The confectionery market has shown an increasing need for natural solutions to produce healthy and, at the same time, indulgent products. Being aware of this need, Galactic has developed a wide range of solutions that provide the very best of nature to confectionery products by combining traditional and innovative technologies.
Galactic has acquired an extensive expertise in biotechnology since its creation in 1994, serving the food, feed, personal & health care and industrial markets.

Based on its valuable experience in lactic acid fermentation and the development of other derivatives, Galactic continuously creates sustainable, innovative and health-friendly solutions.

In collaboration with its customers and scientific partners, Galactic meets the challenge of sharing the unlimited potential of nature for a sustainable future.
Introduction

Galactic has acquired a strong reputation as one of the leading providers of natural lactic acid solutions in the field of nutrition and food safety. In particular, Galactic has developed a range of health-friendly formulations enabling confectionery producers to enhance the consumer flavour experience while improving shelf-life and texture.

Nowadays, people spend more time discussing and sharing their experience about what they eat and why they like a certain product. In addition to taste, consumers want to know that their food choices don't have a negative impact on health. They want natural ingredients, adequate nutrition, quality over quantity and the ability to understand what's in their product. As a result, confectionery manufacturers may face some challenges when it comes to meeting the consumer’s needs.

Confectionary producers must pay great attention to these major market trends and guarantee that both natural and safe ingredients have been used in their products. In order to help manufacturers achieve these goals, Galactic has developed efficient solutions for:

- Flavour enhancement
- Texture improvement
- Fortification

Galactic's product range represents efficient natural and safe solutions for flavour, texture improvement and fortification in confectionery products such as:

- Hard-boiled candies
- Soft candies (jellies, wine gums)
- Chewing gums

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1 The Shelby Report, Consumer Demand For Transparency Drives Confectionery Product Innovation.
I. LACTIC ACID IN CONFECTIONERY PRODUCTS

Organic acids are present in:
- Hard/boiled candies
- Soft candies (jellies, gummies made with gelatin, agar, carrageenan)
- Fruit-filled hard candies
- Sugar-sanded soft candies
- Extruded candies
- Effervescent tablets (acid & sodium bicarbonate)
- Fortified candies
- Chewing gums

A great number of confectionery products contain organic acids. Food-grade organic acids have different functions and play different roles. They enhance or extend flavours, preserve texture, increase shelf-life, etc.

Organic acids can differ in solubility, melting point, molecular weight and taste. The impact on the sensory properties of the finished product depends on several factors such as: the level of taste power, the type of acid, the pH and pKₐ. A proper selection of acids can also help maintain the balance between sourness, tartness and sweetness.

In addition to taste, the choice of acids in confectionery is also important during the production process to avoid sugar inversion which leads to sticky products and generates a negative quality outlook. Adding lactic acid to the recipe is perfect for reducing the effects of sugar inversion by buffering the confectionery product to a specific pH.

In fruit-based confectionery, it is crucial to balance sugar and acids to obtain a perfect and long-lasting flavour profile. Galacid™ range is a natural lactic acid produced by fermentation from sugar that has a positive flavor-dependent effect on the taste.

Table 1: Acids used in Confectionary industry

<table>
<thead>
<tr>
<th>TARTARIC ACID</th>
<th>CITRIC ACID</th>
<th>MALIC ACID</th>
<th>Galacid™ Lactic Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very acidic taste</td>
<td>Intensive and distinct acidic taste</td>
<td>Mild acidic taste</td>
<td>Very light acidic taste</td>
</tr>
<tr>
<td>Very short taste in the mouth</td>
<td>Very short taste in the mouth</td>
<td>Quite long-lasting taste in the mouth</td>
<td>Persistent taste in the mouth</td>
</tr>
</tbody>
</table>
II. FLAVOUR, TEXTURE ENHANCEMENT AND FORTIFICATION

Confectionery products are food formulations characterised by aqueous dispersions of sugar syrups and are available in a broad variety of forms including caramels, marshmallows, gums, jellies and gummies, and hard candies.

1. SOFT CANDIES

A soft jelly is characterized by a soft and chewy texture typically conferred by gelatine, starch carrageenan, guar or pectin-based gel.

When it comes to fruit-flavoured products, sugar and acid need to be balanced in order to achieve the optimal taste. The use of acidifiers combined with buffer salts in gelatine-based gums, for instance, determines the texture and taste. Chewy candies, made with different gelling agents and sweeteners, offer certain specific texture characteristics and eating properties.

Lactic acid do not share the same sour flavour as citric acid which, for example, works well with citrus fruit flavours. Lactic acid, on the contrary has a soft flavour that is used at its best advantage to enhance milder flavours such as cherry, strawberry etc., as proven by a study carried out by Oregon State University (see Figure 1).

Figure 1: Food acids flavour profile

![Figure 1: Food acids flavour profile](image)

Acid intensity

Lasting time

Citric acid

Lactic acid

3 Liana-Claudia SALANȚĂ, Physicochemical Properties and Sensory Evaluation of Jelly Candy Made from Carrots and Strawberries.
5 Utomo, Physicochemical properties and sensory evaluation of jelly candy made from different ratio of carrageenan and konjac
Lactic acid also boosts some fruit taste (melon, mango, carambola, cherry, strawberry and litchi) and enhances mint and herbal confectionery products (some example in the Figure 2).

**Improving sourness**

Sourness is produced by Lowry-Bronsted acids, proton donating molecules. However, pH and titratable acidity have also been shown to contribute to sourness. At a certain pH, and depending on organic acid pkₐ, the sourness will be different meaning adjustable or improved.

The molecular weight is another parameter that has also an impact on the sourness of the confectionery product. For example, lactic acid has a lower molecular weight, a monoacid (90.08 g/mol), compared to citric acid, a triacid (192.12 g/mol): as a general rule, higher molecular weight and hydrophobicity tend to increase sourness. However, perceived sourness is also linked to the molecular structure (single acids – monocarboxylic acids - are sourer than di- and tricarboxylic acids) as well as to acid concentration and titratable acidity.

To help soft confectionery manufacturers create products that feature the sourness they are striving for, Galactic has developed Galacid™, a natural solution available in both powder and liquid form.

Figure 3 shows the perceived sourness for acids at pH 3.5 and 4.5. At pH 3.5, lactic acid has a sourer taste than citric acid, while the opposite is true at pH 4.5.
Galacid™ Powder 60, a powder form of natural L(+) lactic acid, produced by fermentation from sugar, has been developed to achieve strong sourness effect on sanding – coating sugar candies.

Based on a calcium lactate carrier, Galacid™ Powder 60 offers possibilities to achieve a long-lasting sour taste, appetising appearance in soft candies, while harmonizing the final taste of the product.

**Improving texture: Adjusting pH and buffering**

During the manufacturing process of gummy and jelly candies the main challenge resides in controlling the pH since the gel strength of gelatine rapidly decreases when pH is reduced below 4. When pH is kept at a high constant level, gummy candies made with gelatine have a firmer texture. Therefore, for this type of product, the ideal pH should be situated above 4. For this reason, the acid type and dosage need to be carefully selected.

To maintain a constant pH level and avoid problems with gum texture, Galactic has developed specific buffered blends: Galacid™ Buffered and Galimax™ Citrika. Using buffered lactic acid helps maintain a constant pH during gum processing from one batch to the next one, and also prevents gelatine degradation. By increasing the pH of confectionery made with gelatine, the amount of gelatine used for production is reduced, cutting down production costs.

Galacid™ Buffered, is a natural L(+) lactic acid, produced by fermentation, buffered with sodium lactate. Galimax™ Citrika, is a liquid blend of natural L(+) lactic acid partially buffered with potassium citrate.

Galacid™ Buffered and Galimax™ Citrika preserve gum texture quality, and are well-adapted for both sweet flavoured (Galacid™ Buffered) and acid citrus fruit-flavoured confectionery (Galimax™ Citrika).

Manufacturers now seek to achieve fortification which is a difficult process due to the low content of water within the product; thus solubility is an essential criterion of success. For this reason, Galactic recommends Galaxium™ and Galanium™ - a range of minerals based on lactates, having high solubility, bio-availability and a neutral taste.

<table>
<thead>
<tr>
<th>ACID</th>
<th>pH WITH 1G/100 ML WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic acid</td>
<td>2.68</td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td>1.57</td>
</tr>
<tr>
<td>Citric acid</td>
<td>2.20</td>
</tr>
<tr>
<td>LACTIC ACID</td>
<td>2.34</td>
</tr>
<tr>
<td>Malic acid</td>
<td>2.25</td>
</tr>
<tr>
<td>Tartaric acid</td>
<td>2.08</td>
</tr>
</tbody>
</table>
CASE STUDY: TEXTURE IMPROVEMENT IN MARSHMALLOWS

Marshmallows are a form of confection typically made from sugar, water, gelatine, xanthan gum and egg white. They are whipped to become spongeous, then moulded into small cylinders, and coated with corn starch.

Galactic led a study to show the positive effect of its sodium lactate solutions, Galaflow™ SL60 and Galaflow™ SL60 XT to improve the texture in marshmallows.

Sodium lactate, with its ability to bind molecules of water, acts as a process improver during whipping which has a positive impact on the mouthfeel of the finished marshmallow. It increases also the process overrun. More than that, at 1.6% Galaflow™ SL60 XT has the same effect on texture as Galaflow™ SL60 at 2%, which allows a better control of the production costs. As the concentration is reduced by 20% a potential cost in use reduction could happen.

All texture measurements were done with a texturometer Lloyd LRX, with a compression plate as probe to measure firmness. All textures measurements were repeated 6 times for each recipe.

Table 3: The effect of Galactic Sodium Lactate solutions

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Control (%)</th>
<th>Galaflow SL60™ (%)</th>
<th>Galaflow SL60 XT™ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>10.00</td>
<td>9.20</td>
<td>9.36</td>
</tr>
<tr>
<td>Cream of tartar</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Granulated sugar</td>
<td>37.30</td>
<td>36.80</td>
<td>36.90</td>
</tr>
<tr>
<td>Light corn syrup</td>
<td>37.30</td>
<td>36.80</td>
<td>36.90</td>
</tr>
<tr>
<td>Egg white</td>
<td>14.17</td>
<td>13.97</td>
<td>14.01</td>
</tr>
<tr>
<td>Xanthan gum</td>
<td>0.83</td>
<td>0.83</td>
<td>0.83</td>
</tr>
<tr>
<td>Galaflow SL60™</td>
<td></td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>Galaflow SL60 XT™</td>
<td></td>
<td></td>
<td>1.60</td>
</tr>
<tr>
<td>Corn starch</td>
<td>Surface</td>
<td>Surface</td>
<td>Surface</td>
</tr>
</tbody>
</table>

Benefits of Galaflow™ SL60 and Galaflow™ SL60XT:

1. Moisturisation
   Good Water Binding Capacity assuring a very nice texture and mouthfeel

2. Colour stability
   No difference in terms of colour

3. Process improvement
   Better control of the product expansion during the process

Figure 4: Maximum force before rupture (N) on Marshmallows, 1 day after production
2. HARD-BOILED CANDIES

Hard-boiled candies are one of the oldest confectionery products in the market. Raw materials used for their production must be carefully selected in order to achieve proper taste, texture and appearance. The main challenge for manufacturers is to maintain all sensorial product characteristics over time. To control flavours in candies, manufacturers use different kind of acids due to their properties that can improve significantly the taste profile.

For instance, when it comes to the strawberriness of hard boiled candies, Elizabeth A. Baldwin (2001) explains that the perceived strawberry flavour intensity increased with an increase in acid or sucrose content. It has been shown that strawberry flavour intensity is higher when lactic acid is used due to its capacity to enhance flavour intensity particularly concerning flavours of red fruits. The sourness perception of lactic acid tends to linger over a long period of time while citric acid imparts a quick (or sharp) tart taste of high and strong intensity that dissipates rapidly over time. The prolonged effect offers advantages in masking the undesirable aftertastes of some low-calorie sweeteners and gives the perception of a higher acid intensity. It is thus possible to replace, either partially or completely, citric acid and tartaric acid with well-designed formulations containing lactic acid in order to achieve the best flavour profile.

Acidulants offer a sour and fresh taste in overly sweet hard candies. However, using an acidulant to obtain the desired sourness can lead to sugar inversion. Being aware of this, Galactic has developed a range of products to provide manufacturers with both stability and sourness. Galimax™ Citrika (potassium base) and Galimax™ Citrina (sodium base) are liquid blends of natural L(+) lactic acid partially buffered with citric acid. They were specially developed to answer the challenges of manufacturers working on citrus flavours to obtain an ideal organoleptic profile. They offer an excellent compromise to the producers of hard-boiled candies working with lower pH and willing to limit the inversion of the sugar while preserving the aromatic “citric” note.
3. PREVENTING SUGAR INVERSION

Sugar Inversion is a term used to describe the hydrolysis of saccharose, a disaccharide, into its component monosaccharides, glucose and fructose. Inversion of saccharose can be caused by heat, by acidic conditions, or by a combination of both. When saccharose is inverted, it changes from a dry crystalline ingredient to a syrupy form which is very hygroscopic.

Combining the right choice of ingredients and process conditions, prevents the inversion of sugar and significantly improve the quality of candies.

The inversion of saccharose is favoured by high temperatures and lower pH-values. The type of production equipment determines the range of the processing temperature as well as the time the acid is in contact with the sugar at temperatures above 80°C.

As it is shown in Figure 6, the use of a buffered acid is one of the best means to reduce the inversion of sugar due to its ability to maintain the pH level. Galactic offers ideal solutions: Galacid™ Buffered R-30, a clear solution of natural L(+)lactic acid buffered with sodium lactate, and Galimax™ Citrika, a liquid blend of natural L(+) lactic acid partially buffered with citric acid. Buffered lactic acid is a solution of sodium lactate and lactic acid. These blends help reach the desired acid taste in a boiled sweet without causing sugar inversion.

Galactic’s buffered lactic acid formulations offer strong protection against the inversion of sucrose and can be applied both earlier in the process (in the vacuum chamber) and at the end of the process. If compared to the citric acid, Galacid™ Buffered R-30 induces a significantly lower inversion rate due to the ability of lactic acid to hydrolyse the sucrose molecules into glucose and fructose, it prevents the crystallisation of sucrose which results in a perfect texture. Therefore, Galactic advices manufacturers of hard-boiled sweets to use Galacid™ Buffered as a primary solution for the production of crystal clear, shiny and smooth hard candies.
Lactic acid has a better buffering capacity than citric acid because the buffering capacity reaches its highest value at the pKₐ value. This value represents a pH level where 50% of the acid is dissociated and 50% is undissociated. Lactic acid has a relatively high pKₐ value (3.86) and on the range of pH 4-4.5, typical range of pH for hard-boiled candies.

After cooking, Galactic recommends to apply Galaflow™ SL, sodium salt of lactic acid produced by fermentation. Using it as a buffer salt minimizes sugar inversion improves the constancy of the paste (sensitive to the variation of pH) and the ability to work with the texture (viscosity of paste).

Table 4: Galactic’s solutions for the Confectionery Industry

<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>PRODUCTS</th>
<th>BENEFITS</th>
<th>DOSAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gummy candies</td>
<td>Galacid Buffered R-30</td>
<td>• High organoleptic qualities</td>
<td>0.5% - 2%</td>
</tr>
<tr>
<td>Jelly candies</td>
<td>Galacid Heat Stable</td>
<td>• Easy processing, liquid form</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Galacid Powder</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Galimax Citrika</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard-boiled candies</td>
<td>Galacid Buffered R-30</td>
<td>• Low sugar inversion</td>
<td>0.5% - 2%</td>
</tr>
<tr>
<td></td>
<td>Galimax Citrika</td>
<td>• Transparent candy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Galaflow SL</td>
<td>• Easy processing and handling</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Galacid Buffered</td>
<td>• Allows to work on texture</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(viscosity of paste)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Good flavour profile</td>
<td></td>
</tr>
</tbody>
</table>
Since 1994, Galactic has become one of the world leaders in biotechnology serving the food, feed, personal & health care, and industrial markets. Based on its valuable experience in the fermentation of lactic acid and other derivatives, Galactic continuously develops sustainable, innovative and health-friendly solutions in the field of food safety, nutrition and green chemistry. With headquarters and an innovation campus in Belgium, production facilities in the United States (Milwaukee), China (Bengbu) and Europe (Escanaffles), high-performance labs in China (Bengbu) and the United States (Milwaukee) and sales offices in Belgium (Brussels), Japan (Tokyo) and Brazil (Curitiba), Galactic employs more than 380 people worldwide and is active in 65 countries.