FLAVOUR-INGREDIENT INTERACTIONS IN CONFECTIONS

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Abstract

The influence of aroma compound structure and acidulants on the aroma release profile and the flavour perception of hard candy were investigated. In aqueous model systems, the addition of aroma compounds separately versus as a mixture resulted in an aroma release profile that was more rapid and higher in concentration; particularly for aroma compounds with a similar molecular structure. However, the addition of an acidulant to the models did suppress the aroma release for the separate flavour addition technique; although the release profile was still higher in concentration in comparison to the mixture flavour addition technique. Similarly, in hard candy, the aroma release monitored by breath analysis was higher in concentration and was perceived to be more intense by a sensory panel for the separate versus mixture flavour dosed sample formulated with malic acid. In summary, interactions between the flavour compounds themselves were reported to influence the flavour performance of hard candy.

Introduction

The flavour properties of confections are undoubtedly an important product attribute for consumption. Understanding key flavour-ingredient interactions in foods would help to better deliver flavour compounds during mastication that in turn impact flavour perception. The influence of different food ingredients either through binding/partitioning (protein, carbohydrate, and fat) or through texture/structure modifications (viscosity, emulsions) on flavour release have been studied in detail (1-3). However, in some foods such as confections, flavour compound-compound interactions can also play a role in flavour delivery.

In chewing gum, for example, aroma-sugar alcohol interactions have been reported to influence flavour delivery during mastication (4). Typical chewing gum composition consists of a water-insoluble gum base continuous phase and a water-soluble sugar or sugar alcohol discontinuous phase in a ratio of approximately 1:4 with a flavor load of 1%. Previous research by Harrison et al. (5) using stagnant layer theory and de Roos et al. (6) using non-equilibrium partition model emphasized the gum base as a major factor dictating the release kinetics of various flavor compounds based on hydrophobicity. Similarly, the release of flavor compounds from chewing gum has been predicted in the flavor/gum industry based on log P or log cP values. Contrary to the prediction models, Potineni and Peterson (4) reported that the release profile of cinnamaldehyde (log cP= 1.22) was correlated with sorbitol during chewing gum mastication. However for a similar hydrophobic compound, p-cresol (log cP= 1.02), this correlation was not observed. In contrast, breath analysis of a flavored gum base (no sorbitol) reported that release of cinnamaldehyde was similar to cresol, as predicted by Log cP values. Further investigation using tandem mass spectrometry analysis indicated cinnamaldehyde reacted with sorbitol to generate transient hemiacetal products with increased polarity that reverted back to cinnamaldehyde in oral cavity (Figure 1). The increased polarity of these transient reaction products would result in a more rapid release of cinnamaldehdye from chewing gum during mastication than predicted by Log cP models. Therefore flavour release in chewing gum was controlled, in part, by aroma-sugar alcohol interactions.

In other confections, such as hard candy, interactions between the aroma compounds themselves have also been reported to influence flavour release and perception. The flavouring materials in hard candy exist as a discontinuous phase in the continuous glass sugar or sugar alcohol matrix. During candy mastication, the aroma compounds are released as a concentrated material in the oral cavity. The 'close' association of the aroma compounds during mastication would facilitate molecular interactions and potentially could alter compound volatility. Schober and Peterson (7) investigated flavour compound-compound interactions on flavour delivery by monitoring the release of menthol and 1,8-cineol during mastication by breath analysis using a binary flavoured candy (menthol and 1,8-cineol) prepared by two different flavour dosing techniques: (a) the flavour compounds were added as a mixture and (b) the flavour compounds were added separately during candy manufacture. Although both samples had equal flavour concentrations, the release profile of menthol and 1,8-cineol was approximately 2-fold higher during mastication for the separate flavour addition candy. A trained sensory panel also found the separate flavour addition dosed sample to have higher perceived flavour intensity (7).

This paper investigates in more detail the influence of molecular structure on aroma compound-compound interactions as well as the influence of aroma-acidulant interactions on aroma delivery and perception of hard candy.

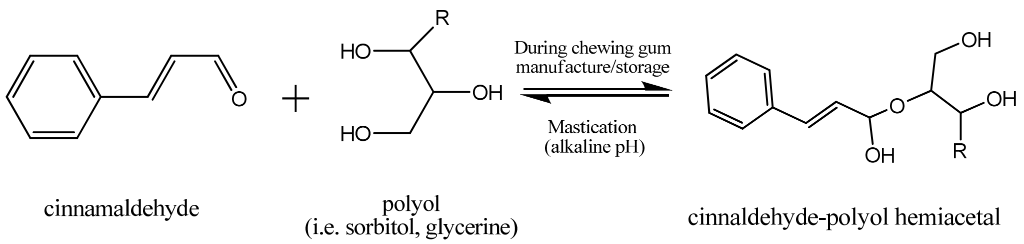

Figure 1. *A proposed flavour delivery mechanism for cinnamaldehyde (aldehyde) in chewing gum; adapted from Potineni and Peterson (4).*

Experimental

Hard candy sample preparation. Samples were prepared as previously described by Schober and Peterson (7). The fruit flavoured sample consisted of malic acid, *cis*-hexenol, benzaldehyde and ethyl hexanoate at 11, 0.03, 0.04 and 0.04 mg/g of candy respectively.

Aqueous model system: Flavour compound-compound interactions analysis. A custom 218-mL sealed water jacketed vessel fitted with Teflon cap interfaced with an atmospheric pressure chemical ionization – mass spectrometer (APCI-MS) was used to monitor the release of binary or tertiary aroma mixtures into the air from water in real time. Flavours were injected as a mixture or separately. For the binary mixture, benzaldehyde release was monitored in combination with octanol, octanal, ethyl hexanoate, 3-phenyl-1-propanal, 3-phenyl-1-propanol, or 2-phenylethyl formate. For the tertiary mixture, the release profile was determined for *cis*-3-hexenol, benzaldehyde and ethyl hexanoate (fruit model) added as a mixture or added separately into the aqueous model with and without malic acid.

Breath analysis. The volatile release from hard candy and chewing gum were measured using APcI-MS as described by Schober and Peterson for hard candy (*7*).

Gas Chromatography (GC). Quantification of the volatile compounds from hard candy was analysed using a Agilent 6890 GC equipped with a split/splitless injector, flame ionization detector (FID), auto sampler (HP 7673) and a capillary column (DB-5 or DB-WAX) as previous reported (*7*).

Sensory analysis. Time-intensity analysis of the hard candy samples were conducted as previously described (*7*).

Results

To examine the role of molecular structure on the flavour release profile of a mixture versus separate flavour dosed candy, the release of benzaldehyde from a series of binary flavours from an aqueous model system was determined. Each binary flavour consisted of benzaldehyde and one other compound from two distinct structural groups (Set 1: octanol, octanal or ethyl hexanoate - aliphatic; Set 2: phenylpropanal, 3-phenyl-1-propanol or 2-phenylethyl formate - aromatic). Overall, a larger difference in the benzaldehyde release profile for the separate versus the mixture flavour addition technique was reported for the compounds in Set 2 compared to the compounds from Set 1. Benzaldehyde release when added as a mixture or added separately with octanol or 3-phenyl-1-propanol is shown in (Figure 2). The release of benzaldehyde was more rapid for both separate additions in comparison to the mixture addition techniques. The greatest suppression in release was observed for the 3-phenyl-1-propanol binary flavour. These results suggest that pi-pi interactions between benzaldehyde and the compounds from Set 2 may result in stronger compound interactions (i.e. enhanced colloidal interactions) formed during their injection into the aqueous phase which suppressed compound volatility and flavour delivery.

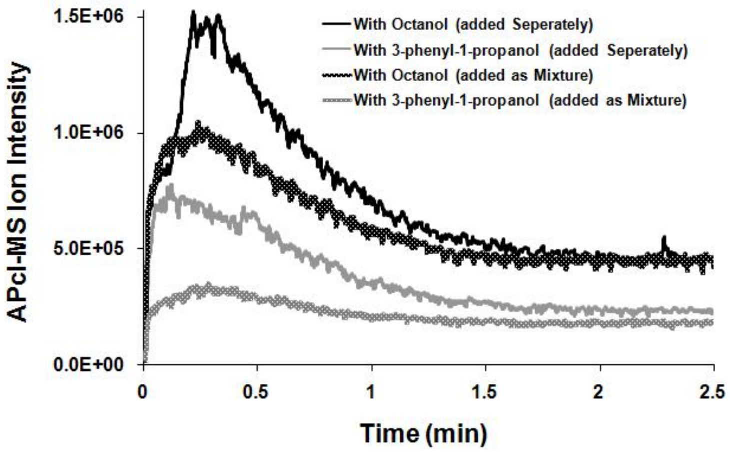

Figure 2. *Release of benzaldehyde added separately or as a mixture with 3-phenyl-1-propanol or octanol from an aqueous model system.*

In addition to aroma compounds, acidulants are common candy flavourings, particularly in fruit flavoured products. The influence malic acid on the release of *cis*-3-hexenol, benzaldehyde and ethyl hexanoate added by separate versus mixture addition was analysed using a model mouth and subsequently by breath and sensory analysis of a candy sample. Based on the model mouth, the addition of acidulant to the aqueous phase suppressed the release profiles of the separate flavour addition technique for these three aroma compounds; however, the separate addition still had a higher flavour release profile in comparison to the mixture addition analysis (data not shown). In the hard candy, the results generally agreed with the model mouth analysis. The release of benzaldehyde during mastication for the mixture and separate flavour dosed samples are illustrated in Figure 3. The release of benzaldehyde was generally 2-fold higher during the first 1.5 min of mastication for the separate flavour addition candy; however negligible differences were reported after this time point. Similar results were reported for ethyl hexanoate, while for *cis*-3-hexenol the release was similar for both samples (data not shown). Perhaps, during mastication, the acidulant concentration increased in the oral cavity which increased aroma-acidulant interactions over time and for the separate flavour dosed sample ultimately further suppressed the aroma release profile. Sensory time-intensity analysis was in agreement with the analytical data. The separate flavour dosed sample had higher perceived fruit flavour intensity (data not shown).

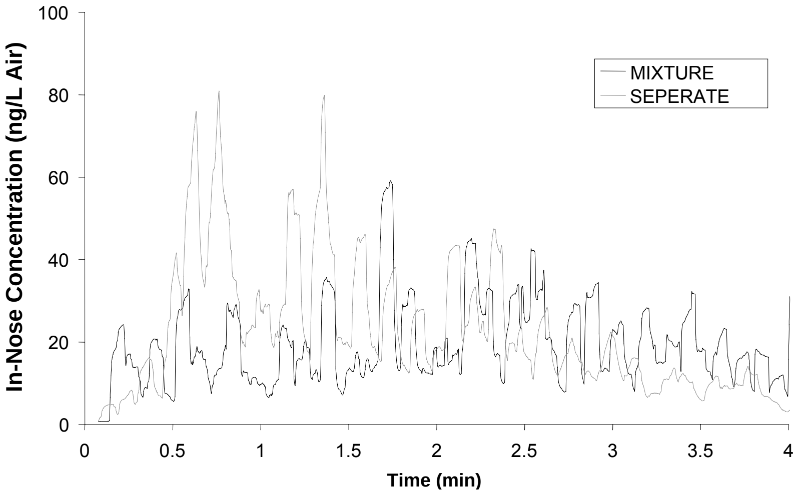

Figure 3. *Breath analysis profile of benzaldehyde from hard candy with 1% malic acid comparing two techniques of flavour addition, flavour added as a 1) mixture or 2) separately with cis-3-hexenol and ethyl hexanoate; each aroma compound at equivalent concentrations. Each curve represents the mean of three replicates from one representative panellist subsequently smoothed by a 1.5-s moving average trend line.*

In summary, aroma release and perception in hard candy can be enhanced by adding the aroma compounds separately as opposed to the conventional protocol of mixture addition during manufacture, particularly for aroma compounds with the similar chemical structure. However, the difference in the aroma release profile between the separate and the mixture dosed sample was suppressed by the addition of malic acid, indicating aroma-acidulant interactions also influence flavour aroma delivery in these products.

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