



## Review

## Chewing gum: Production, quality parameters and opportunities for delivering bioactive compounds

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## ARTICLE INFO

## Article history:

Received 9 April 2016

Received in revised form

4 July 2016

Accepted 7 July 2016

Available online 9 July 2016

## Keywords:

Chewing gum

Flavor

Texture

Bioactive compounds

## ABSTRACT

**Background:** Chewing gum has an amazing statistics. The entire industry is worth \$25 billion and annually 1.74 trillion sticks of chewing gum are produced. It would account for 290 billion hours' duration of staying in mouth if each piece of gum was chewed for 10 min every year. Concerning these statistics at least smoke cessation, oral health and new form of drug delivery system potentials of chewing gum are clear. Therefore, fundamentals of chewing gum should be realized in detail to take the advantage of this product.

**Scope and approach:** In this review, due to limited studies concerning chewing gum in food science and technology area, key points in production, quality parameters and bioactive compounds delivering properties of chewing gum were reviewed with aim to show promising study areas to researchers. Production of different types of gums, ingredients used, sensory and texture properties and potential future functions of chewing gums were discussed with a special emphasis on the bioactive compounds carrier properties of chewing gum.

**Key findings and conclusions:** Encapsulation not only improved a sensation of flavor for a long period when applied in the chewing gum but also had a potential to give functionality to chewing gum. Only recently the idea of healthy chewing gums and using chewing gum as an alternative form of drug delivery system have been developed. Therefore, food technologists should give attention to this promising subject of producing chewing gums having long lasting flavors, being biodegradable and forming a type of functional confection consumed with pleasure by everyone.

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## 1. Introduction

The consumption of confectionery products has grown tremendously in recent years, especially among children and teenagers (Carbonell-Baaranchina, Garcia, Sanchez Soriano, Aracil, & Burlo, 2002) and chewing gum is a popular confectionery product worldwide (Wong, Yu, Curran, & Zhou, 2009; Yang, Yin, & Shao, 2011). It is consumed by a diverse set of consumers. Also accessibility is another advantage (Hearty, Lau, & Roberts, 2014). Especially, people enjoy it as a confection and latterly as an aid in oral hygiene and an alternative to smoking (McGowan, Padua, & Lee, 2005).

Chewing gums have rubbery-like structure and depending on

the type of final product they are composed of various ingredients such as sugar, polyols, gum base, aroma, acidulants, colors, sweeteners and different additives, (Valduga, Lazzari, Xardanega, & Di Luccio, 2012). It is a two-phase product and consists of water-soluble continuous phase and - discontinuous phase which is gum base. These phases are generally mixed in proportion of 1:3, respectively. Flavoring ingredient concentration of chewing gum is approximately 1% (Potineni & Peterson, 2008a). Chewing gum is generally produced from chicle, a natural latex raw material, or polyisobutylene (Baysal, Ozbek, & Akman, 2010).

Chewing gum plays an important role in the confectionery industry (Valduga et al., 2012). Moreover, chewing gums have been produced for treating disorder/disease conditions like inhibition of dental disorders, appetite arrangement delivery, smoking mimetics, carriers of functional ingredients and regulation of stress and mood changes (Deshpande & Jadad, 2008; Hearty et al., 2014; Hetherington & Regan, 2011; Ribelles, Guinot, Mayne, & Bellet,

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2010; Smith, Chaplain, & Wadsworth, 2012).

According to Euromonitor International GmbH, the sales value in chewing gum market is 25 billion dollars in the world in 2014 (Euromonitor, 2014). Annual chewing gum consumption rate in America was reported to be 160–180 sticks per person. Although these statistical data showed that chewing gum market is very huge, studies about chewing gum is scarce. Chewing gum will be expected to attract great attention from industry and scientific world in the near future for several reasons including its high consumption rate, importance of chewing gum market in the confectionery industry and potential health benefits by delivering bioactive compounds. Therefore, from production to quality parameters of the finished product, critical aspects of chewing gum was reviewed with special emphasis on its potential of delivering bioactive compounds. This study will provide insight into the optimization of formulation and manufacturing process to obtain the product with desired quality. The present work included classification of chewing gums, ingredients used in the formulation, production processes, quality parameters and opportunities in terms of delivering bioactive compounds.

## 2. Classification, ingredients and process

### 2.1. Classification

Chewing gums are mainly classified into 4 groups: (i) sugar chewing gum, (ii) sugar-free chewing gum, (iii) coated chewing gum and (iv) medicated chewing gum.

General composition of sugar and sugar-free chewing gums is summarized in Fig. 1. Sugar chewing gums contain almost

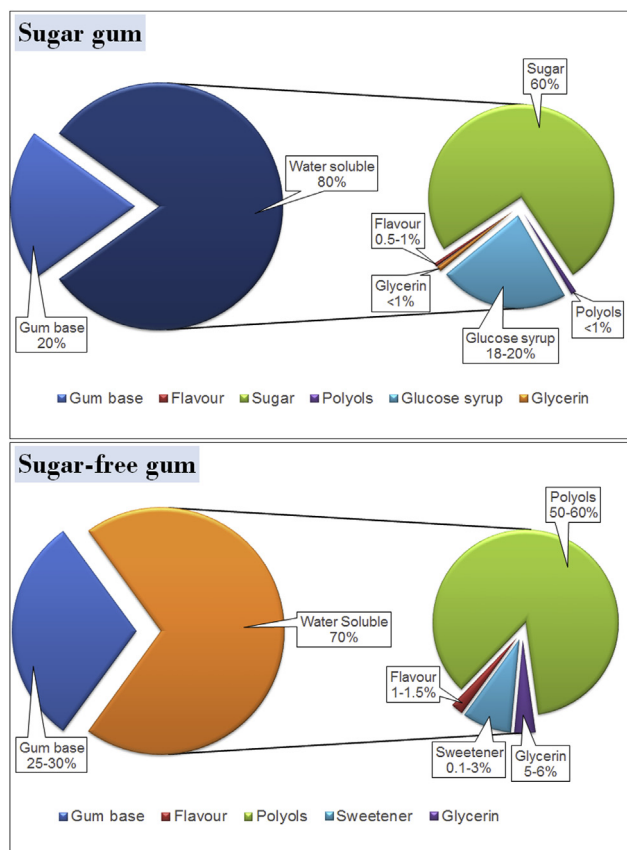


Fig. 1. Average quantitative formulation of sugar and sugar-free chewing gum components.

80 weight % sugar and glucose syrup mixed with gum base. The main difference between sugar chewing gum and sugar-free chewing gum depends on substitution of different sugar alcohols and high intensity sweeteners for sugar and glucose syrup. Concerning the coated chewing gum, coating is used to improve visual impact of the product and control of the water activity and shelf life. Sugar, sugar-free and coated chewing gum with different flavors, shapes and sizes are produced in the industry. Chewing gum having the property of blowing bubbles due to film forming characteristics is called a bubble gum. Concerning the other type of gums, center-filled gums has flavored liquid in the form of soft mass in its center. Depending on its shapes there are also ball gum, stick gum, ribbon gum, tab gum, tube gum, dragee gum and wrap gum in the market. Moreover, for various human needs, tailormade chewing gums can be made which is called functional gum. Vitamins and minerals can be added to gum giving practical function to it.

Medicated chewing gums include pharmaceutical or nutraceutical compounds which are released in a controlled manner during chewing and therefore they are accepted as drug delivery systems (Maggi, Conte, Nhamias, Grenier, & Vergnault, 2013). According to the European Pharmacopoeia and report prepared for pharmaceutical dosage forms in 1991 by the Committee for Medicinal Products for Human Use (CPMP), medicated chewing gums are described as “solid single dose preparations with a base consisting mainly of gum that are intended to be chewed but not to be swallowed, providing a slow steady release of the medicine contained” (Paradkar, Gajra, & Patel, 2015). Chewing gums are attractive and effective alternative drug delivery systems when these factors are considered; people of all age savorily chew gums, release of active substance can be controlled, buccal drug administration for the treatment of local oral diseases can be effective and it can make oral administration very convenient (Yang, Wang, & Zhang, 2004). They are suitable for therapeutic uses such as preventing oral cavity, treatment of motion sickness and otitis media, smoke cessation, pain reliever, antioxidant, oral antifungal, alertness, anti-nausea, anti-emetic, anti-septic, healing, etc. since they are chewed in the mouth for a long duration. Moreover since the bioactive compound or drug is absorbed by oral mucose, chewing gums can provide a faster onset of therapeutic effect and potentially reduce gastrointestinal and hepatic first-pass metabolism of susceptible drugs (Maggi et al., 2013). Investigations on the bioavailability and distribution of some active substances in tissue showed the advantages of chewing gums (Yang et al., 2004).

### 2.2. Ingredients

Chewing gum is generally fabricated by mixing of a required amount of water-insoluble gum base and different additives which are sweeteners, softeners, food colorings, preservatives (Yang et al., 2011). It consists of two phases; (i) gum phase (water-insoluble), and (ii) sugar or sugar alcohol phase (water-soluble). Regarding coated chewing gum, it is possible to specify the compound material as a third phase. Corn syrup and/or glucose are employed as humectants and they play an important role in coating of the sugar particles to stabilize their suspension and in maintaining flexibility of the product (Wong et al., 2009). Amount and size of the granulated sugar present in these phases are responsible for the texture of the end product. Moreover, various softeners, food colorings, preservatives, and flavorings are used in the formulation to produce the product with desired quality.

It has been reported that the composition of chewing gum (for example the chewing gum bases, the carbohydrate and solvent) could affect the retronasal aroma release (Itobe, Kumazawa, Inagaki, & Nishimura, 2012; Potinene & Peterson, 2008a,b; Soutmann, Van Lochem, & De Roos, 2003), and the composition

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