Melting and recrystallisation of fat crystals in food

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Fats in food products are dynamic ingredients in the sense that they are continually undergoing melting and recrystallisation as the temperature of the product fluctuates. While, in many cases, these temperature fluctuations are small enough not to cause significant changes to occur in the food there are numerous examples of where changes can take place that are noticeable.

Take, for example, a confectionery coating. If this is made from ‘real’ chocolate, i.e. is based on cocoa butter, this melting-recrystallisation process can have a drastic effect on the product. This is because when the melted cocoa butter recrystallises it often does so in a different crystal form from the original and so manifests itself as a surface layer of fat bloom (see Figure 1). Even in compound coatings, which do not undergo such changes to the crystal form, there can be effects on the surface gloss as a result of melting and recrystallisation.

Margarines and spreads that have undergone similar melting-recrystallisation cycles, albeit at lower temperatures, often become ‘grainy’ as a result of these changes.

It is important to understand how these changes affect the surface of the fat at near-molecular levels so that we can, at least, have some idea about how to control them and, perhaps, modify their effects.

Fundamental research funded by IOI Loders Croklaan at YKI (Institute of Surface Chemistry in Stockholm) has given some useful clues as to what may be happening on the surface of fat crystals during melting-recrystallisation or solution-dissolution.

Nuclear Magnetic Resonance (NMR) spectrometry is often used to determine the ratio of solid:liquid in fats. It achieves this by energising the protons (hydrogen atoms) in the fat and measuring how quickly they lose this energy. Protons in the solid state lose this energy more quickly than protons in the liquid state thus allowing the calculation of solid fat content to be made.

The study referred to above uses much more complex NMR measurements and, instead of looking at conventional hydrogen atoms, it uses deuterium atoms – deuterium being an isotope of hydrogen with double the atomic weight.

One of the highest melting components in palm oil is a triglyceride known as tripalmitin (PPP). This has a finite, but limited solubility in other oils. In the YKI study the deuterated form of PPP was used. This is the form in which all the hydrogen atoms have been replaced by deuterium. The deuterated-PPP was added to an oil known as an MCT oil (or medium chain triglyceride oil). This is an oil almost totally composed of fatty acids with 8 and 10 carbon atoms. Enough PPP was added to the MCT oil to give a saturated solution at 28°C.

When the temperature of this mix was raised to 33°C some of the PPP crystals dissolved. When the temperature was reduced back down to 28°C then the dissolved PPP came back out of solution and recrystallised. The rate at which recrystallisation occurred could be monitored by the NMR measurements.

Having made the measurements it was possible to fit mathematical equations to them in order to define how the recrystallisation was occurring. One of the more common crystallisation models or equations is known as the Avrami equation. Without going into the complex mathematics of this, it is enough to say that it is possible, from some of the terms in the equation, to predict what the likely shape is of the crystals being formed, for example, whether they are rod-like or more circular.

The results clearly showed (Figure 2) that the recrystallisation when the temperature was reduced back down from 33°C to 28°C, took place in two stages. The first stage was very...
Sometimes it’s right in front of your eyes...

Light beverages are becoming increasingly popular. Obesity, calorie intake and weight management are now day to day topics, as the drinks industry continues to try to win customers through the creation of calorie reduced products that are similar to existing products.

The market leaders are still the ‘golden’ full-calorie beverages, but sales of reduced-calorie alternatives are starting to grow more strongly. It is because of this growth that the industry continues its search to find lower calorie products with the same high quality taste and healthy aura.

However, instead of creating new beverages from scratch (with the inherent difficulties in matching existing products that this entails), it is sometimes preferable to re-examine existing products, in this instance sports drinks.

Sports drinks are already well established in the market. They are, if you select a hydrating isotonic sports variant, low in calories in comparison to full sugar alternatives, generally pleasant tasting, and at the same time, inherently evoke strong connotations of a healthy lifestyle: the person with bottle of sports drink in-hand, living a vigorous and active life ‘on-the-go’.

There is a good reason why this should be: sports drinks are made up of totally different ingredients to regular full-calorie sugar alternatives. Fructose is one of the key elements in this, providing a high quality ‘sweetness’ whilst naturally providing enough sweetness.

Indeed fructose also boosts fruit flavours, offering a fast-hitting sweet taste which synergises effectively with SPLENDA® Sucralose. This is a good way of achieving the right taste balance in a drink, important as the lower level of glucides in isotonic sports beverages do not naturally provide enough sweetness.

A few ppm of SPLENDA® Sucralose will resolve this without increasing the amount of calories in the drink or creating an unpleasant aftertaste, as some high intensity sweeteners on the market do. In effect a limited amount of SPLENDA® Sucralose allows the product developer to fine tune the sweetness level, without adding glucides or changing the osmolarity of the sports drink thereby ensuring that the isotonicity remains almost the same. Ultimately this will help to shorten the development time of new isotonic sports drink prototypes.

In summary, there are a number of reasons why SPLENDA® Sucralose should be used in energy reduced drinks and hydrating sports drinks:

- Pleasant sweetness without added calories
- Effective sweetness synergy with fructose; fruity notes are enhanced by fructose
- Non-caloric sweetener (600x sweeter than sugar)
- Made from sugar, tasting like sugar
- Tooth friendly (non-cariogenic)
- Label friendly ingredient declaration: no additional warning statements required
- Heat and acid stability
- No impact on osmolarity

There is another good reason as to why hydrating sports drinks should be considered as a new addition to the lower calorie soft drink market, the possibility of incorporating functional ingredients.

In recent years this has become an increasingly popular trend. Indeed isotonic hydrating beverages that contain tea extracts are well established in the market. These drinks can be sweetened with SPLENDA® Sucralose, the bitterness of the tea balancing with SPLENDA’s sweetness to create an extremely agreeable after-taste.

This is particularly true if the acidity profile is balanced with other ingredients. For example Tate & Lyle Malic acid is frequently used to fine tune the sourness in a number of different types of teas.

Summary
Finding a way to include functional ingredients in beverages is not easily done. One method is to start with a hydrating sports drink that already has fewer calories. Citrus flavoured soft drinks, sweetened with SPLENDA® Sucralose in combination with Fructopure™ (pure fructose from T&L) is an example of how you can do this.

Similarly, flavours with a tea-like ingredient profile (including many herbal extracts) combine exceptionally well with SPLENDA® Sucralose, the contrasting bitterness and sweetness working together to provide a high quality taste experience. The taste can be further enhanced through the use of T&L Malic acid to find the optimum level of sourness.

www.tateandlyle.com

References

National Starch Food Innovation strengthens team in Russia, Kazakhstan and Belarus

Leading global supplier of functional and nutritional ingredients, National Starch Food Innovation, has expanded its global customer support network with the appointment of Tatiana Matveeva. Matveeva will join the company’s food business as regional sales manager for Russia, Kazakhstan and Belarus. This appointment represents an important step in the company’s commitment to strengthening local resources in the region’s dynamic food market.

Moscow-based Matveeva holds a Masters degree in Chemical Engineering and a MBA from Plekhanov Russian Academy of Economics. She brings extensive experience in management roles at international companies, including the food industry.

Thomas Barth, Sales Manager Central and Emerging Europe, National Starch Food Innovation, comments: “Tatiana will lead the development and implementation of our activity in these key territories, strengthening relationships and promoting growth. The appointment enables us to extend our capabilities in these markets, helping our customers to benefit from the enormous potential this region offers.”

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