Eco-friendly fat crystallisation

In this era of ever more rapid throughput in food processes, maximising aspects such as crystallisation are of major importance. In fat-based products it is not always as easy as simply cooling the product a bit more and hoping that it will speed things up sufficiently because many fats supercool and need a helping hand as far as crystallisation is concerned. That ‘helping hand’ comes in the form of crystallisation starters and promoters.

Starters and promoters are usually high melting triglycerides which, in order to enhance their solid fat content and therefore their functionality in starting and promoting crystallisation, have often been fully or almost fully hydrogenated vegetable oils. This is a problem both for retailers and especially consumers because, over recent years, they have been educated to associate the word ‘hydrogenated’ with the presence of trans fatty acids. In turn, they associate the presence of trans fatty acids with health risks. This means that a crystallisation starter that is made from non-hydrogenated fats will appeal to both consumers and retailers because of its cleaner label.

Recently though, the whole subject has become somewhat more complex because, in the European Union, the Food Information for Consumers Regulation came into force on December 14th 2014. This requires that when a fat or oil is hydrogenated, it is declared as either ‘fully hydrogenated’ or ‘partly hydrogenated’. Technically, this is an improvement on the previous declaration of ‘hydrogenated oil’ or ‘hydrogenated fat’, because now the consumer may know whether it has been fully or partly hydrogenated. Whether the consumer will appreciate the difference though, is questionable. Additionally, as the terms ‘hydrogenated’ and ‘trans’ are often used synonymously, it is questionable that consumers will understand that it is possible for fully hydrogenated fats to contain effectively no trans fatty acids. As such, a
crystallisation starter made from non-hydrogenated fats is just as important in terms of ingredient labelling as it was before.

In moving from a fully hydrogenated fat to a non-hydrogenated fat as a means of enhancing crystallisation on a high-speed production line, it is important that the new fat at least matches the performance of the old hydrogenated fats. As well as this, shelf life is a further aspect to take into consideration. Manufacturers and retailers are always looking for ways to extend product shelf life, and some of the confectionery products that crystallisation starters and promoters are used in suffer from shelf life issues. For example, these ingredients are often used in chocolate spreads and nut spreads. Because of their relatively low viscosity they can occasionally ‘oil out’, meaning that some of the oil in the spread separates out and forms a ‘pool’ on the top of the spread. Crystallisation starters are also used in chocolate-flavoured compound coatings where they help to reduce the uneven appearance called ‘mottling’. They can also help to extend the shelf life of such coatings by slowing down the formation of white films of fat (fat bloom) on the surface of the coating. Any changes made from a fully hydrogenated to a non-hydrogenated crystallisation starter must also address these issues.

Enhancing non-hydrogenated palm oil functionality

Historically, the most commonly used crystallisation starters in confectionery products have been either fully hydrogenated palm oil (PO60) or the high melting stearin fraction of palm oil (POs). While PO60 is hydrogenated, POs is not. However, the functionality of POs is not as good as that of the hydrogenated PO60, mainly because its melting profile as measured by solid fat content is not as good or as high as that of PO60 (i.e. it has to be used at higher levels to achieve the same effect). The need for a non-hydrogenated crystallisation starter with the functionality at least that of PO60 resulted in the development of our CristaGreen™ product, which was awarded with the Fi Excellence award in the Confectionery category at the 2013 Food Ingredients Europe event.

Amongst other technologies, we have developed expertise in two types of oil modification technology, both of which are crucial in achieving this functionality: fractionation and enzymatic rearrangement.

Fractionation is the process of separating high melting triglycerides from low melting triglycerides. There are two basic types of fractionation – dry and wet. Dry fractionation is where oil is held at a temperature at which it is partly liquid and partly solid. The solid (stearin) fraction is then separated from the liquid (olein) fraction by filtration. In wet fractionation, oil is dissolved and the solution is chilled until crystallisation occurs. The crystals (stearin) are then again separated by filtration leaving the olein fraction remaining in solution. Wet fractionation is more complex and expensive than dry fractionation, and only used for high value stearin fractions.

Processes that rearrange the fatty acid groups on the glycerol backbone of a triglyceride molecule have long been used to change the melting profile of fats or blends of fats. Such a process is often called interesterification and historically, has been catalysed by chemicals such as sodium or sodium methoxide. In the current climate of moving away as far as is possible from chemical processes, chemically catalysed interesterification is increasingly being seen as potentially problematic. The alternative is to use an enzyme. Over the years, we have done considerable research into the process of enzymatic rearrangement culminating in the construction of a full scale production unit near Rotterdam in the Netherlands. Enzymatic rearrangement is the eco-friendly alternative to chemical interesterification. It uses lower temperatures, less energy and less water and so is ideal for making a new, consumer-friendly product.

We used both fractionation and enzymatic rearrangement to achieve the triglyceride composition necessary to match the functionality of PO60 without the use of hydrogenation. First we fractionate...
a conventional palm stearin from palm oil. This stearin is then enzymatically rearranged before fractionating again to obtain the desired high melt, high solid fat fraction.

Applications
Achieving the right melting profile is key to achieving the correct functionality. Figure 1 (page 20) shows the melting profile of CristalGreen™ compared with those of PO60 and palm stearin. Not only does it closely match the melting profile of PO60 throughout, its Mettler drop point (an indication of final melting point) of 62°C compares well with PO60, which has a Mettler drop point of 61.5°C. It is also much higher in solid fat than palm stearin.

One of the applications to benefit from this development is in compound coatings. These are confectionery coatings that look and taste like chocolate but whose main fat is a cocoa butter alternative rather than cocoa butter itself. They are used in cheaper confectionery products such as bakery coatings and wafer coatings as well as in solutions for home baking. They are often based on lauric fats such as palm kernel stearin. Lauric fats are known to crystallise quite quickly but, in this day and age of rapid throughput, even they need a helping hand. Figure 2 (page 20) compares PO60 and CristalGreen™ as crystallisation promoters in palm kernel stearin. PO60 does have a slight edge but this is hydrogenated and has to be labelled as such, whereas our alternative offers a ‘clean’ ingredient declaration.

Crystallisation speed is not the only issue we have addressed in palm kernel stearin compound coatings. Recrystallisation on storage, often resulting in the formation of fat bloom on the surface of the coating, is a problem that can beset these types of coating. Table 1 shows the content such a palm kernel stearin-based coating. To this coating, 0.4% lecithin and either 0.8% wt PO60 or 0.8% wt CristalGreen™ were added. Bars were then moulded at 50°C and cooled at 13°C.

The future
This of course is not the only application as this process has already been used in nut and chocolate spreads to prevent the oil exudation that results in oily ‘puddles’ on the surface. We are currently opening up further areas of application through our ‘Creative Studio’. This allows clients to work with the company’s application experts to, together, create new technologies, new applications and new products. Two examples we are currently working on are high melting triglycerides for hardstock in margarines and fat-based spreads, and optimisation of flavour release. There is no doubt that working in this way with clients results in an optimal balance between market pull and technology push, resulting in new applications.

About the Author
Geoff Talbot (also known as The Fat Consultant) has spent 46 years in the food industry, mainly with Unilever and Loders Croklaan before branching out into consultancy in 2003. He writes and lectures widely and runs training courses on all aspects of fats and oils technology and use. He has written and edited books on confectionery and on saturated fat reduction and is now editing a book on speciality fats and oils.

Helga Manson holds a bachelor’s degree in Chemical Engineering from the Technical College in Groningen. As an application technologist she has led the application lab and for the past 12 years, has been Application and Technical Support Manager at Loders Croklaan. In The Netherlands.

Krish Bhagvan holds a master’s degree in Bio-organic Chemistry from the University of Utrecht. As Product and Process Development Manager he has led the pilot plant at Loders Croklaan. For the last seven years, he has been R&D Manager leading the Research and Development group at Loders Croklaan.

References

Table 1: Formulation of palm kernel stearin-based coating

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<th>Component</th>
<th>%wt</th>
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<tbody>
<tr>
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<tr>
<td>Palm kernel stearin</td>
<td>31</td>
</tr>
<tr>
<td>Cocoa powder DR74</td>
<td>7</td>
</tr>
<tr>
<td>Cocoa powder NE</td>
<td>7</td>
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<tr>
<td>Skimmed milk powder</td>
<td>7</td>
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