum chewers; Addy et al.²³ found that both sucrose gum and sugar free gum reduced plaque accumulation, and removed established plaque, compared with no gum, albeit in the absence of oral hygiene measures.

In an oral environment lacking hygiene, Hoerman et al.²⁶ found that plaque accumulation during use of sorbitol chewing gum or sucrose chewing gum was statistically the same. However, chewing gum, irrespective of sweetener, caused significantly less plaque accumulation than no chewing.

Many studies, however, have tried to add additives to gum for periodontal health improvement as *hydrogen peroxide*,²⁷ *chlorhexidine*,^{28,30} *bicarbonate*,^{31,32} or even *rough particle as zirconium silicate*³³ showed good results but still requires longer term investigations.

Chewing gum and xerostomia

There is an increased masticatory effort involved in frequent gum chewing which can cause a significant increase in salivary gland function over a relatively short time frame, in conjunction with a reduction in plaque acidogenicity.³⁴ This may have implications for the patient with reduced salivary output who is at risk for coronal or root caries, and would constitute a non invasive, non pharmacological form of therapy.³⁴

Jenkins and Edgar³⁵ demonstrated that the chewing of four sticks of sugar free gum per day for eight weeks significantly increased unstimulated whole saliva flow rate. In addition to its effect on sugar clearance, since it is unstimulated saliva that bathes the teeth and plaque for the greater proportion of our waking hours, an increase in its flow rate presumably leads to a more frequent replenishment and greater supply of

antibacterial factors, sialin, buffers, minerals, and other constituents beneficial to the plaque and surfaces of the teeth.

People suffering from xerostomia should avoid gum containing sugar, as it seems unlikely that any saliva stimulation induced would be sufficient to counterbalance the cariogenic challenge from the sugars.³⁶

Chewing gum as a vehicle for medicaments

In 1924, the first medicated chewing gum (which contained acetylsalicylic acid) was marketed in the USA. However, it was not until nicotine containing gums became available in 1978 that chewing gum, as a system of drug delivery, began to gain acceptability.³ Many therapeutic substances have been added to gum in an attempt to prevent dental caries, periodontal disease or other oral conditions.

a. Xylitol

As mentioned earlier, the use of any sugar-free chewing gum helps preventing dental caries. Based on clinical trials, it has been suggested that mastication of xylitol chewing gum reduces dental caries in children and young adults better than any other sugar free chewing gums.^{6,37} This improvement has been associated with a reduced content of streptococcus mutans³⁸⁻³⁹ and lactobacilli⁴⁰ in saliva, a reduced amount of plaque and an increased plaque pH. During the last 10 years, more than a hundred scientific articles have been published on xylitol and dental caries.

b. Carbamide

Due to the pH rising effect of carbamide (urea), it was proposed to incorporate it into sweets and other products containing fermentable carbohydrates as a caries preventive measure.^{41,42} The beneficial effects of carbamide chewing gum have been discussed by Bjornstrom et al.⁴²

c. Bicarbonate

Igarashi K. et al.³¹ found that the presence of bicarbonate in chewing gum can supplement the saliva buffering system, causing a faster rise in pH, and allowing the plaque pH to remain at an elevated level for at least 20 min. It also shows antimicrobial activity against various oral bacteria associated with the development of periodontal disease as

reported by New Burn G. et al.³²

d. Fluoride

As an alternative to fluoride mouthrinses, fluoride chewing gums offer the advantages of convenience, dose control and plaque pH increasing abilities.^{43,44} Results of Lin and Corpron study⁴⁵ indicate that fluoride containing chewing gum has a highly significant fluoride uptake and remineralization compared to sorbital gum and control regimens .

e. Chlorhexidine

A study³⁰ showed that 20 mg per day doses of Chlorhexidine from chewing gum were as effective as 40 mg per day from rinses. Also, two main disadvantages are associated with chlorhexidine mouth wash [it's bitter taste & the staining] can be overcome by administering chlorhexidine in a chewing gum formulation .

f. Miconazole!

Rindum et al.⁴⁶ investigated chewing gum as a vehicle for miconazole and they found that patients preferred gum to miconazole gel & the lower doses of miconazole in gum form were clinically as effective as larger doses in the gel form.

g. Nicotine

Nicotine chewing gum contains 2 mg of nicotine per piece. It produces a blood nicotine concentration similar to, but somewhat less than, that produced by a single cigarette.⁴⁷ The efficacy of this product has been investigated in more than 60 different clinical studies in more than 20 countries where they strongly suggested that nicotine containing chewing gum is an effective adjunct in helping people quit smoking.³

Unfortunately, few persons using Nicorette became addicted to nicotine chewing gum; however, the use of Nicorette is not nearly as risky as smoking cigarettes since Nicorette does not contain carcinogenic tar substances.⁴⁸

h. Vitamin C

Vitamin C in chewing gum (60gm) and in chewing tablets (60mg) were compared in a clinical trial. The relative recovered fraction of vitamin C (chewing gum compared to chewing tablets) in urine was approximately 1.3. The explanation for this result might be that vitamin C released from chewing gum is passed to the

stomach dissolved while from chewing tablets, the vitamin is passed partly in tablet fractions.³ Thus, vitamin C administered in a chewing gum is a convenient way of providing additional vitamin C, however, a more important advantage from a therapeutic point of view is the reduction in the occasional risk of erosion of dental enamel observed when administered as chewing tablets.³

Cum of Acacia Arabica

The gum of acacia Arabica has been an article of commerce for thousands of years. It was exported to the gulf of Aden 1700 years before Christ and was mentioned by Theophrastus in the third century BC under the name of "Egyptian Cum."⁴⁹

Acacia gum consists primarily of *Arabica*, a complex mixture of *calcium*, *magnesium* and *potassium salts* of Arabic acid. It contains *tannins* which are reported to exhibit astringent, homeostatic and healing properties. It also contains *cyanogenic glycosides* in addition to several enzymes such as *oxidase*, *peroxides* and *pectinases*, all of which have been shown to exhibit antimicrobial properties.⁵⁰ Acacia Arabica type of chewing gum has potential to inhibit early plaque formation. The nature of this inhibition, however, is not yet known.⁵⁰ Further studies are suggested to identify and purify its active ingredients for future trials in tooth pastes and mouth wash formula.

Conclusion

The considerable body of information on the dental effects of chewing gum attests to the importance attached to this confectionery item. It can be concluded that the habitual use of chewing gum effectively stimulates salivary flow and improves plaque pH. Indeed, the unregulated use of sugared gum can be associated with significantly increased caries rates. It is advised to adopt a pattern of consumption which may minimize (or perhaps eliminate) the caries risk, by chewing sucrose gum after meals and snacks for at least 20 minutes.

In contrast, sugar free gum can be recommended for use both after meals and snacks and at other times. Long term clinical trials have demonstrated that use of all sugar free gums reduces dental caries. However, benefits derived from sugar-free gum appear to increase as the xylitol concentration increases.

Regarding periodontal health, usage of sugared gum has not conclusively been shown to benefit periodontal health. Conversely, sugar free gum has been shown to reduce plaque and improve gingival health in short term studies, although longer investigations are required.

For patients with temporary xerostomia, sugar-free gum appears to increase saliva flow and produce subjective relief from the discomfort of dry mouth.

Finally, it is foreseen that drugs may be formulated into chewing gum, in preference to other delivery systems, in order to deliver drugs to the oral cavity. The reason is simple - that the chewing gum delivery system is convenient, easy to administer- anywhere, anytime - and is pleasantly tasting making it patient acceptable.

Recommendations

The conclusions arrived at from this review lead to the recommendation of sugar-free gums, chewed as a confectionery; to reduce sucrose consumption and after meals consumption; to reverse pH challenges.

Among those who prefer sugared gum, chewing after meals at least *20 minutes* will help minimize risk and maximize salivary protective effects . The addition of chewing sugar-free gum following meals should be considered for individuals at risk of dental caries or complaining from dry mouth. *Chewing gum is without a doubt, a treat and not a trick!!!*

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