Understanding the impact of repeated consumption using temporal sequential profiling

C. Withers, C. Barnaganzi, V. Milon

1MMR UK, 2MMR USA

Introduction

Obesity and diabetes have become global health problems. This has led food and beverage manufacturers to investigate ingredient alternatives that reduce the caloric content of products, whilst having minimal impact on sensory characteristics.

Consumers are also demanding natural and healthy sweetening alternatives, and through these are a range of natural sugars available, these are highly calorific (Fig 1). High intensity sweeteners, which offer a low caloric alternative to sugar, have been in use for many years; however, the majority of these are artificial and linked to other health concerns, which limit consumer acceptance.

The sensory characteristics of sweeteners have been widely studied, with some sweetening agents more sensorially similar to sucrose, the ideal sweetening agent, whilst others including Stevia, are further away (Fig 2). However, all previous research to sucrose, the ideal sweetening agent, whilst others including Stevia, have been in use for many years; however, the majority of these are artificial and linked to other health concerns, which limit consumer acceptance.

These characteristics have been conducted using descriptive analysis and single sip methods, which are different to consumers’ typical consumption of larger volumes of sweetened products.

Objectives

This study investigated the effect higher volumes and repeated consumption have on the sensory profile of a range of sweetening agents and sugar, and to determine the ideal high intensity sweetener to replace sucrose.

Method

Four sweeteners at each of the three sugars and five sweeteners all of which are commonly used in a wide range of food and drink products were selected for this study (Table 3).

The sequential profiling method involved panelists drinking 8 x 15ml of a sweetened solution and rating attributes immediately after consumption, then twice more after 45 seconds and 90 seconds for after-effects. No palate cleaning was conducted between each 15ml drink and all panelists consumed 120ml of each sweetened solution. The attributes assessed in this study were selected from literature and refined by the MMR sensory panel, and included nine flavour and mouthfeel attributes (Table 4).

Findings

Figure 5 shows the sensory space of the sugars and sweeteners with each of the sweetening agents mapped at two consumption points: after the initial 15ml drink and after the full 120ml volume.

Sucrose does not change significantly over repeat consumption, whereas Fructose becomes sweeter and more drying. Glucose changes the most out of the sugars, developing more icy sugar and chalkiness. Of the sweeteners, Xylitol, Ascorllum K and Sucralose do not change significantly overall during repeat consumption, whilst Aspartame becomes significantly more metallic and Stevia increases in both bitter and metallic notes.

Comparing sequential profiles directly helps to determine the most suitable sweetener to replace Sucrose. Figure 6a shows the sequential profile for Sucrose with very few off-flavours, although drying builds up very slightly.

A high intensity sweetener which provides a similar clean taste, including bitter and metallic, which increases in some sweetening agents as additional volumes are consumed. This further emphasises the role of repeat consumption methods, which are more representative of consumer product use than typical sip tests, and which should be part of tests performed by food manufacturers as a viable sweetening option, but repeat consumption as conducted in this study has highlighted that masking and reducing the build-up of multiple off-notes may be necessary to replace Sucrose.

Conclusion

This study found repeat consumption influences the sensory characteristics of sugars and sweeteners, but the extent of change depends on the sweetening agent.

Repeat consumption profiling has highlighted a range of attributes, including bitter and metallic, which increase in some sweetening agents as additional volumes are consumed. This further emphasises the role of repeat consumption methods, which are more representative of consumer product use than typical sip tests, and which should be part of tests performed by food manufacturers as a viable sweetening option, but repeat consumption as conducted in this study has highlighted that masking and reducing the build-up of multiple off-notes may be necessary to replace Sucrose.

Fig. 6 Sequential profiles of Sucrose, Ascorllum K, Sucralose and Stevia

Table 4 Defined sensory attributes

<table>
<thead>
<tr>
<th>Sweet (F)</th>
<th>Icing Sugar (F)</th>
<th>Bitter (F)</th>
<th>Chalky (Mf)</th>
<th>Metallic (F)</th>
<th>Drying (Mf)</th>
<th>Salty (F)</th>
<th>Cooling (Mf)</th>
<th>Liquorice (F)</th>
</tr>
</thead>
</table>

Table 3 Selected sugar and sweetener solutions

<table>
<thead>
<tr>
<th>Sugar</th>
<th>Concentration (% w/v)</th>
<th>Taste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucrose</td>
<td>2.5</td>
<td>Universal sweetness agent - very weak notes, clean, slightly sweet, neutral mouthfeel, and minimal off-notes.</td>
</tr>
<tr>
<td>Fructose</td>
<td>1.3</td>
<td>甜甜</td>
</tr>
<tr>
<td>Glucose</td>
<td>2.4</td>
<td>Used to sweeten; slightly sweet, neutral mouthfeel, and minimal off-notes.</td>
</tr>
</tbody>
</table>

Equi-sweet solutions of all sweetening agents were developed and refined by the MMR UK sensory panel, ahead of sequential profiling which was adopted and used for this study to assess the effect of repeated consumption (Fig 5).

The sequential profiling method involved panelists drinking 8 x 15ml of a sweetened solution and rating attributes immediately after consumption, then twice more after 45 seconds and 90 seconds for after-effects. No palate cleaning was conducted between each 15ml drink and all panelists consumed 120ml of each sweetened solution. The attributes assessed in this study were selected from literature and refined by the MMR sensory panel, and included nine flavour and mouthfeel attributes (Table 4).

This study investigated the effect higher volumes and repeated consumption have on the sensory profile of a range of sweetening agents and sugar, and to determine the ideal high intensity sweetener to replace sucrose.

Objectives

This study investigated the effect higher volumes and repeated consumption have on the sensory profile of a range of sweetening agents and sugar, and to determine the ideal high intensity sweetener to replace sucrose.

Method

Three sugars and five sweeteners all of which are commonly used in a wide range of food and drink products were selected for this study (Table 3).

The sequential profiling method involved panelists drinking 8 x 15ml of a sweetened solution and rating attributes immediately after consumption, then twice more after 45 seconds and 90 seconds for after-effects. No palate cleaning was conducted between each 15ml drink and all panelists consumed 120ml of each sweetened solution. The attributes assessed in this study were selected from literature and refined by the MMR sensory panel, ahead of sequential profiling which was adopted and used for this study to assess the effect of repeated consumption (Fig 5).

The sequential profiling method involved panelists drinking 8 x 15ml of a sweetened solution and rating attributes immediately after consumption, then twice more after 45 seconds and 90 seconds for after-effects. No palate cleaning was conducted between each 15ml drink and all panelists consumed 120ml of each sweetened solution. The attributes assessed in this study were selected from literature and refined by the MMR sensory panel, ahead of sequential profiling which was adopted and used for this study to assess the effect of repeated consumption (Fig 5).

The sequential profiling method involved panelists drinking 8 x 15ml of a sweetened solution and rating attributes immediately after consumption, then twice more after 45 seconds and 90 seconds for after-effects. No palate cleaning was conducted between each 15ml drink and all panelists consumed 120ml of each sweetened solution. The attributes assessed in this study were selected from literature and refined by the MMR sensory panel, ahead of sequential profiling which was adopted and used for this study to assess the effect of repeated consumption (Fig 5).