Stabilization of ice creams produced with a reduced level of saturated fat

Palsgaard Technical Paper, August 2012

Palsgaard®
Heart working people

By
Claus Prior Hansen,
Application Scientist,
Ice Cream & Dairy
Palsgaard A/S.

In recent years there has been an increased focus on the amount of saturated fats present in food products, both from an economical point of view due to taxation on saturated fats and for health reasons. For ice cream this has put a demand on the ice cream producers to develop ice cream with a healthier profile by using more healthy ingredients or by reducing the content of the less healthy ones.
This article presents the results of a study into how the emulsifiers mono- and diglycerides can help manufacturers reduce the amount of saturated fats in ice cream.

FAT TYPES IN ICE CREAM

Fat is a key ingredient in ice cream. It plays a major role in building the internal structure of the ice cream as well as providing creaminess and smoothness. Traditionally, coconut- and palm kernel oils have been used for the production of ice cream. These oils have a high content of saturated fat - coconut 92% and palm kernel over 80%.

This high level of saturated fat gives the fats a good ability to form the internal structure of the ice cream. However, when the level of saturated fat is reduced it makes the fat softer. This makes it more challenging to produce ice cream with a good structure and the desired eating quality, without making adjustments in the rest of the ingredients, such as the emulsifier and stabilizer systems used.

THE EFFECT OF THE EMULSIFIER

The fat and the emulsifier used in ice cream both play a role in building the internal structure that stabilizes the ice cream. The emulsifier is added to reduce the stability of the ice cream emulsion. This makes it easier for the emulsion to partly break down and for the fat globules to make a partially coalesced structure once the ice cream emulsion is being whipped in the ice cream freezer. This partially coalesced fat structure stabilizes the air bubbles inside the ice cream making the ice cream more smooth. Additionally, this partially coalesced fat structure has a great influence on the melting properties of the ice cream.

SETUP OF STUDY

Emulsifier and stabilizer expert Palsgaard has recently performed a study investigating the effects of different types of mono- and diglycerides on the stabilization of ice creams with reduced levels of saturated fat.
The recipe and the production methods used in this study are shown in tables 1 - 3.

In the study three different types of mono - and diglyceride systems were tested:

- Fully saturated mono- and diglycerides **(FS)**
- Partly unsaturated mono- and diglycerides, containing trans fatty acids **(PuS-T)**
- Partly unsaturated mono- and diglycerides, without trans fatty acids **(PuS-nT)**

Table 1:
Ice cream recipe used

Ingredient	%
Vegetable fat	10.00%
Skim milk powder	11.40%
Sucrose	11.50%
Glucose Syrup, 42 DE	3.35%
Stabilizer system (E410, E412)	0.16%
Mono- and diglycerides	0.40%
Water	63.20%

Table 2:
Production process

Process used for the production of the ice cream mix:
Mixing of all ingredients at 40°C
Homogenization: 140 bar at 75°C
Pasteurisation: 85°C for 5 sec.
Cooling to 5°C
Aging overnight at 5°C

Table 3:
Ice cream production

Ice cream production:
Continuous ice cream freezer: Gram Equipment GIF 400
Overrun: 100%
Ice cream outlet temperature: approx. -5.5°C
Hardening at -35°C for 24 hours.
Storage at -20°C

The different vegetable fats used in the study were all without trans fatty acids:

- Vegetable fat with 92% saturated fat **(reference fat)**
- Vegetable fat with 50% saturated fat **(Fat 50)**
- Vegetable fat with 40% saturated fat **(Fat 40)**

Heat Shock (HS) method:

- Storage at -10°C for 4 days, after this storage at -20°C.

The combination of the three different mono- and diglyceride systems with the three different types of fats mean that nine trials were made for this study.

ANALYSES PERFORMED

In the study three different analyses were performed in order to evaluate the effect of the emulsifier:

- Viscosity of aged ice cream mix using Brookfield DV-III, spindle 2, 20 rpm
- Particle size distribution of ice cream mix after aging and of melted ice cream using Horiba LA 950
- Melting resistance of ice cream before and after heat shock. Melting was monitored for 90 minutes at 25°C.

VISCOSITY MEASUREMENTS

A mix viscosity of 300 to 500 cps was measured for the nine different ice cream mixes. Hence all nine mixes are within the common viscosity range used by the ice cream industry.

PARTICLE SIZE DISTRIBUTION

The aged ice cream mixes were also subjected to a particle size distribution measurement, the responding curves can be seen across in figures 1a, 1b and 1 c.

All mixes show two peaks, at 0.1-0.5 µm and at 1-2 µm, with the main peak at 1-2 µm. For the reference fat the emulsifier system

Figure 1a:
Reference fat

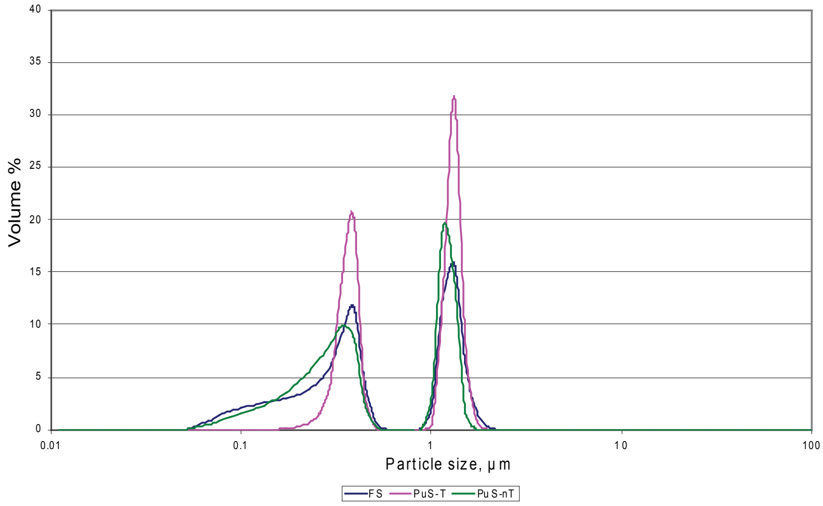


Figure 1b:
Fat 50

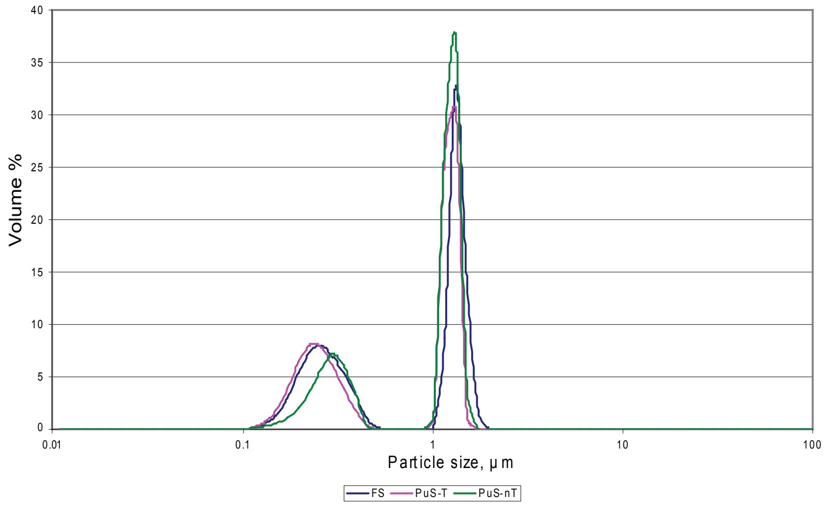
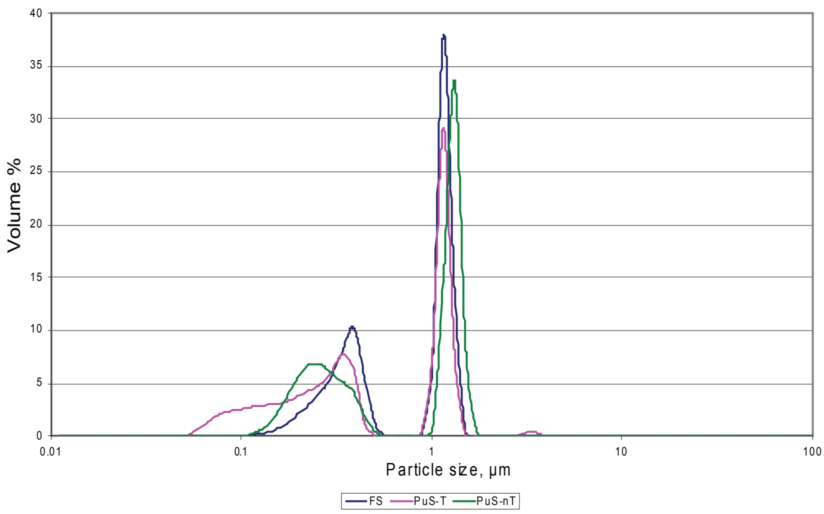


Figure 1c:
Fat 40



giving the narrowest particle size distribution at the main peak was **PuS-T**.
For Fat 50 all three emulsifier system gave very similar particle sizes for both peaks as indicated in figure 1b, with **PuS-nT** being slightly narrower at the main peak than the two other systems.
For Fat 40, like for Fat 50, the main peaks were very similar in their particle size distribution as indicated in figure 1c, but here **FS** gave the narrowest particle size distribution.

The particle size distribution of the ice cream mixes indicate that they can be used for the production of ice cream.

PARTICLE SIZE DISTRIBUTION IN ICE CREAMS MADE WITH VEGETABLE FAT WITH 92% SATURATED FAT

For ice cream produced with the reference fat, there is a significant difference in the particle size distribution of the melted ice creams as can be seen from figure 2.

The emulsifier system, **FS**, gave a very narrow particle size distribution compared to the two unsaturated emulsifier systems, indicating that the unsaturated emulsifier creates a larger sized partially coalesced fat structure.

PARTICLE SIZE DISTRIBUTION IN ICE CREAMS MADE WITH VEGETABLE FAT WITH 50% SATURATED FAT

For ice cream produced with Fat 50, there is a difference in the particle size distribution for the melted ice cream as can be seen from figure 3. Here as for the reference fat, the emulsifier system, **FS**, gave a narrower particle size distribution compared to the two unsaturated emulsifier systems.

When comparing the main peaks of the ice creams containing the emulsifier system **FS** for the refer-

BENEFITS FROM SWITCHING FROM SATURATED TO UNSATURATED FATS

Saturated fat has been linked to an increased risk of heart disease which is why the WHO recommends that the intake of saturated fat should be restricted to maximum 10% of the daily energy intake.

Reducing the amount of total fat or switching to a fat with reduced levels of saturated fat has an effect on the cost of the final ice cream in countries where there is a taxation on the amount of saturated fat in the ice cream like in Denmark. As an example the Danish tax is 16 DKK + 25% VAT per kg of saturated fat.

Figure 2:
Reference fat - particle size distribution of melted ice cream

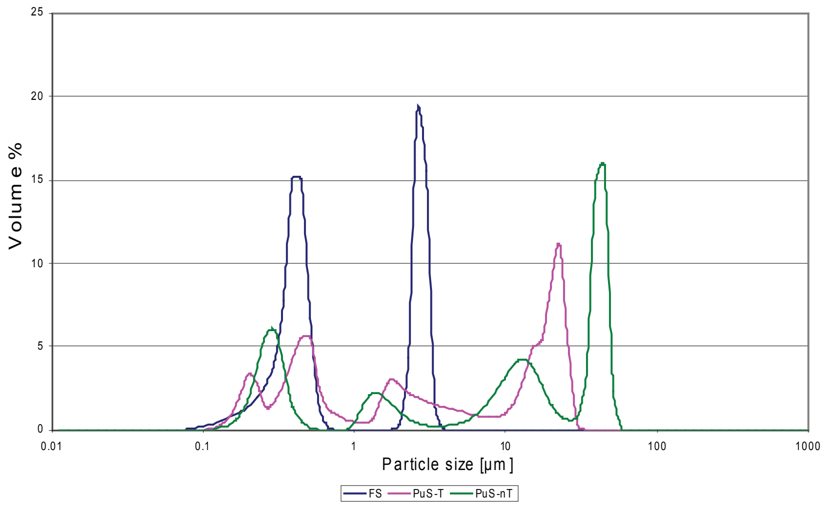
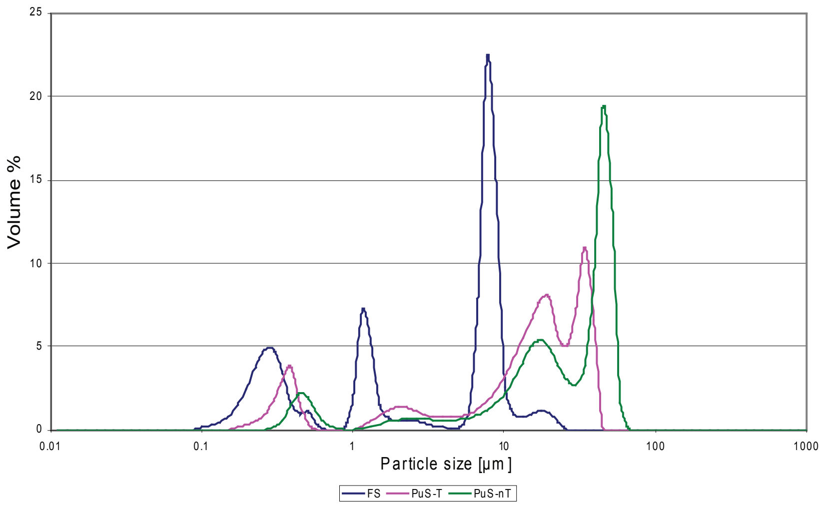


Figure 3:
Fat 50 - particle size distribution of melted ice cream



ence fat and Fat 50, it can be seen that the particle size distribution of the reference fat are smaller than for Fat 50, indicating that the combination of the emulsifier system **FS** and Fat 50 are better at making a partially coalesced fat structure. The ice creams containing the two unsaturated emulsifiers are again containing particles of a larger size. This indicates that these emulsifiers are better at making larger sized partially coalesced fat structures.

PARTICLE SIZE DISTRIBUTION IN ICE CREAMS MADE WITH VEGETABLE FAT WITH 40% SATURATED FAT

Ice creams produced with Fat 40, have similar particle size distribution with the emulsifier systems **FS** and **PuS-T**, whereas the emulsifier system **Pus-nT** creates larger particles than the two other systems as shown in figure 4.

TESTING THE MELTING RESISTANCE OF ICE CREAMS MADE WITH VEGETABLE FAT WITH 92% SATURATED FAT

The melting resistance of the ice creams produced with the reference fat, is strongly influenced by the type of emulsifier used. This is evident when looking at figure 5. Ice creams made using the emulsifier system **FS** loose 25-30% of its weight after 90 min, whereas the ice creams made with the unsaturated emulsifier systems only loose up to 5% after 90 min. This correlates well with the particle size distribution of the ice creams produced with the reference fat as discussed earlier. The unsaturated emulsifier systems gave much larger particles than the emulsifier system **FS** as indicated in figure 2.

Figure 4:
Fat 40 - particle size distribution of melted ice cream

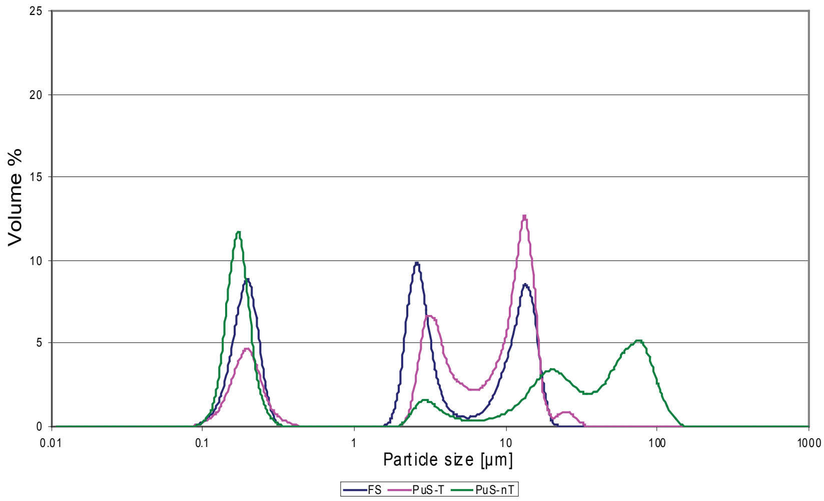
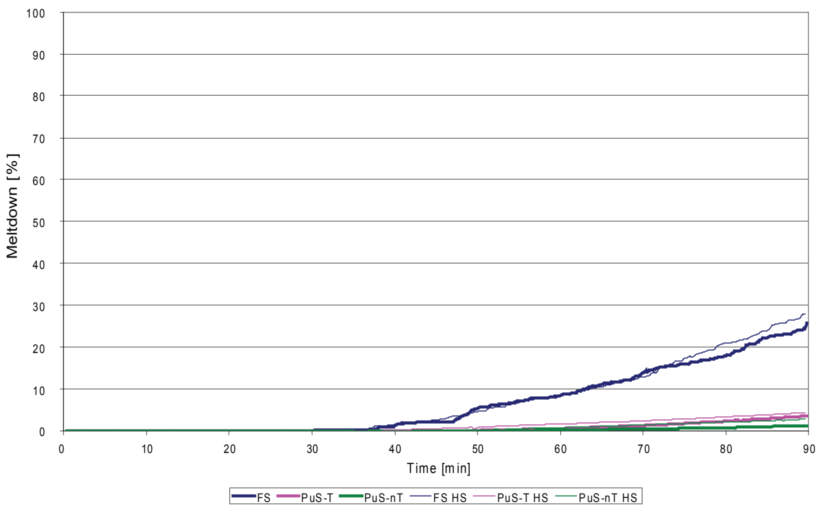
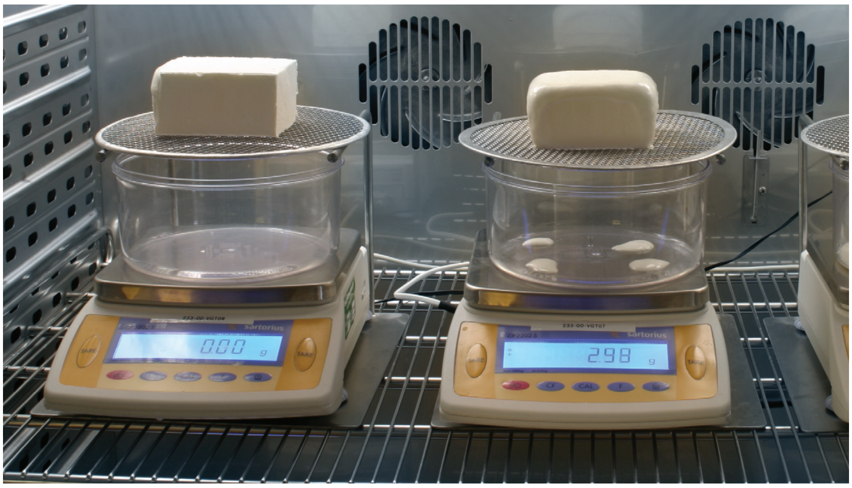


Figure 5:
Reference fat - melting resistance





TESTING THE MELTING RESISTANCE OF ICE CREAMS MADE WITH VEGETABLE FAT WITH 50% SATURATED FATS

The melting resistance of the ice creams made with Fat 50, are very similar, as can be seen from figure 6. All the ice creams loose up to 5% of their weight after 90 min.

From the results of the particle size distribution of the ice creams shown in figure 3 one would expect that the combination of Fat 50 and emulsifier system **FS** would offer the least melting resistance. This is due to the more narrow particle size distribution of the ice creams made with **FS** than with the unsaturated emulsifier systems.

However, as this is not the case this could indicate that the ability to make a partially coalesced fat structure in the ice cream is less sensitive to the type of emulsifier used in combination with Fat 50.

TESTING THE MELTING RESISTANCE OF ICE CREAMS MADE WITH VEGETABLE FAT WITH 40% SATURATED FATS

The melting resistance of the ice creams made with Fat 40 are influenced by the type of emulsifier used. The ice creams produced with **PuS-nT** loose up to 12% of their weight after 90 min. Whereas the ice creams produced with emulsifier systems **FS** and **PuS-T** only loose up to 5% after 90 min - as indicated in figure 7. When comparing these results with the particle size distribution for Fat 40 discussed earlier, it would be expected that these ice creams gave very similar melting resistances. However, the fact that **PuS-nT** offered the least melting resistance, but had the largest particles, as can be seen in figure 4, could indicate that these partially coalesced fat structures are more coalesced and therefore not participating in building the internal structure if the ice cream.

Figure 6:
Fat 50 - melting resistance

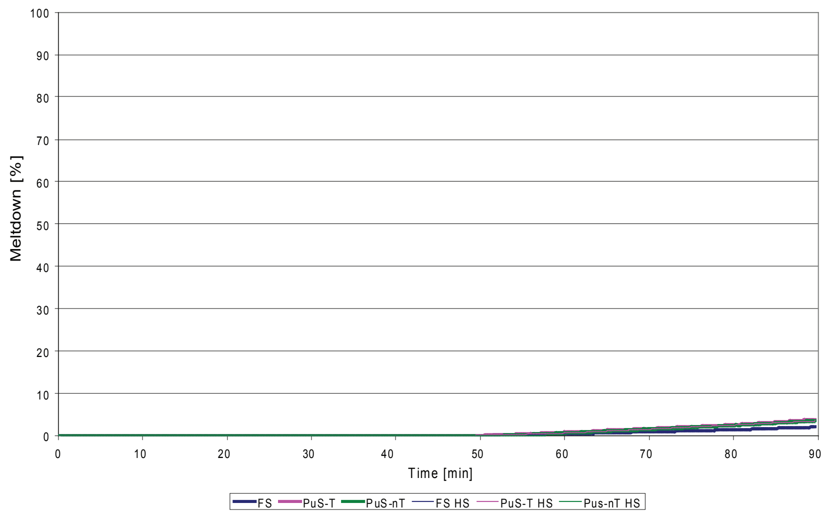
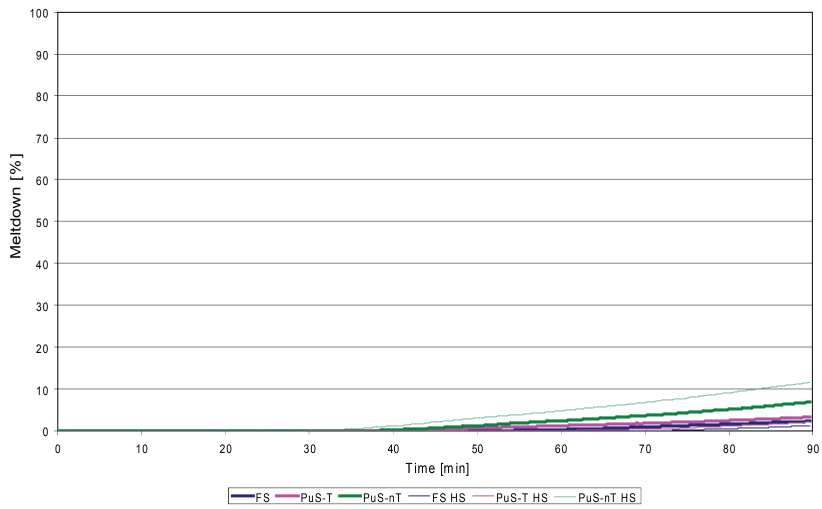


Figure 7:
Fat 40 - melting resistance



CONCLUSION

Based on this study it can be concluded that an adjustment of the mono- and diglyceride systems used in production of ice cream will have to be considered when switching to fats with a lower amount of saturated fats.

Palsgaard will be pleased to assist you in selecting the right mono- and diglyceride system for your requirements be it for a new product or for reformulating an existing product in order to adhere to consumer requests for healthier ice creams.

The emulsifier systems used in this study are part of the integrated emulsifier and stabilizer blends within the product ranges Palsgaard® ExtruIce and Palsgaard® MouldIce.

ABOUT PALSGAARD

Palsgaard is a specialist in developing emulsifiers and stabilizer blends for various types of ice cream ranging from moulded to extruded ice cream and sorbets and water ices. With application plants on three continents Palsgaard also helps its customers develop new products or optimize existing formulations.

Palsgaard's application centres are fully equipped with continuous ice cream pilot freezers, two-stage homogenizers and pasteurization units. Which is why the company is capable of simulating every single processing step of a real size production facility.

For more information on this study, please contact:
Application Scientist
Claus Prior Hansen at
cph@palsgaard.dk or
Tel +45 7682 7682

Palsgaard®
Heart working people