The erosive potential of candy sprays

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IN BRIEF

- Highlights a recently introduced type of candy, so-called candy sprays.
- These candy sprays have an extremely low pH and a high buffer capacity.
- Use of these candy sprays can decrease the salivary pH to values below 5.5 and so they may have an erosive potential.

Objective To determine the erosive potential of seven different commercially available candy sprays *in vitro* and *in vivo*. **Material and methods** The erosive potential was determined *in vitro* by measuring the pH and neutralisable acidity. The salivary pH and flow rate were measured in healthy volunteers after administration of a single dose of candy spray. **Results** Candy sprays have an extremely low pH (1.9–2.3) and a neutralisable acidity varying between 0.8–1.6 ml of 0.25M NaOH. *In vivo*, candy sprays induced a short-term 3.0 to 5.8-fold increase in salivary flow rate with a concomitant drop in salivary pH to values between 4.4 and 5.8. **Conclusion** All candy sprays tested have an erosive potential. This information is of use for clinicians counselling juvenile patients with dental erosion.

INTRODUCTION

Dental erosion has been defined as the physical result of a pathologic, chronic localised loss of dental hard tissue that is chemically etched away from the tooth surface by acid and/or chelation without bacterial involvement.¹ In the United Kingdom, the prevalence of dental erosion is high in children and young adolescents and the prevalence still seems to be increasing.^{2–14} Although the aetiology of dental erosion is multifactorial, it is assumed that dietary sources of acids are the major risk factor in this age group. Several studies found an association between the presence of dental erosion and a high level of consumption of cola-type and other flavoured carbonated beverages.^{7,9,12,13,15–17} Many soft drinks contain phosphoric, citric and other acids as ingredients, and their pH is often less than 4.0.^{18–20}

Solid acidic candies also contain organic acids like citric acid, lactic and/or malic

Fig. 1 A child using a candy spray

acids to develop the characteristic sour taste. Homogenised candies dissolved in water decrease the pH to values below 4.²¹ *In vivo* studies have shown that sucking acidic candies decreases the salivary pH to 4.5.^{22,23} Acidic candies were capable of softening enamel both *in vitro* and *in situ*.^{24,25} Taken together, this suggests that (excessive) consumption of acidic candies can contribute to the development of dental erosion, especially in individuals with low salivary flow rates and low salivary buffer capacity.²⁵

A recently introduced type of acidic candy is the so-called candy spray, which has to be sprayed directly into the mouth (Fig. 1). This gives an immediate sour-fresh taste and tingling feeling on the tongue. Candy sprays are very popular among primary school children. In the Netherlands,

Fig. 2 Erosion of occlusal surfaces in a nine-year-old girl with a history of excessive use of candy spray

31% of children between four and eight years old and 58% of children between nine and 12 years old reported they had used candy sprays.²⁶ In the same study, a nine-year-old girl was presented with severe erosion of the occlusal surfaces attributed to excessive use of candy spray, indicating that candy sprays have a potential risk for dental erosion (Fig. 2). Since several types and tastes of candy sprays are available in the United Kingdom, the aim of this study was to compare the erosive potential of a number of commercially available candy sprays both *in vitro* and *in vivo*.

METHODS

Seven candy sprays, widely available to the general public, were chosen for this study (Table 1, Fig. 3). First, the pH of each candy spray was determined with

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an electronic pH meter (PHM 240 Sentron 1001, Radiometer, Copenhagen, Denmark), calibrated each morning with reference buffers of pH 4.00 and pH 7.00 (Sigma-Aldrich, St. Louis, USA). Neutralisable acidity ('buffer capacity') of the candy sprays was determined by stepwise addition of 0.1 ml 0.25M NaOH to 1 ml of candy spray till a pH >7 was obtained. The volume of a single dose of each candy spray was determined gravimetrically (assuming 1 g = 1 ml).

The effect of candy sprays on saliva secretion rate and pH were investigated in three healthy volunteers, 53 ± 9 years of age, fully dentate (≥ 28 teeth), without active caries and not suffering from taste abnormalities or xerostomia. The volunteers were instructed to abstain from smoking, eating, drinking and tooth brushing at least 1 h before the experiments.²⁷

First, unstimulated whole saliva was collected for five minutes.²⁸ Next, in random order a single dose of each candy spray was administered on the tongue and whole saliva was collected in one minute intervals for a total period of five minutes. The saliva secretion rates were determined gravimetrically (assuming 1 g = 1 ml) and the salivary pH was measured as described above.

RESULTS

The pH values of the candy sprays were very low and ranged from 1.90-2.28 (Table 1). The results for the neutralisable acidity are presented in Figure 4. Most candy sprays tested had a neutralisable acidity between 0.8-1.0 ml of 0.25M NaOH, but the 'Candy spray strawberry' and the 'Fruitti squirt strawberry' had an almost two-fold higher neutralisable acidity than the other candy sprays.

The volume of a single dose is comparable for all candy sprays (range 132–147 μl), with the exception of ‘Magic spray strawberry’ which produces a smaller volume (95 μl , see Table 1). Intraoral administration of a single dose of candy spray induced a transient 3.0 to 5.8-fold increase in salivary flow rate (Fig. 5). The highest salivary flow rates were observed after use of the ‘Candy spray strawberry’ and the ‘Fruitti squirt strawberry’, the lowest after the ‘Magic spray strawberry’. Concomitantly, the salivary pH dropped instantly to values between 4.4 and 5.8 (Fig. 6), and for five

Table 1 Details of the candy sprays used in the study

Product	pH	Single dose (µl)	Acid	Distributor
Candy spray strawberry	1.99	145	citric acid	Starsweets International
Fruitti squirt strawberry	2.00	132	citric acid	Starsweets International
Magic spray strawberry	2.28	95	citric acid	Pemi Trade
Mega mouth spray strawberry	1.92	146	citric acid	Topps International Ltd
Mega mouth spray orange	1.90	146	citric acid	Topps International Ltd
Mega mouth spray blackcurrent	1.92	147	citric acid	Topps International Ltd
Mega mouth spray apple	1.91	137	citric acid	Topps International Ltd

of the candy sprays the values were below pH 5.5. The strongest decrease in salivary pH was observed using the 'Candy spray strawberry' (pH 4.4) and the 'Fruitti squirt strawberry' (pH 4.8). For the 'Magic spray strawberry' and the 'Mega mouth spray apple', the salivary pH remained above pH 5.5. Both the salivary flow rate and the pH returned to normal values within 2-3 minutes (Figs 5 and 6).

DISCUSSION

The aim of this study was to compare the potential erosive effects of several candy sprays. All candy sprays tested in this study were highly acidic, indicating that they contain high levels of citric acid (Table 1). Their initial pH values ranged from 1.90–2.28, well below the pH value of 5.5 that has generally been adopted as the critical value below which hydroxyapatite may dissolve.^{29,30}

The erosive potential does not exclusively depend on the pH of the candy spray, but is also strongly influenced by its neutralisable acidity ('buffer capacity') and the volume administered. The greater the neutralisable acidity of the candy spray, the longer it will take for saliva to neutralise it.¹⁹ Of the candy sprays tested, the 'Candy spray strawberry' and the 'Fruitti squirt strawberry' had a much higher neutralisable acidity than the other candy sprays (Fig. 4). After intraoral administration, these two candy sprays result in pH values far below 5.5 (Fig 6), indicating that this type of candy has the potential to lower the salivary pH considerably *in vivo*. This is in agreement with comparable studies showing the erosive potential of solid acidic candies.²¹⁻²⁵ The smallest decrease in salivary pH *in vivo* was observed after

Fig. 3 The different types of candy sprays investigated in this study

administration of a single dose of 'Magic spray strawberry'. This is probably related to three factors. First, this candy spray has a higher pH (Table 1). Second, the amount of neutralisable acidity in 'Magic spray strawberry' is smaller (Fig. 4). Finally, the volume of a single dose of this candy spray is considerably smaller than the other candy sprays tested (Table 1 and Fig. 4).

The citric acid in the candy sprays stimulates the salivary flow immediately after they have been introduced into the mouth (Fig. 5). The buffering effects of the stimulated salivary flow may provide some protection against the erosive potential of acidic candy.^{21,22,31} However, citric acid is a complex organic acid. At low pH values, citric acid provides protons which directly attack the mineral surface. At higher pH levels around pH 7.0, the citrate anion may draw calcium away from the enamel by chelation. This means that the demineralising effect of citric acid is exceptionally great and may even continue after the pH at the tooth surface has increased.^{18,31,32}

Our *in vivo* results are based on a single administration of candy spray to adult volunteers. However, candy sprays are frequently used by children during the

day²⁶ and the volume of saliva in children is smaller than in adults.^{33,34} Therefore, in children a single dose of candy spray will introduce a relatively higher amount of spray in the oral cavity and thus probably an even lower salivary pH value. Repeated use of candy sprays may also exacerbate the erosive potential, as the longer the teeth are bathed in acid the longer the period of time when erosion can occur and the shorter the time period for remineralisation to take place.^{19,20}

Differences seem to exist in susceptibility of deciduous and permanent dentition to erosion by low pH drinks and solid acidic candy. In general, erosion of enamel was greater in the deciduous tissue, especially with increased frequency of consumption.^{21,35,36} In combination with the reduced dimensions, this makes the deciduous dentition more susceptible to exposure to candy sprays, especially when used frequently.

CONCLUSION

In summary, candy sprays are potentially capable of causing dental erosion. Both healthcare professionals as well as consumers should be aware of this erosive potential. However, candy sprays are usually consumed by young children. In 70% of cases, their parents were unaware that their children used this type of candy.²⁶ Therefore, both juvenile patients and their parents should be informed that (excessive) use of candy sprays may cause dental erosion.

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Fig. 4 Neutralisable acidity ('buffer capacity') of seven different candy sprays

Fig. 5 Mean salivary flow rate at different time points after application of seven different candy sprays (n = 3)

Fig. 6 Mean pH of saliva at different time points after application of seven different candy sprays (n = 3)

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