Alternative heat-stable sweeteners for bakery products

Identification

Key words
Thermal behavior, Microcapsules, Rebaudioside, Steviol glycosides, Polyols, Oligofructose, Erythritol, Stevia, Raisin juice, Neotame, glycosylsucrose, fructooligosaccharides, maltooligosaccharides, isomalto-oligosaccharides (branched-oligosaccharides), galacto-oligosaccharides, xylo-oligosaccharides, isomaltulose (palatinose), lactosucrose, Honey, aspartame, fructose, sorbitol, xylitol.

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How does it work?

Primary objective
The main aim of this technology was the preparation of heat stable sweeteners for bakery products with low sugar content. Some loss of sweetness is caused by participation in the Maillard reaction. Encapsulation technology is the right method to prevent such a loss. Besides this, manufacturers currently are looking to provide consumers with an increasing variety of low-calorie food and beverage choices.
The number of alternative sweeteners available to the food producers has expanded to include more high-potency sweeteners whose only function is to sweeten. Replacement of sweetening alone is not sufficient in foods such as bakery products, confections, in which sugar has a variety of functions [1]. Cakes and biscuits for low energy supply and aimed also for diabetic subjects can be sweetened with low levels of aspartame in combination with fructose, sorbitol and xylitol [2]. Aspartame is usually added during the cooling step to minimize losses caused by heat. The heat-stable encapsulated form can be used during the cooking process, to minimize the loss of sweetness that occurs with heat and variations in pH. We can mention a series of new starch oligosaccharides such as \( \beta-1,6 \) linked gentio-oligosaccharides, \( \alpha, \alpha-1,1 \) linked trehalose, \( \alpha, 1,3 \) linked nigeroligosaccharides, and branched-cyclodextrins. Also, soybean oligosaccharides containing raffinose, stachyose, and other oligosaccharides mentioned above are now used in beverages, confectionery, bakery products, yogurts, daily products, and infant milk [3]. Lactitol, sorbitol and maltitol were used for sugar replacement in low-fat, sugar-free cookies [4]. Very original sweetener presented recently is the raisin juice, a natural sweetener that contains no preservatives, has lower caloric content than sucrose, and includes a number of important vitamins and minerals [5]. Certain polyols (mannitol, maltitol, sorbitol, and lactitol), fructose, oligofructose and polydextrose were tested as sweeteners in cake formulations. The rheological behavior of the cake batter and the physical characteristics of the cakes containing sugar substitutes were compared with the respective attributes of the control cake. The best results were obtained by using oligofructose, lactitol or maltitol as sugar replacers, which exhibited similar behavior to sucrose in terms of batter rheology and increased starch gelatinization temperature [6]. Polyols or sugar alcohols, a group of reduced calorie sweeteners, are natural and nutritive sweeteners. These are neither sugars nor alcohols; rather they are a group of low-digestible carbohydrates which can be used instead of sucrose. They occur naturally in foods and come from plant products such as fruit and berries. They are used in food as sweeteners and bulking agents. Polyols have slightly reduced sweetness and caloric values compared to sucrose. Polyols available as either in solid crystalline form or syrups are emerging as a sugar replacer as well as a sugar substitute. They would provide the functional benefits to bakery goods when the sugars used are replaced with polyols [7]. Sucrose was replaced by hot water extract. Steviol glycosides are highly sweet natural compounds from Stevia rebaudiana Bertoni leaves which have recently been approved as sweeteners for a range of foods. To evaluate whether Steviol glycosides may be used for partial replacement of sucrose in bakery products, muffins were produced where 30% sucrose of the formulation was exchanged against an iso-sweet amount of rebaudioside A in combination with several fibres. Baked products were subjected to chemical, colour and texture analysis, and sensory characteristics were assessed by flash profiling. Multivariate analysis of instrumental and sensory data indicates that a combination of inulin or polydextrose with rebaudioside A results in products with characteristics close to those of a reference [8]. Very effective technology how to increase the fluidity and resistance to high temperatures and prolong sensation of sweetness is microencapsulation. This technology was applied on sucralose that was microencapsulated by double emulsion followed by complex coacervation (encapsulation for sweeteners such as aspartame and flavors in chewing gum is well known). The microcapsules were evaluated by different methods including the thermal behavior. The microcapsules presented low hygroscopicity and solubility, and average size ranging from 81.04 to 113.49 μm. The glass transition temperature (Tg) values were above room temperature (53.59 to 56.88 °C). Among the formulation studied, the one produced with 5% gelatin and gum Arabic and core material 75% presented the best characteristics [9]. Microencapsulation technologies applied to encapsulate the sweeteners used in the bakery are very important and several TDSs are describing this technology.
### Additional effects

Sweeteners are, often subject to the effects of moisture and/or temperature. Encapsulation of sweeteners—namely sugars and other nutritive sweeteners—reduces their hygroscopicity, improves their flowability, and prolongs their sweetness perception. Sweeteners can be used in limited concentration and in combination with much lower content of the classical sugar. Sweeteners stable for heating during baking saved the sweetness and other effect that exhibits original sucrose in bakery products.

### Important process parameters

Encapsulated ingredients are currently gaining considerable attention for they stability through high-temperature/short-time processes. Temperatures during baking should not increase over the stability temperature of modified/encapsulated heat stable sweeteners.

### Important product parameters

Heat stable sweeteners are modified/encapsulated products to keep sweetness during baking process, e.g. microencapsulated (covered by protective layer).

### What can it be used for?

<table>
<thead>
<tr>
<th>Products</th>
<th>Bakery products.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations</td>
<td>Baking of cakes and other bakery products.</td>
</tr>
<tr>
<td>Solutions for short comings</td>
<td>Heat stable sweeteners solve the problem of original artificial sweeteners for bakery products: heat decay, sweet taste loss, contamination by degraded product caused by non-stable versions.</td>
</tr>
</tbody>
</table>

### What can it NOT be used for?

<table>
<thead>
<tr>
<th>Products</th>
<th>The unusual properties afforded by encapsulated ingredients offer the food technologist great flexibility and control in developed foods; encapsulation prevents certain critical ingredients from partaking in premature or undesirable interactions in dough or batter.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations</td>
<td>Heat stable sweeteners cannot be applied at temperatures higher than 80°C that are behind the limit of stability.</td>
</tr>
<tr>
<td>Other limitations</td>
<td>Application of heat stable sweeteners is limited to temperatures below 60 – 80°C that are common during baking of dough inner volume.</td>
</tr>
<tr>
<td>Risks or hazards</td>
<td>Degradation of the sweetener by very high temperature during baking.</td>
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</tbody>
</table>

### Implementation

<table>
<thead>
<tr>
<th>Maturity</th>
<th>Most of heat stable sweeteners determined for bakery products are commercially available.</th>
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<tr>
<td>Modularity /Implementation</td>
<td>This technology can be applied in commercial baking of sweet bakery products. Specific requirements are given by the producer of the sweetener: maximum temperature during baking.</td>
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<tr>
<td>Consumer aspects</td>
<td>Low-calorie sweetener provides consumers with a sweet taste without the calories or carbohydrates that come with sugar and other caloric sweeteners, and consumer acceptance of a sweetener is closely linked to how similar its taste is to sugar.</td>
</tr>
</tbody>
</table>
Legal aspects

Sweeteners are under the objective of acceptance procedure of USDA, FDA and EFSA. Sweeteners cannot be used in foods for infants and young children mentioned in Directive 89/398/EEC, including foods for infants and young children who are not in good health, except if provided otherwise. Food additives including carriers in food flavoring from COMMISSION REGULATION (EU) No 1130/2011, framework Directive 89/107/EEC on food additives, Sweeteners authorized by Community regulations must comply with the specific purity criteria defined by Directive 2008/60/EC.

Environmental aspects

Sugar savings can save the energy value of sweet bakery products (much less of the sugar content).

Facilities that might be interesting for you

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Further Information

Institutes

Department of Foods and Nutrition Kansas State University United States, Food Science and Technology Department Faculty of Agriculture University of Menoufiya ET-Shibin El-Kom Egypt, Department of Sensory Science Food Technol. Res. Institute Mysore India, Research Institute Nihon Shokuhin Kako Japan, Laboratory of Food Chemistry and Technology Department of Chemical Engineering National Technical University of Athens Greece, Food Science and Human Nutrition Department Faculty of Agriculture and Veterinary Medicine Qassim University Saudi Arabia, Flour Milling Baking and Confectionery Technology Department CSIR Central Food Technological Research Institute Mysore India, Institute of Food Technology and Bioprocess Engineering Technische Universität Dresden Germany, University of Campinas Brazil.

Companies

NutraSweet Co. United States, Jungbunzlauer International AG Basel Switzerland

References
