FINAL PROJECT REPORT

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1. Summary

Chocolate is a complex material, which can be damaged by means of fat bloom growth or cracking. This is a significant issue for filled products such as pralines that can prevent the manufacture of products of sufficient quality. In the ProPraline project, the mechanisms behind bloom and crack formation have been studied using advanced methodologies and ways to solve these problems have been developed.

The objective of this project was to improve the competitiveness of the European SMEs producing exclusive, complicated and niche-oriented filled products like chocolate pralines by developing knowledge and technical solutions to improve quality and to extend the shelf life of their products.

1. The problems associated with quality assessment of pralines were described and a methodology for efficiently carrying it out was set up. The consumer perspective was taken into account.

2. The mechanisms of crack development and fat bloom in chocolate pralines were studied and routes for their prevention were developed. Focus was on development of chocolate microstructures with improved cracking resistance and reduced fat migration from the filling to the shell.

3. The relations between process - structure - properties were quantified and the knowledge was used to develop processing solutions for tailor-made cracking and bloom resistant chocolate microstructures.

The project involved 14 partners from 7 different European countries; three national SME associations, six research organizations and universities, three SME praline producers and two large companies providing expertise on equipment and ingredients.

The project has, through SME associations, provided demonstrations and training to a large number of European SMEs in how to manufacture new innovative chocolate pralines with high quality. A total of eleven demonstrations with industry regarding technologies developed in the project have been performed; three targeted directly at each of the three participating SMEs, and carried out in their production lines, and eight demonstrations open for all European stakeholders. Two courses were organized in four different European locations, Sweden, Belgium, Czech Republic and Switzerland. The first course focused on the current state-of-the-art of technologies available and the second on the new knowledge generated in the project to prevent fat bloom and cracking in pralines. The three national SME associations taking part in the project have disseminated the results to their members, and in cooperation with the CAOBISCO (Association of chocolate, biscuit and confectionery industries of the European Union) the results have been presented to all Europe. Furthermore, the project results have been widely disseminated through e.g. a variety of presentations at scientific conferences and in articles published both in industrial magazines and also in scientific journals.

2. Description of project and main objectives

The objective of this project was to improve the competitiveness of the European SMEs producing exclusive, complicated and niche-oriented filled products like chocolate pralines by *developing knowledge and technical solutions to improve quality and to extend shelf-life of their products*. Moreover, the project has, through SMEs associations, provided demonstration and training to a large number of European SMEs in how to manufacture new innovative chocolate pralines with high quality.

Chocolate is a very evocative product and it is often related to feeling good. Chocolate can be considered as an affordable luxury product, which is regularly eaten by many people. Typical Europeans eat 2 to 10 kilos of chocolate per head per year. Consumption varies from country to country. In Switzerland the annual consumption per person is around 10 kg, whereas in Spain only about 2 kg is consumed.

Production of chocolate is an important industry in Europe. Over 200 000 people in Europe are involved in the chocolate manufacture in over **2000 companies of which over 90% are SMEs**. The annual turnover of these companies is about 43 billion Euros. Furthermore, chocolate to a **value of more than 3 billion Euros is exported.** SMEs are able to compete in a market strongly dominated by multinational companies by producing exclusive and niche-oriented products like chocolate pralines. These products are technologically more complicated than chocolate bars, due to the characteristics of the fillings; fat bloom and cracking are common problems in pralines leading to significant reduction of shelf-life and rejection of the products by consumers. It is estimated that 143 000 ton chocolate is affected by quality problems like fat bloom and cracks, which costs the European chocolate industry up to 1.2 million Euro a year.

Chocolate is a very special product in that it is solid at room temperature, but quickly melts in the mouth, giving a unique sensorial experience. From a technological point of view, chocolate is a complex food containing solid particles (cocoa powder, sugar, milk powder) solid and liquid fat as well as an emulsifier. Chocolate manufacture is a multi-step process, involving fermentation of cocoa, drying, cleaning and roasting of cocoa beans, grinding to produce cocoa mass, adding and mixing with other ingredients such as sugar, emulsifiers or milk powder, and conching for flavour and texture development before the production of the chocolate itself. After the chocolate is deposited it must be tempered and carefully cooled in a cooling tunnel in order to obtain the correct crystal form in the cocoa butter. Everything from growing of the cocoa bean to the storage of the finished chocolate in the store will influence the final sensorial properties of the chocolate. Several physico-chemical processes are active during all these steps that influence the quality and stability of chocolate. For example, in chocolate without filling, fat or sugar migration and subsequent fat recrystallisation can occur and may result in polymorphic fat or sugar bloom during storage, respectively, that affects the appearance and structure of the chocolate.

In addition to blocks or tablets, more complex products with other flavours and textures are highly desired. Many SMEs working with confectionery and chocolate do not produce simple chocolate bars; instead they manufacture exclusive, complicated and niche-oriented products where fillings, biscuits or wafers can be included. Many of these products consist of a thin shell with some kind of filling.

In case of chocolate pralines, the filling could be oil based, nut based, alcohol based or a biscuit / wafer. These products often have certain attributes such as taste and/or appearance, which can be coupled to the origin of the products or the background of the manufacturer. These compound **products lead to increased processing complexity and higher risk of quality issues, see figure 1.** An example is that relatively different rates of expansion and contraction of chocolate and the other components can lead to **cracking** or other quality problems. There is also the issue of undesired interactions between the different components. It is well known that fat bloom is encouraged by the presence of foreign oils, such as from fillings. The rate of oil migration from a filling is strongly influenced by the structures of the filling and the chocolate. Therefore **understanding and controlling these processes can lead to an improved product with a longer shelf life.** These products with extended shelf-life will open up new business and market opportunities for European SMEs increasing their export potential outside Europe.

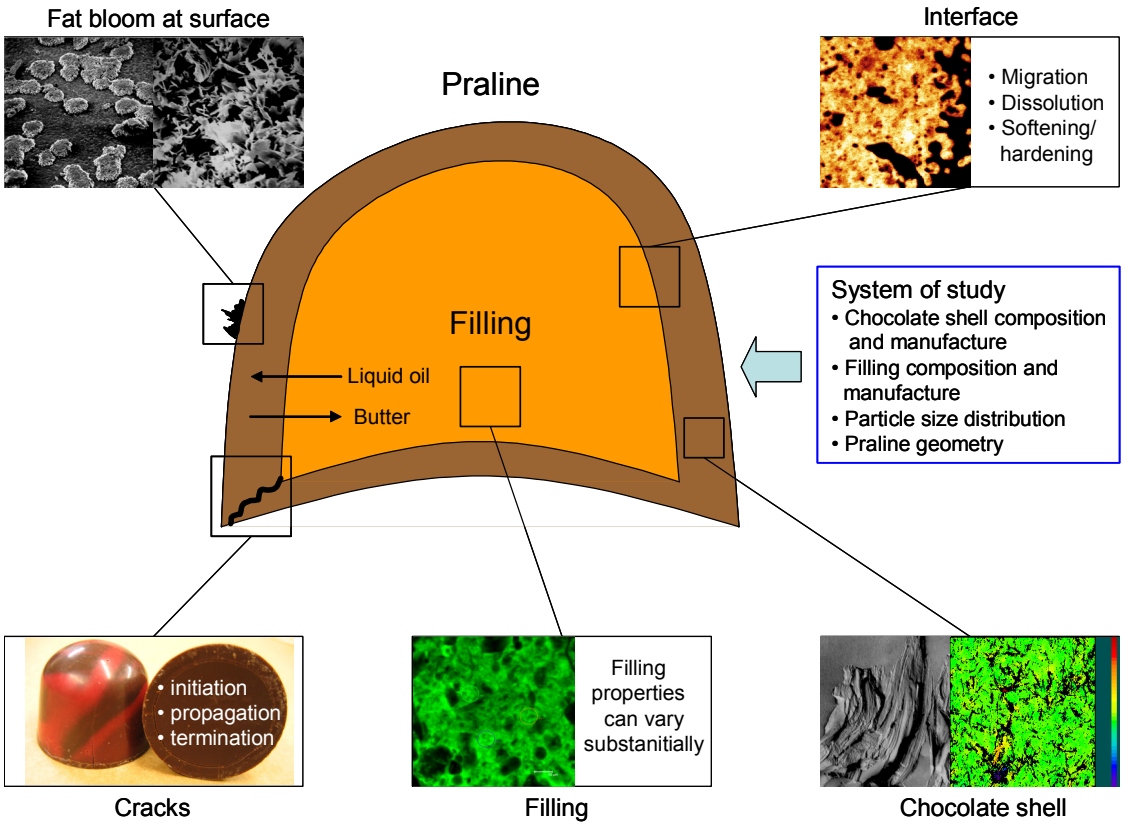


Figure 1. Schematic picture that shows different quality issues and structural parts in a praline.

This project intended to determine the mechanisms involved in crack initiation and crack propagation in the shell that surrounds the filling and to find routes to avoid fat bloom in filled products.

For confectionery industry crack formation and surface bloom in filled chocolate/praline-systems are largely relevant problems related to deficiencies in microstructure affecting its (1) mechanical strength, (2) diffusivity /permeability-characteristics and (3) micro-/macro homogeneity. In order to

tackle these problems from a joint scientific and industrial point of view respective Property-Structure Functions (PSF) and Structure – Process Functions (SPF) have to be identified and quantified as showed in figure 2.

The *property-structure functions* have allowed for identifying the structure aspects of relevance triggering crack formation and surface bloom from a molecular to a macro-disperse structure scale. It is expected that, besides formulation related molecular aspects, the structural aspects of major importance within the project are structure density (i), the disperse component's size distributions (ii), the fat polymorph distribution (iii) and the fat crystal network morphology (iv).The *structure-process functions* provided quantitative rules for processing of the tailor-made structures of preference identified by the property-structure functions. With respect to processing, the major processing steps determining bulk and surface/interface structure characteristics of filled chocolate/praline products are pre-crystallization/tempering (a), moulding (b), cooling (c) and de-moulding (d). These parameters determine the property-structure functions related properties (Figure 2).

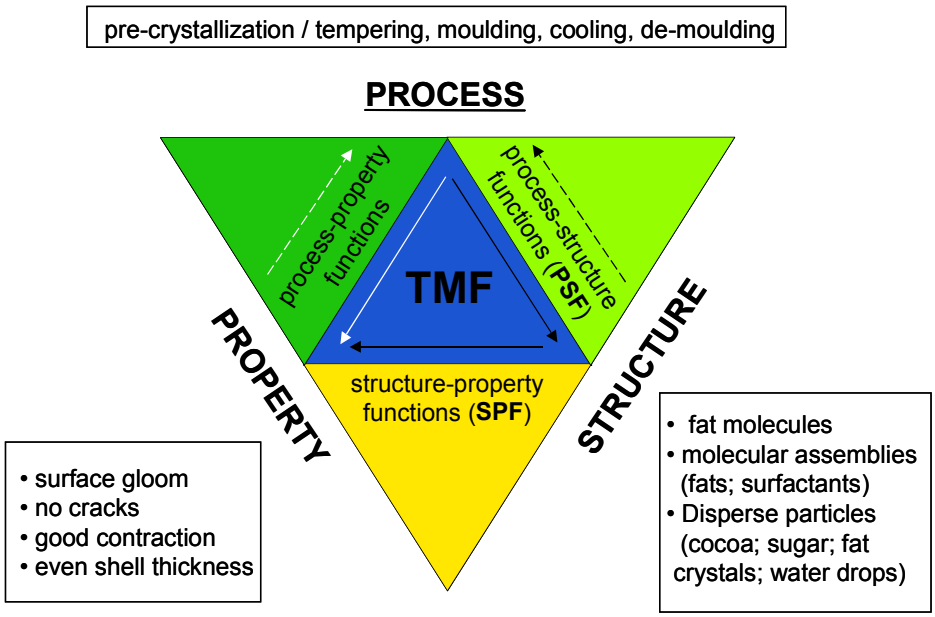


Figure 2: Process-Structure-Property Relationships of relevance for filled chocolate/praline (TMF = Tailor Made Food)[1]

[1] Windhab E. J. (2007); Process Engineering Concepts for Tailor Made Food; Plenary Lecture / Proc. - IUFoST Int. Congress; 17-21.Sept. 2006; Nantes France

The **Scientific & Technical objectives of the ProPraline project were:**

- To generate an adequate description of the problems and a methodology set-up for quality assessment of pralines, taking into account the consumer perspective;
- To create an understanding of the mechanisms of crack development and fat bloom in chocolate pralines and to develop routes for its prevention, with focus on development of chocolate microstructures with improved cracking resistance and fat migration from filling to the shell
- To quantify process – structure - property relationships and to use this knowledge to develop processing solutions for tailor-making cracking and bloom resistant chocolate microstructures

The knowledge generated by the research institutes and the universities in the project has been transferred to the European SMEs producing chocolate through courses, demonstrations and dissemination activities. The three national branch organisations from Belgium, Czech Republic and Sweden, together with the European branch association CAOBISCO, have played a major role in dissemination of results in Europe.

Key results of the project are a book of methods, course material and a handbook, and these will be further disseminated through the associations, and will form a long standing source of information to be widely used by praline producers.

The **Training & Technology Transfer objectives of the ProPraline project were:**

- To increase the knowledge base of European SMEs producing chocolate pralines by carrying out 2 courses in 3 different European locations
- To implement and demonstrate the main findings of the projects in collaboration with SME partners and two large demonstration activities towards the entire European SME community
- To disseminate the results of the project in congresses and publications to increase knowledge about chocolate quality and technology

In total four training courses were organised in Gothenburg, Sweden, in Prague, Czech Republic, in Zürich, Switzerland and in Ghent , Belgium. In connection with the courses eight practical demonstrations were organised, covering different aspects of processing.

The results of the project have been orally presented at 90 meetings/workshops/ conferences (including 70 presentation to industry and 17 scientific conferences) and has generated so far 40 publications (including 15 publications in industrial magazines; 5 scientific publications in peer reviewed journals, and 10 MSc thesis) . More than 10 publications are planned for the coming period.

The ProPraline project also managed to successfully combine research for SMEs with education of PhDs. Five PhDs have been involved in the ProPraline project contributing with good scientific grounds for the understanding of mechanisms behind fat bloom and cracking and with further transformation of this knowledge into methods or processing solutions to be used by SMEs.

3. Description of the main S & T results/foregrounds

The objective of ProPraline project has been to improve the competitiveness of the European SMEs producing exclusive, complicated and niche-oriented filled products like chocolate pralines by *developing knowledge and technical solutions to improve quality and to extend shelf-life of their products*. Moreover, the project will, through SMEs associations, provide demonstration and training to a large number of European SMEs in how to manufacture new innovative chocolate pralines with high quality.

In the beginning of the project a large number of SME chocolate producers were interviewed by the SME associations in Belgium, Czech Republic and Sweden to gather information about quality problems in pralines. The results were published in the New Food magazine. Results of the questionnaire showed that fat bloom is a major quality problem for filled chocolates, especially when worldwide export is envisaged as this requires longer shelf life to cover transports. There is a need for an integrated research approach in order to provide a global solution towards quality problems in filled chocolates.

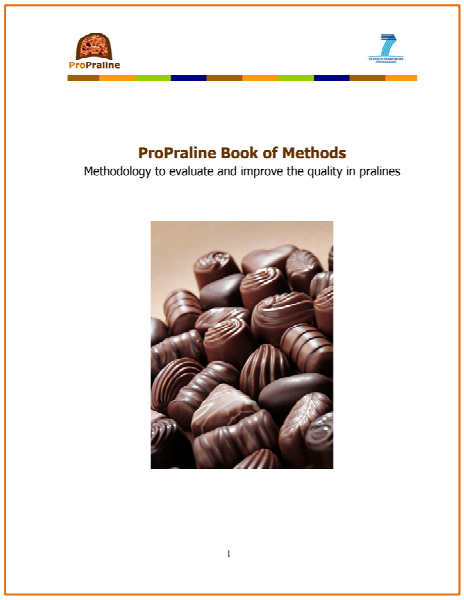
The main S&T results obtained are well aligned with the objectives of the project as showed in table below.

New Knowledge available for SMEs on Propraline website	**Technical solutions to increase shelf-life**
• Book of methods for quality assessment • Routes to prevent fat bloom and cracking • Handbook to manufacture high quality pralines • Course material	*To control fat bloom:* • Seed tempering • Thermal post- treatments • Control of cooling/ Detachlog *To control cracking:* • Control of water activity in the fillings • Selection of praline geometry
Training and Demonstration towards SMEs	**Dissemination of results**
• 3 specific demonstrations with the SMEs participating • 8 open demonstration with chocolate industry in Sweden, Belgium, Czech republic and Switzerland • 2 courses in Sweden, Belgium, Czech republic and Switzerland	• 50 presentation in industrial AGs board • 2 presentations at CAOBISCO • 15 manuscripts in industrial magazines • 5 scientific publications • 20 participation in congresses • 10 MSc Thesis performed • 5 PhD thesis planned

More details can be found on the next sections.

New Knowledge available for SMEs on Propraline website

Four booklets containing scientific information to help SMEs to produce pralines of high quality and extended shelf-life have been developed during the project and are now available for downloading on ProPraline external website. www.sik.se/propraline.



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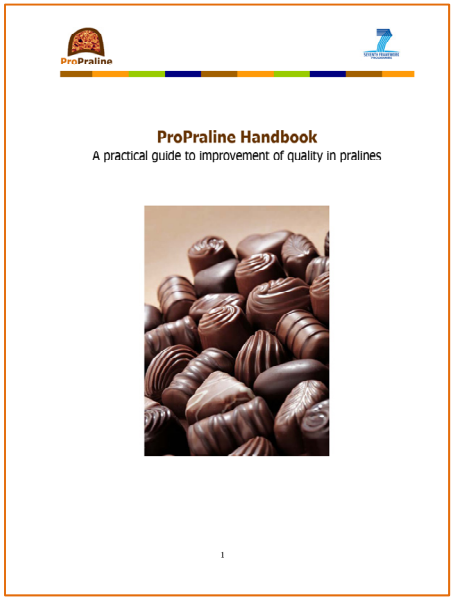

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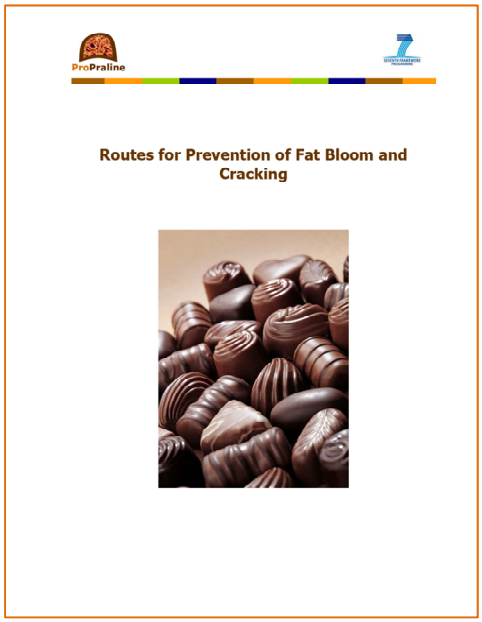

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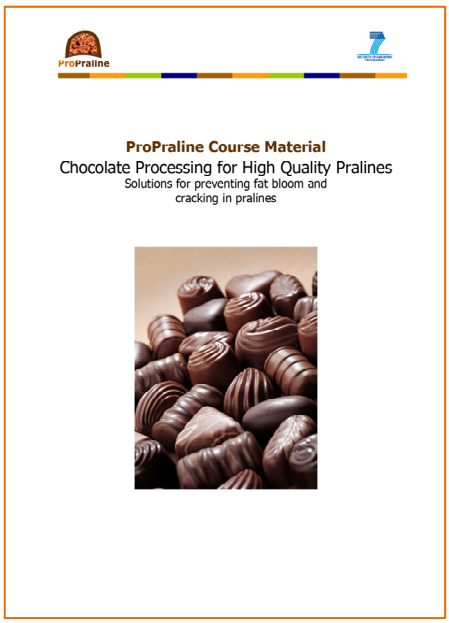

148 pages

Book of methods

The ProPraline Book of Methods describes methods that are useful to study fat bloom and cracking and is directed towards praline producing companies, and more specifically towards SMEs. Several simple methods, such as for instance colour-, micrometric and temper degree measurements, are described in this book. The devices for these methods are usually relatively affordable for SMEs and easy-to-handle. In addition, also more complex (and usually more expensive) methods, such as for instance atomic force microscopy and confocal laser scanning microscopy, are included in this book. Even though SMEs usually cannot afford buying this type of equipment, they can learn about the existing possibilities and how to understand the results. For every method, the aim, some background information and a description of the method is given. Furthermore, an example is given which helps to understand how to evaluate and interpret the results.

ProPraline handbook – a practical guide for prevention of fat bloom and cracks

The handbook provides concise and practical information about the processing of high quality pralines in a format easily comprehended by SMEs. The handbook is divided into 4 main parts. The first part is the introduction that gives overview of the production process, of product defects such as cracking and blooming and the general aspects of the raw materials and handling of pralines. The second part collects the advices and solutions for processing (e.g: tempering, cooling, molding/demolding, post-treatment and storage) to prevent the formation of fat bloom and cracking. The third part gives an overview of the product aspects (particle size, product geometry, composition of the filling, sensory analysis) that must be considered for the prevention of fat bloom and cracking. The fourth chapter includes the conclusion and take home messages.

Routes to prevent fat bloom and cracking

In this document the research in the project that has led to practical procedures and applicable knowledge that can be used to prevent chocolate bloom and cracking are presented and explained with detail. The routes selected are relatively easy to implement in a SME chocolate producer and they bring significant impact on product quality. Some of the routes are more suitable for the industrial producers, while others are well suited also for artisan producers. Some findings of practical relevance for the SME praline producer presented are:

- Control of tempering or alternatively a new seeding tempering, that has been further developed in this project for SMEs, are important to reduce fat bloom
- Thermal post-treatments of shell and pralines can be used to control the development of chocolate bloom
- Control of cooling can reduce fat bloom
- Particle size in chocolate has relevance for the kinetics of fat bloom development
- Water activity in fillings has strong influence on the tendency of pralines to crack

ProPraline course material

All the power point presentations presented in the course "*"Possible routes for prevention of fat bloom and cracks in pralines"* are compiled in this document. This gives a pedagogic presentation of the scientific results obtained in the project, providing possibilities for a better understanding of the principles and their practical use.

Technical solutions to increase shelf-life

New seeding technology

Better understanding of the effect of chocolate structure on fat bloom gave origin to development of a new seeding process suitable for SMEs to replace the traditional tempering process. Seeding of both the chocolate and the filling retards fat bloom in pralines compared to conventional tempering.

A business idea to start a spinoff company, ChocoWinS, has been awarded in a Venture Cup competition in Sweden and it is now been further explored in Switzerland.

A schematic representation of the new seeding technology for SMEs is shown in figure 3.

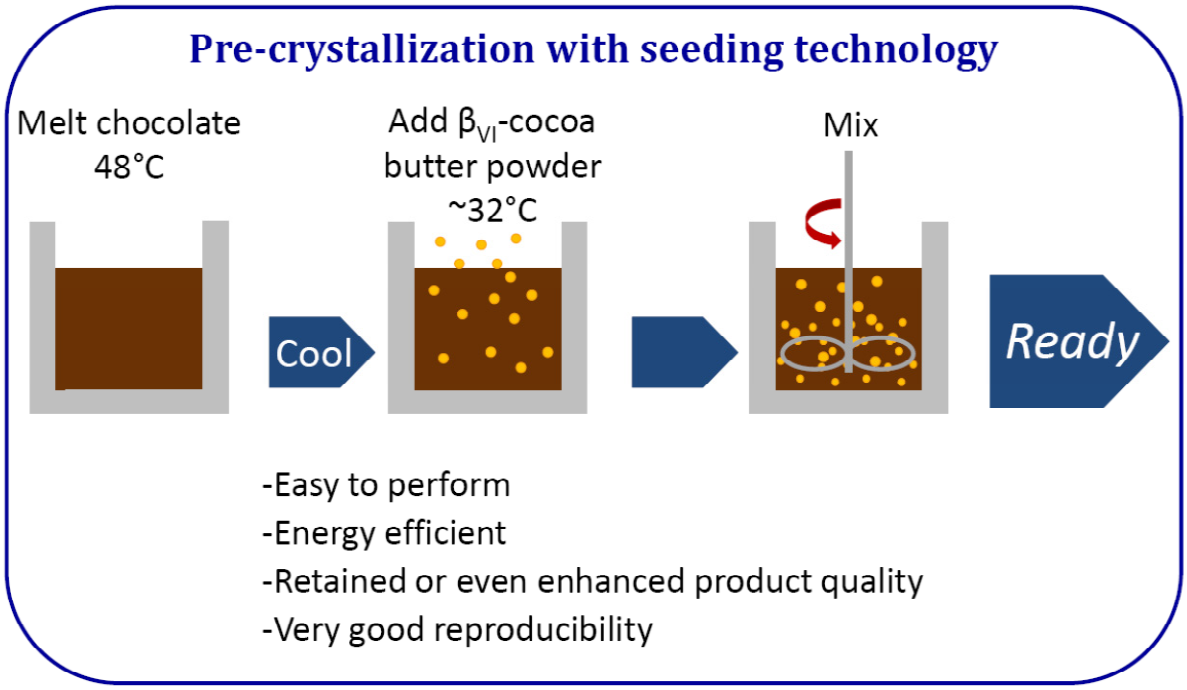

Figure 3. New seeding process, consists of addition of β_{VI} seeds to the molten chocolate instead of a complicated multi-step process

The new seeding process allows the fast development of a chocolate structure that gives a more compact and homogeneous structure after cooling. Figure 4 shows the differences in microstructure between the traditional tempering process and the new seeding technology.

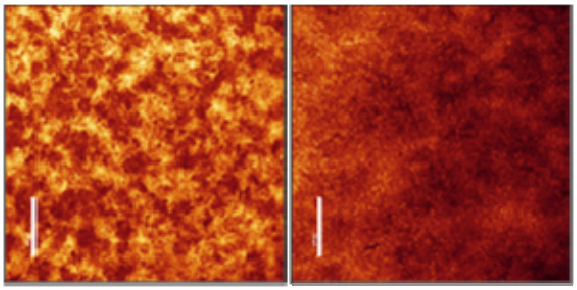

Figure 4. Microstructure of seeded (right) and traditional tempered (left) cacao butter

The reduction of fat bloom caused by this technology, evaluated as oil migration, can be seen in figure 5, where an extension of 2-3 weeks shelf-life can be achieved.

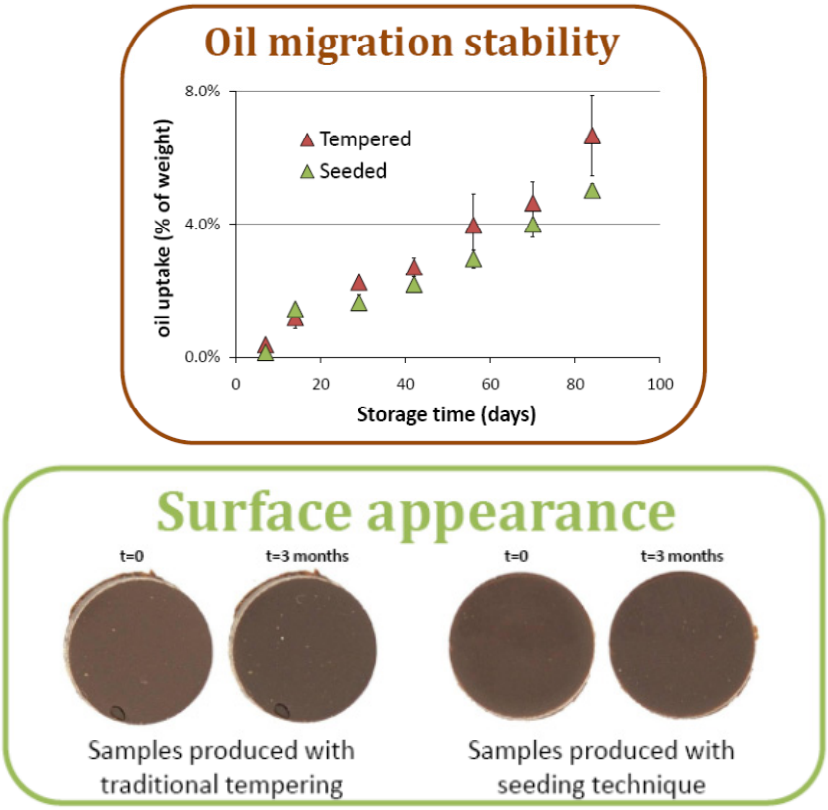

Figure 5. Stability to oil migration and surface properties of seeded and non-seeded pralines

Thermal post-treatments of pralines after production

One conclusion of the project is that the process of making a chocolate praline is not finalized directly after the cooling process – but that the treatment, and especially the temperature, during the first hours / day after production has a significant impact on the quality and shelf life of the final product.

Comparison of different thermal post-treatments in their ability to make chocolate more resistant towards oil migration showed that:

- Not only low-temperature but also short high-temperature treatments prior to storage are effective in retarding oil migration and fat bloom development in filled chocolate products.
- The reference pralines and the pralines treated at 4°C started to bloom faster than the pralines treated at -18°C. Oil migration was reduced in the pralines treated at -18°C, with a longer treatment being more effective.
- The pralines treated at 30°C showed no fat bloom, even after 12 months of storage. Oil migration was reduced in these pralines, with a shorter treatment being more effective.

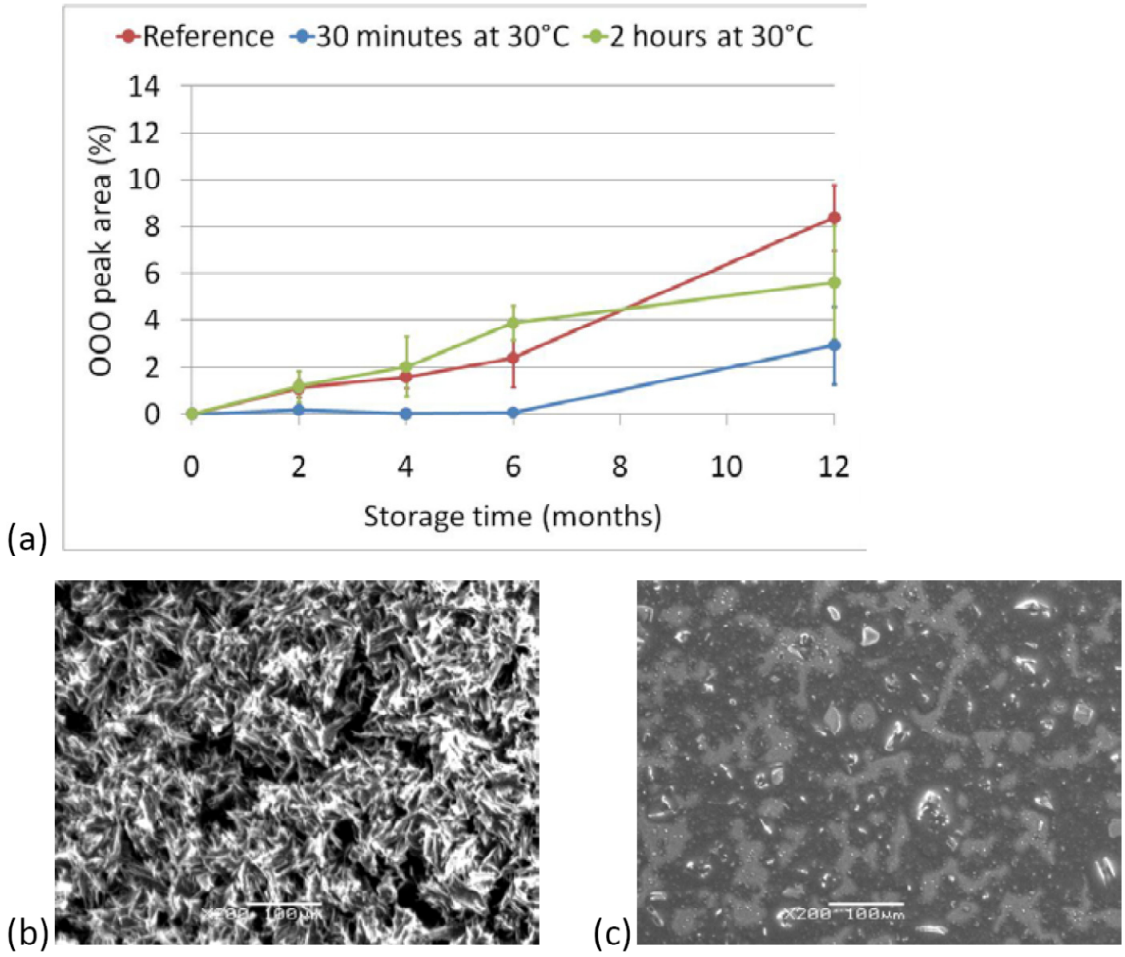

Figure 6. (a) The amount of triolein that migrated from the filling to the chocolate in pralines is an indicator of the fat migration through the chocolate. The data show that a treatment at 30°C strongly reduces fat migration. Fast migration indicates more chocolate bloom development as confirmed by the SEM micrographs of chocolate surface (b) no post-treatment and (c) 30 minutes at 30°C.

New Equipment and methodology to monitor crystallization in process during cooling

Moulds for filled chocolate plates and pralines as used in industrial productions were equipped with the newly developed ultrasonic device called DetachLog (figure 7). This device combines Ultrasound attenuation measurements between two locations at the mould wall, and temperature measurement of the solidifying chocolate mass at a representative location at the mould wall surface. After test-measurements with moulds in a laboratory environment, we applied this technique for in-line measurement during product cooling under industrial chocolate production conditions. It was possible to do real time in-line detection of (i) the solidification during cooling, (ii) temper degree and (iii) product detachment from the mould wall as a consequence of its contraction. Related characteristics (i) to (iii) allow for process optimization, in particular for the tempering but as well for the cooling process. In addition criteria for improved product development could be derived.

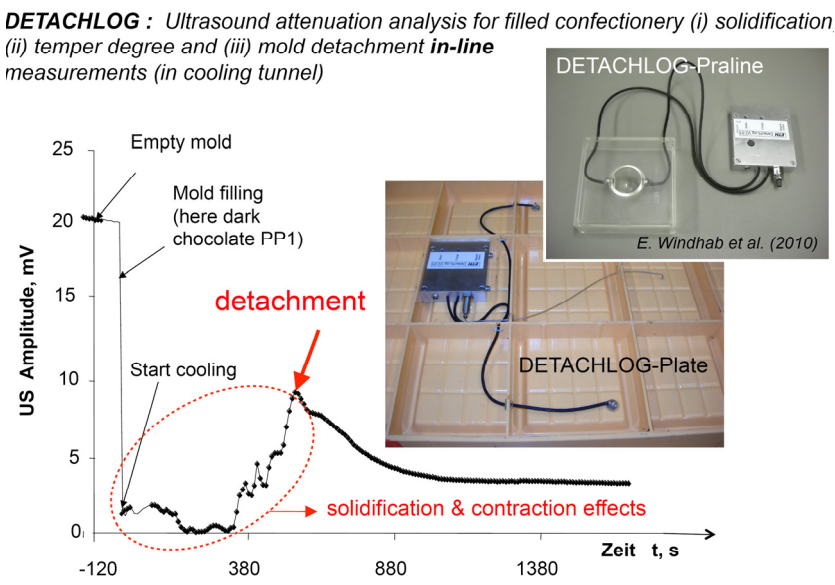

Figure 7. DETACHLOG in-line measuring technique

Molding technologies

Comparison between conventional moulding, frozen cone moulding and one-shot moulding showed that in general, conventional molding showed superior visible bloom resistance and frozen cone technology the least. DSC (Differential Scanning Calorimetry) measurements of chocolate end-set temperature showed lowest values for conventional molding, translating into highest bloom stability. Gaps between filling and chocolate could be observed after 12 weeks of storage for frozen cone and conventional molding but not for one-shot processing where chocolate and filling crystallization takes place simultaneously.

Cooling of Pralines

Decreasing the cooling temperature to maximise the output and speed up demoulding can have a negative impact on product quality. It could be demonstrated that cooling rates are not only dependent on temperature but also air velocity. An increase of air velocity from 1 to 6 m/s could compensate a temperature difference of 22°C in heat flux. Optimisation of cooling velocity gave good possibilities to decrease the cooling time and achieve good praline quality. A two-step cooling has been suggested as an energy effective alternative to perform the cooling step.

The results showed a clear difference between the different samples and the samples with highest resistance against fat bloom was those cooled at 7°C with an air velocity of 1 m/s (. In general, slower air velocity (1 m/s) together with lower cooling temperature (7°C or -10°C) generated less fat bloom compared to higher cooling temperature (12°C) and air velocity (6 m/s). One illustrating example of this is presented in Figure 8 where the percentage of the surface covered by various shadings of bloom during storage is presented for different cooling temperatures but same air velocity (1 m/s).

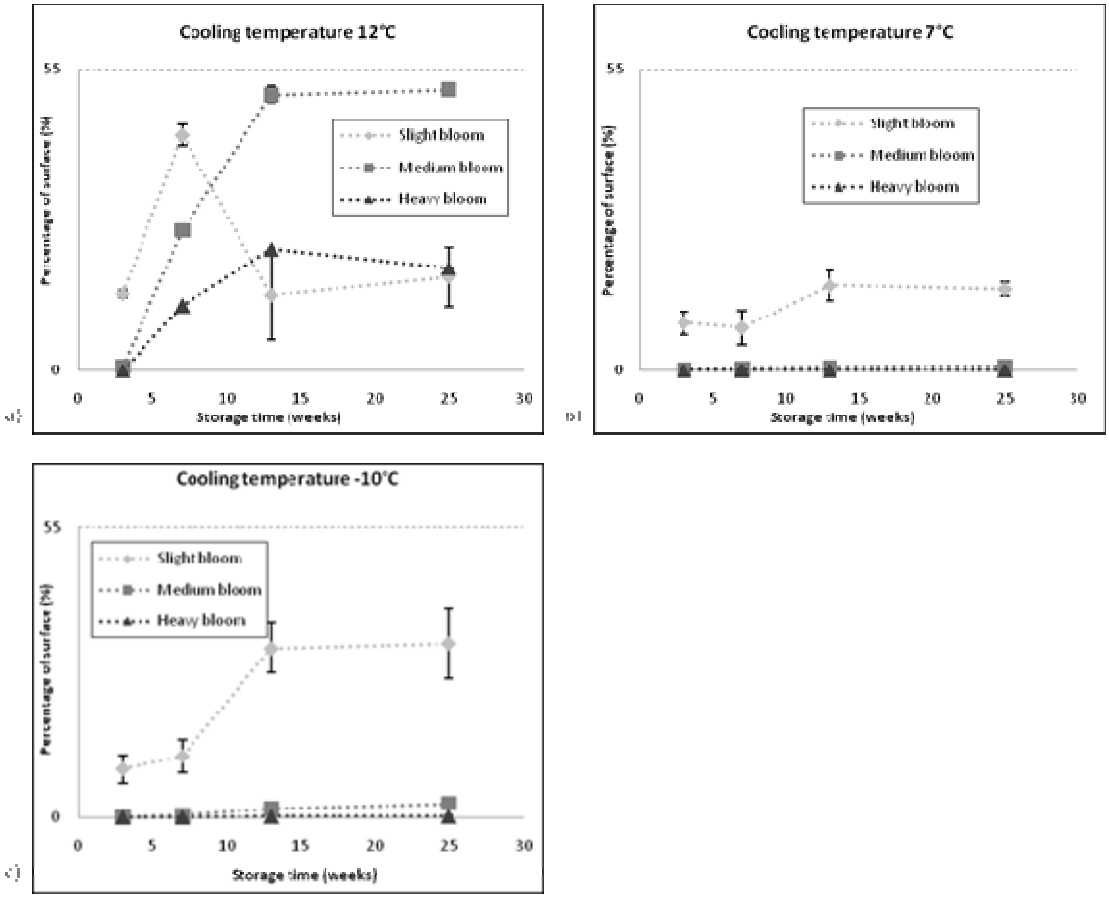

Figure 8. The percentage of the surface covered by fat bloom identified by different pre-set colour standards on the DigiEye software for pralines produced with cooling temperature of (a) 12°C., (b) 7°C and (c) -10°C and air velocity of 1m/s. Appearance of heavy bloom was clearly delayed for pralines cooled at 7°C. After 25 weeks storage no fat bloom was observed.

Milling of particles

The results obtained indicated that model pralines, stored at 23°C, with a particle size of 15 µm undergo a faster fat migration from filling to shell and thus a higher development of fat bloom, than model pralines with a particle size of 20 or 30 µm..

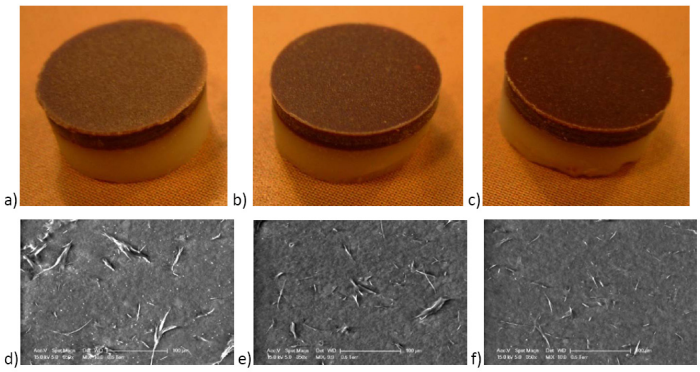

Figure 9. Photos (a-c) and SEM micrographs (d-f) of model pralines made with chocolate with particle sizes, (a,d) < 15 µm, (b, e) < 20 µm and (c,f) < 30 µm after storage for 6 weeks at 23°C. More bloom is observed in pralines made with chocolate containing particle size lower that 15 µm.

Combined results from the project were integrated in the manufacture of pralines

The results obtained in the project were integrated in the manufacture of pralines. The improvement was carried out on two levels: tempering (seed tempering instead of conventional or no tempering) and thermal post-treatments (application of low- or high-temperature treatments), following the conventional production process (table 1). The conventional moulding was chosen because the products made with this process showed better resistance to fat bloom than frozen cone and one shot moulding.

Table 1. Description of the improved pralines

Name	**Tempering shell**	**Tempering filling**	**Moulding**	**Post-treatment**
Reference	Conventional		Conventional	
Improved 1	Seeding	Seeding	Conventional	1 week at -18°C
Improved 2	Seeding	Seeding	Conventional	1 hour at 28°C

The results showed that:

- Seeding of both the chocolate and the filling retards triolein migration to the chocolate surface of pralines compared to conventional tempering
- A thermal post-treatment at 28°C was able to increased shelf-life by 8 weeks when storing the products at 23°C

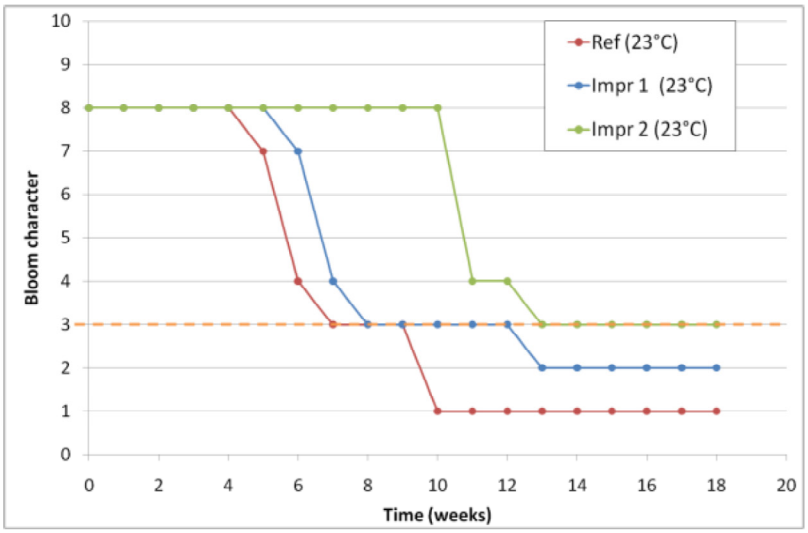

Figure 10. Visible bloom during storage time at 23°C. Rating data range from 8 (nice gloss, shiny like a perfect made dark chocolate) over 3 (considerable bloom on the whole surface, not recommended for sale) to 1 (heavy bloom, not for acceptable for sale). The shelf life of pralines is significantly extended by performing a thermal post-treatment at 30°C or by seed tempering.

Storage temperature

The storage conditions have strong influence on the shelf life of the pralines. The careful processing described above sets the stage for a shelf stable product, but inappropriate storage can ruin the most perfectly produced praline. In this project we have studied storage at 20°C and 23°C for many of the pralines produced. Frozen storage in combination with a careful thawing protocol has also been used to keep fresh pralines for a longer time. The improved storage stability and the delayed fat bloom at 20°C compared to 23°C has been well proven. We can therefore advise the producers to store their products at controlled temperature at or below 20°C. The typical time to observed fat bloom was 7 weeks at 23°C while at 20°C no significant bloom was observed after 20 weeks. Frozen storage preserves the fresh pralines very well, but the thawing must be done carefully, at different temperatures and over a period of days in order to avoid condensation on the pralines surface, which may lead to sugar bloom. Figure 11 shows the fat bloom development by scanning electron microscopy and by rating by visual observation.

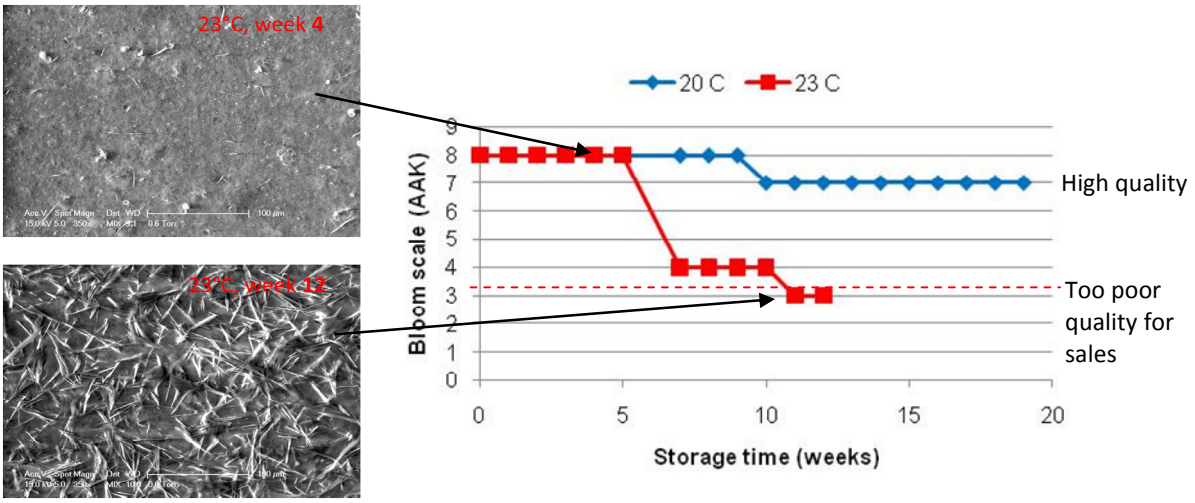

Figure 11. Rating data range from 10 (good) - 1 (bad) and the corresponding SEM micrographs showing the surface structure of a sample stored at 23°C. The data show that it is indeed the fat bloom that is observed with SEM. The quality is much better preserved by the lower storage temperature.

Filling of the chocolate shell

Routes for prevention of the fat bloom and cracking have been identified through the understanding of chocolate microstructure and how the chocolate microstructure is formed during processing, changed during storage as a consequence of storage temperature or affected by migration (oil or water) from the filling to the chocolate shell. Based on the knowledge developed regarding the development of chocolate microstructure during processing, it could be concluded that the microstructure of the cocoa butter in chocolate is crucial in order to retard fat migration and subsequent bloom. Once placed in contact with a filling the chocolate needs to have a dense structure. Experiments were conducted where pralines were filled up with nougat filling directly after the shells had solidified or after first being stored for 24 h at 15°C. A significant delay in fat bloom

was observed when the shells were left to fully solidify and develop a more dense structure before being filled (figure 12).

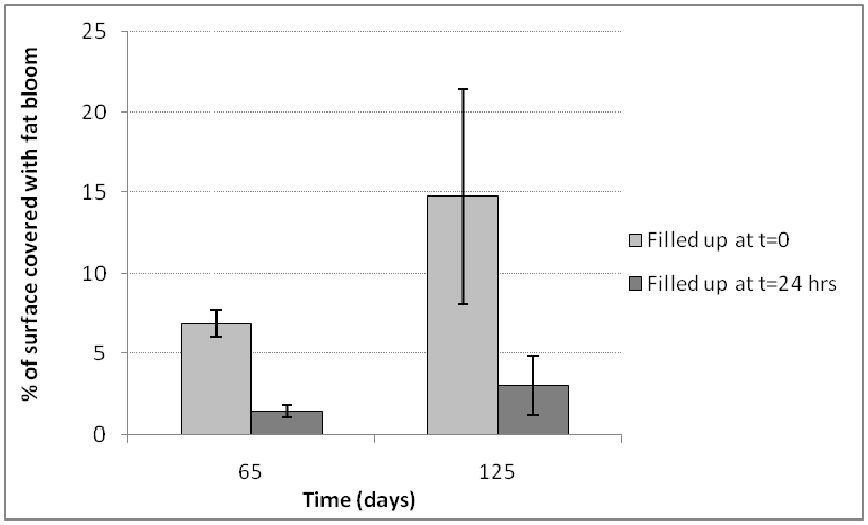

Figure 12. The percentage of the praline surface covered with fat bloom.

Filling composition – water based fillings

Water activity in the filling and the geometry of the praline proved to have significant impact on the cracking behaviour. The water activity in the filling highly influenced the occurrence of cracks and it was found that aw<0.7 is required in order to avoid the problem (figure 13). With the experimental set-up used in this work, square-shaped pralines cracked to a less extent than cone-shaped, and it can therefore be concluded that praline geometry has an effect on cracking. However, a more fundamental study is required before any general conclusion regarding cone versus square can be determined.

Modelling of crack formation (Finite Element Analysis (FEA) simulations) confirmed the experimental observations and demonstrated that cracking is influenced by the shell thickness (figure 14). Indeed, a thicker shell delays and limits the development of cracks as it provides a superior strength to resist the internal tensions. The FEA simulations have enabled the identification of a number of geometric parameters that may prevent cracking: A shell of a minimum 2mm thickness, small meniscus radius at the connection of the bottom shell with the top shell and smooth profiles with a minimum of angles.

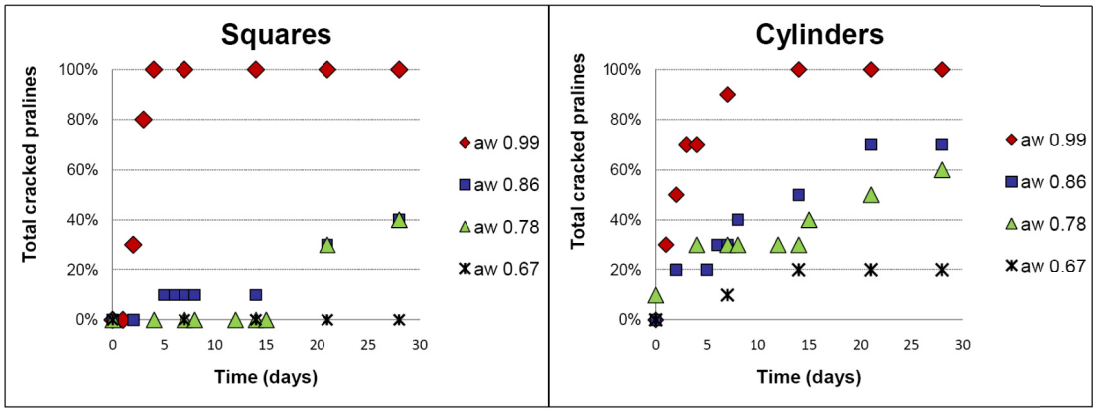

Figure 13. Percentage of cracked pralines with model filling I-IV corresponding to a water activity of 0.99 , 0.86, 0.78 and 0.67 in a) square shaped and b) cone shaped pralines.

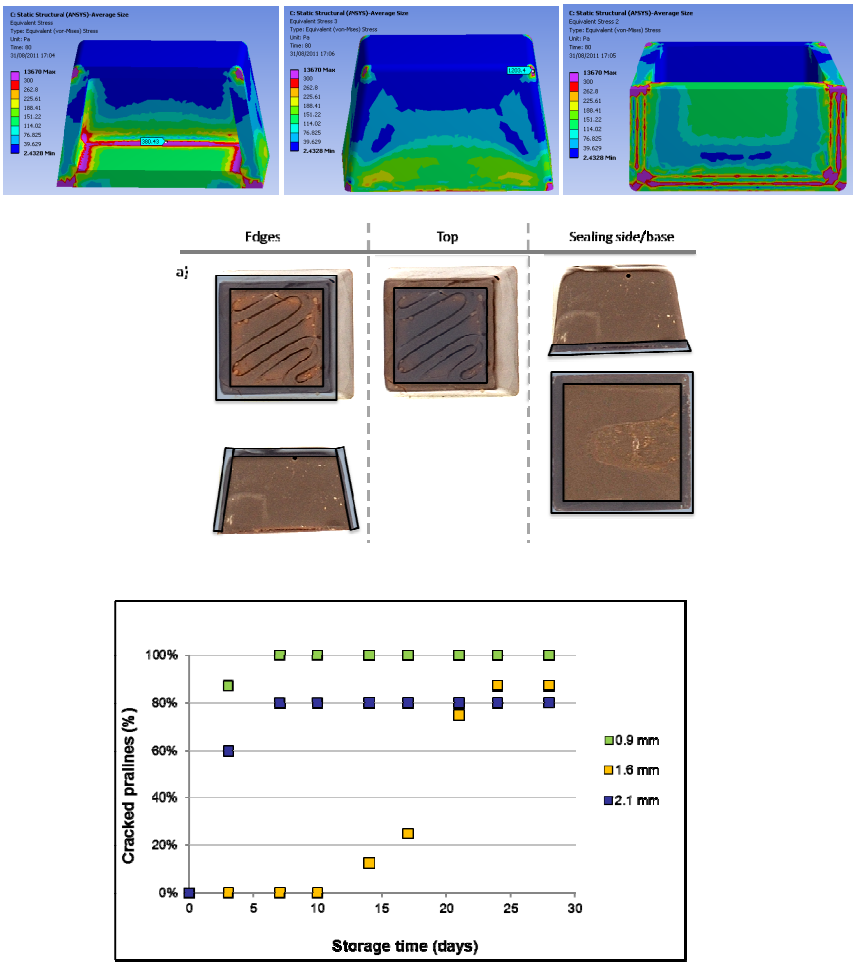

Figure 14. Simulation versus visual observation for the truncated squared praline.

New methods have been developed to understand and measure fat bloom and cracking

A variety of new methods have been developed or further developed in order to measure and evaluate chocolate structure and fat bloom. Some examples are:

- New experimental methodology to measure mechanical properties (Young´s modulus, tensile strength and tensile strain) – published in Journal of Texture Studies
- New method to measure expansion properties in dark chocolate as a function of fat and moisture migration has been developed
- A new method to detect oil migration into chocolate, based on NMR analyses was developed
- The measurement tool Detachlog – used to monitor fat crystallization during cooling - was further developed for pralines
- DigiEye method to measure fat bloom
- Profilometry methods to measure fat bloom
- Microscopy based method to follow fat crystallization and to elucidate the role of chocolate microstructure on fat bloom and cracking.
- Development of techniques to measure diffusion and migration of small molecules in the chocolate structure

Sensorial and consumer studies

Trained panels have been established in Hungary and Belgium. During the training, a list of 28 descriptors has been set up to describe quality attributes of pralines. Consumer attitudes have been studied in Hungary, using the focus group technique. It was shown that *product choice* and *purchasing frequency* depended on the purpose of the purchase. The most important factors for own consumption of pralines were flavour, brand and price. When the pralines are given as a gift, the important parameters are packaging, price and brand.

Consumer acceptance to bloom has been clarified. Pralines for the consumer studies performed in Belgium and Hungary have been produced at Guylian in Ghent, Belgium, and Szamos in Budapest, Hungary. An online survey was conducted to research 400 people in both Belgium and Hungary. In this survey a lot of information was gathered for segmentation of the consumers and to find similarities and differences between both countries. As a second step, an experiment was set up where 100 consumers were selected out of the 400 respondents of the on-line survey to taste 12 samples over three sessions. In these sessions, the consumers evaluated the samples on appearance and more in detail cracking and blooming, aroma, flavour and texture. The main outcomes from the sensorial evaluation and consumer studies were the following:

- Results showed differences between countries in terms of preferences. Belgian consumers did not like the pralines with alcoholic filling, while Hungarian consumers found them appealing. Overall we can conclude that flavour and texture had a major effect on liking, but the perception of ‘too weak’ or ‘too strong’ levels can differ by country.
- The perception and acceptance of product defects differed by country. Hungarian consumers were more willing to accept blooming than Belgian consumers, whereas Belgian consumers were more tolerant of product cracking. In Belgium the heavy

bloom and cracking as a product defect was less acceptable for the heavy users. In Hungary the heavily bloomed and cracked samples received the lowest acceptance level with people with low consumption frequency.

- Blooming had a pronounced effect on liking and resulted in lower levels of aroma and flavour intensity, and perceived hardness. On the other hand, in some cases, positive taste aspects emerged even if the product was bloomed: pralines that were bloomed but with high levels of nut filling (more intense nut flavour) received significantly higher scores in Hungary for taste and overall preference than samples which were less bloomed but had a weaker nut flavour.

To understand consumers' responses, the degree of liking was also analysed by preference mapping. The extended internal preference map gave an overall picture about the praline samples and the sensory characteristics that drove consumer preferences.

A house of quality

A House of Quality matrix was built for chocolate pralines. The house of quality contains two important parts:

- Sensory analysis: sensory relations of the model pralines
- Consumer test: consumer demand and preference

This useful tool can be used by SMEs to detect the problems with their products in relation to in-house products or competitor products.

An example of the results obtained is shown in figure 15, for two pralines where it is clearly seen that flavor is the most important customer preference. From the competitive analysis it is seen that the main differences between the two pralines are found in appearance and texture but to a less extent in flavor and aroma.

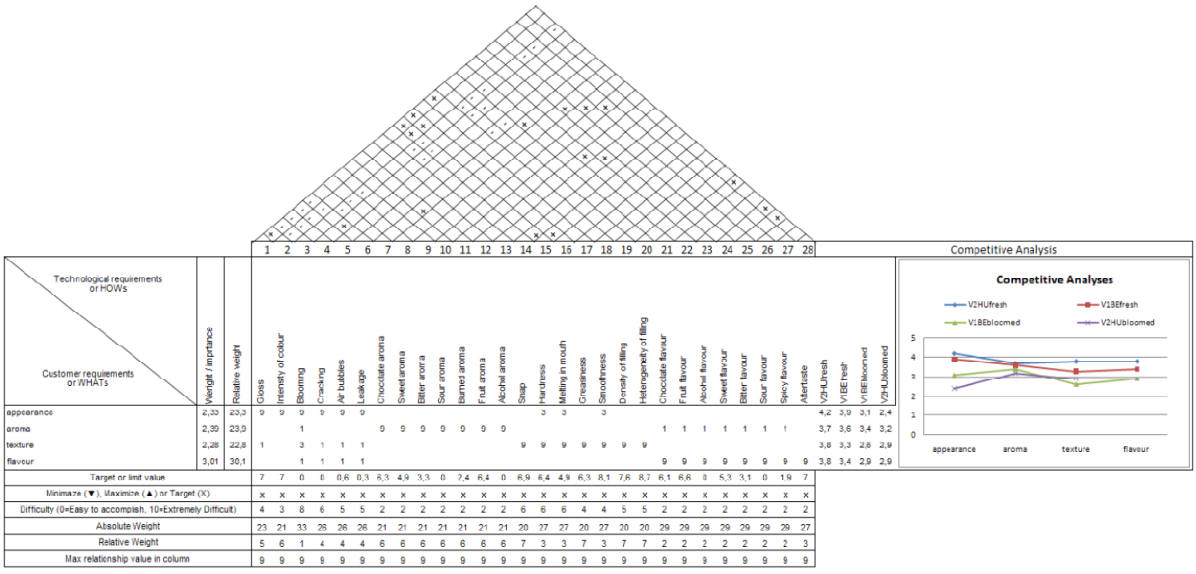

Figure 15. House of quality for two pralines

Training and Demonstration towards SMEs

Training and demonstrations of solutions to prevent fat bloom and cracking in pralines have been extensively done in the Propraline project. They have included:

- Two courses carried out respectively in 3 and 4 locations in Europe
- Three demonstrations with each of the SMEs participating in the project
- 8 open demonstrations in 4 European locations
- Brokerage event

Intensive training

Two courses have been organised in the ProPraline project. The first course was organised just before the month 18 and focused on existing knowledge about fat bloom and cracking. The courses were conducted in Sweden in May 2010 (organised by SIK and Chokofa), Czech Republic in May 2010 (organized by FFDI) and in Belgium in June 2010 (organized by GHU and Choprabisco). Visits to labs and demonstrations of equipment such as: Multhiterm and detachlog were performed after the courses. A total of 120 people participated on the 1st training course. Most of the participants were satisfied with the course but there were some differences in opinion between countries. The training met the expectations of most of the participants in Czech Republic; on the other hand the number of satisfied participants was lower in Belgium.

Figure 15. Demonstration activities carried out in Sweden (Niklas Lorén, SIK; William Hasselman, ETH; Yaungtong Zeng, Buhler and Katarina Slettengren, SIK – showing some of the process solutions)

The 2nd ProPraline training course was organised together with 8 demonstrations (see below). They were organised in 4 countries; Sweden (organized by SIK and Chokofa), Czech Republic (organized by FFDI), Switzerland (organized by ETH and Buhler) and Belgium (organized by GHU and Choprabisco) in May/ June 2011. Altogether 125 people participated in the training course and 106 on the demonstrations. Most of the participants were SME or non-SME chocolate/praline producers but this event attracted people from other area as well, for example from research institutes or universities. Most of the participants scored that the course and the demonstration totally or almost met their expectation, they were satisfied / almost satisfied with their own achievement and involvement and the integrated events provided added value for their professional activities.

Demonstration activities with the SMEs participating in the project

- *Demonstration activity Ganache/SIK*

Five different praline recipes with decreasing water activity were produced at partner Ganache after SIK has been helping to improve the filling recipe. The original filling with very high water activity was compared with new recipes with lower water activities. The taste, consistency and mouthfeel were important to be maintained. The fillings were evaluated during production by tasting, consistency, filling ability and water activity measurements. The produced pralines were then stored at SIK at approximately 20 degrees. Their tendencies for cracking were evaluated using DigiEye during the storage time (figure 16). The new recipe clearly extended the shelf-life of pralines. No cracking was observed up to 60 days in pralines filled with recipe 5 (aw <0.7)

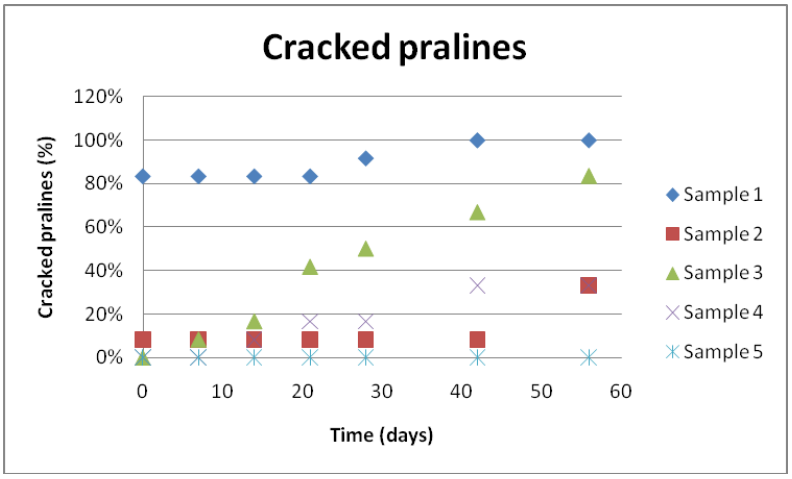

Figure 16. Amount of pralines that cracked for each filling (sample) up to 56 days of storage.

- *Demonstration with Szamos/ETH*

SZAMOS selected 2 pralines for improvement of fat bloom and cracking. ETH spent almost one week at SZA assessing their praline production with the following points of improvement in order to reduce bloom development of pralines. The improvements included actions regarding:

- Temper assessment
- Tempermeter
- Temper operation
- Temperature measurements
- Chocolate recipe
- Praline handling
- Storage cooling

- *Demonstration with Guylian/Ghent*

Two products which showed problems in terms of fat bloom were selected as demonstration pralines. Several thermal treatments were tested for their possibility to retard oil migration and fat bloom development. The production and the application of these treatments took place at Guylian, whereas the characterization during storage was carried out by Ghent University. High performance liquid chromatography (HPLC) was used to study the migration from the filling to the shell and the formation of fat bloom crystals at the surface was studied using scanning electron microscopy (SEM). Several thermal treatments reduced the formation of fat bloom on the surface of the pralines, which was an interesting and useful result for Guylian. Shelf-life could be significantly improved by thermal treatment at 30°C.

Demonstrations open to European SMEs

The demonstrations for the European community of SMEs were conducted by the ProPraline partners in connection with the four training courses on:

- May 5, 2011, in Gothenburg, Sweden,
- May 11, 2011, in Prague, Czech Republic
- June 1, 2011, in Zürich, Switzerland
- June 8, 2011, in Ghent, Belgium.

The 8 demonstrations covered the following topics:

- *Effect of seeding/tempering vs. non-tempering , Lina Svanberg, SIK, Sweden*
  The project has shown that it is important that the chocolate of a praline, but also cocoa butter based praline fillings, are subjected to a process that ensures that the fat phase crystallizes in a stable form. The demonstration shows the difference on oil migration from the centre to the coating and the effect of the traditional tempering processes or a seeding process on the appearance of the pralines after 3 months

- *Effect of different cooling regimes, temperature/time, William Hanselmann, ETH, Switzerland*
  The demonstration focused on one process parameter in the process of producing pralines – the cooling process. Using a DetachLog (a measurement tool logging the cooling process of a chocolate product in a mould) the demonstration shows the effect of different cooling regimes in a controlled laboratory environment and how the DetachLog may be used as a control parameter of the cooling process in an industrial environment.

- *Effect of water activity in water based fillings , Katarina Slettengren, SIK, Sweden*
  One of the main problems addressed in the project was the problem of macro cracks in pralines. The project has shown that this problem is mainly related to pralines with a water based filling (fruit and / or alcohol based syrups, marzipan etc.) The demonstration introduced the concept of water activity, demonstrated that a high (above a_w 0.8)water activity increased the risk of cracking and sugar bloom significantly and demonstrated formulation tactics to decrease the water activity of a water based filling without affecting the sensory properties of the filling.

- *Effect of storage temperature on pralines , Hanna Dahlenborg, YKI, Sweden*
  Even though chocolate is a microbiologically stable product that does not require specific storage temperature it has been shown that the storage temperature of pralines has an effect on the shelf life. The demonstration shows the effect of storing pralines at different "ambient" temperature, in this case 20 ˚C and 23 ˚C, after different process parameters as described in some of the other demonstrations. The conclusion is that even small differences, as between 20 ˚C and 23 ˚C, have a major impact on the shelf life of a praline.

- *Reduction of fat bloom by using thermal post-treatments prior to storage, Claudia Delbaere, Ghent University, Belgium*
  One conclusion of the project is that the process of making a chocolate praline is not finalized directly after the cooling process – but that the thermal treatment during the first hours / day after production has a significant impact on the quality and shelf life of the final product. In this demonstration the effect on quality and shelf life of a relative short (hours) treatment at a high temperatures (28 – 30˚ C) or slightly longer (days) treatment at low temperatures (4˚ C and -18˚ C is shown. The conclusion is that a short temperature treatment at 28 – 30˚ C or a few days at low positive or sub-zero temperature prolongs the shelf life of the pralines.

- *Effects of sensory attributes on the liking of pralines, Adrienn Hegyi & Tünde Kuti, Campden BRI, Hungary*
  Different consumer research methods used in the ProPraline project was demonstrated and a comparison of preference towards chocolate pralines in Belgium and Hungary was presented. The effect of individual sensory attributes on the liking and acceptance of product defects were also presented and the differences between Belgium and Hungary were highlighted. The demonstration showed examples of how to identify product / attribute deficiencies and emphasized that the flavour and texture need to be prioritised.

- *Effect of bloom inhibiting filling fats , Bjarne Juul / Karsten Nielsen, AAK, Denmark*
  Specific triglycerides are known to prevent fat bloom and thereby to improve the shelf life of pralines. Different strategies on how to introduce these vegetable fats into the praline was demonstrated. The conclusion is that these vegetable fats may be introduced directly into the chocolate coating, in the filling, or, to minimize the sensory properties of an existing product, as a very thin barrier between the filling and the coating.

- *Cocoa butter quality analysis with MultiTherm TC-Buhler Crystallization Index (BCITM) , Yuantong Zeng, Buhler AG, Switzerland*
  A major conclusion of the project is that process control is of utmost importance and that especially the quality of the tempering process is important. Equipment that determines the quality of the tempering process in about 5 minutes was demonstrated. Using this method the praline producer can assure that the chocolate or the cocoa butter based filling is properly tempered and thereby predict the shelf life. The same equipment may also be used to measure the cooling curve of a cocoa butter or a chocolate mass and thereby indicate its ability to

crystallize in the process. A new way of crystallizing chocolate and cocoa butter based fillings using seeding technology to ensure long shelf life of pralines was also demonstrated.

In addition, a brokerage event was organized, where the companies had the chance to have a one-to-one discussion with one of the research performers to discuss their fat bloom and cracking related problems.

Figure 16. Prof Windhab meeting one of the companies during the brokerage event carried out in Sweden

4. Potential impact (including the socio-economic impact and the wider societal implications of the project so far)

Propraline aims to improve the competitiveness and innovation potential of the European SMEs producing chocolate pralines by *developing knowledge and technical solutions to improve quality and extend the shelf-life of their products*.

Figure 17 outlines direct benefits arising from the ProPraline project activities.

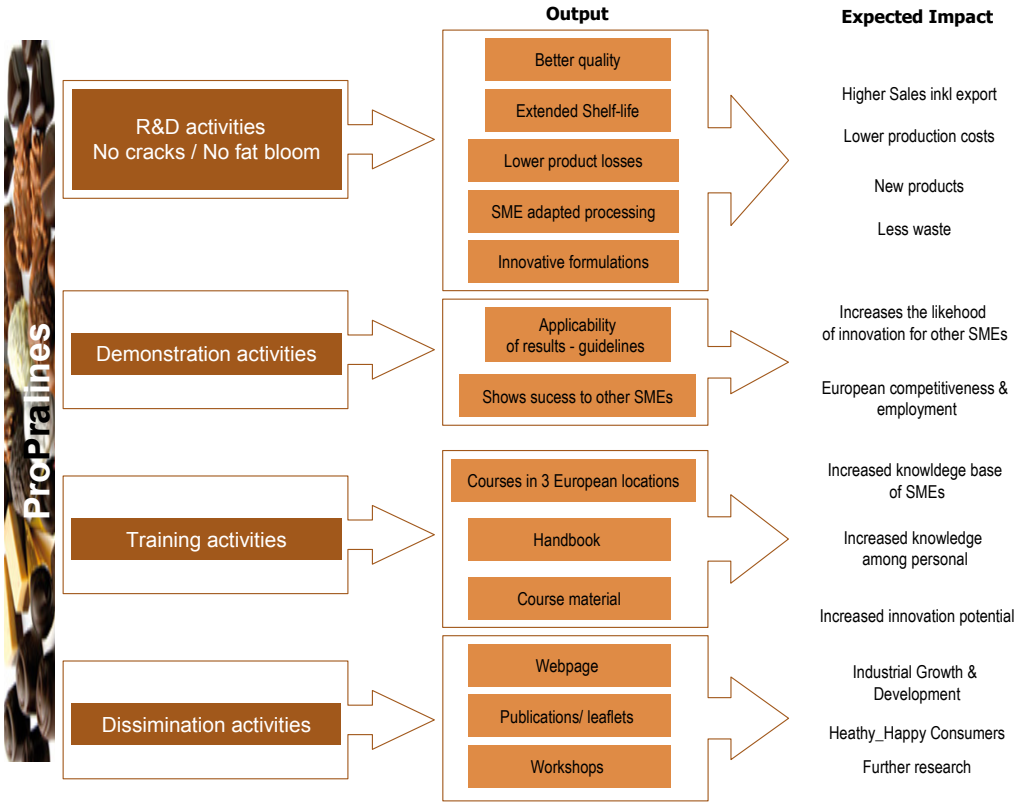

Figure 17. Outline of the main outputs of Propraline and expected impact

- *Better quality pralines with extended shelf-life has impact on SME competitiveness*

Manufacturers and retailers will benefit from the ProPraline project through improved quality of the chocolate sold/supplied. The solutions developed in the project to reduce fat bloom and cracking will enable European chocolate manufacturers to continue to lead this industry and maintain Europe's global leading position in terms of quality products. The increase of shelf-life that can be achieved is estimated to give an increased sale of chocolate pralines by 5-10%, which will have a significant impact on employment and future development of this industry in Europe.

Extended shelf-life of praline products will foster export of such products outside Europe, consequently increasing the European competitiveness. ProPraline results have shown that the developed solutions can extend the shelf-life of pralines from 3 to 8 weeks when the product is stored at 23°C, and up to several months when the product is stored at 20°C, which allow increasing export.

- *Advantage for SMEs participating*

Three SMEs of different size (Guylian with 250 employees; Szamos Marcipán with 240 employees and Ganache with 3) were involved in the research & development activities, as well as demonstrations. The improved production methods were easy and rapid to implement at SMEs and now they have products of better quality. Ganache is now planning to export their pralines to US.

- *SME associations will benefit from improved branch competitiveness*

The AGs have performed active dissemination and technology transfer targeted on SMEs, where the scientific results are translated into practical guidelines for day-to-day praline manufacture. The two presentations at CAOBISCO had an important role in disseminating the knowledge to all Europe. The Book of Methods, the course material, and the Handbook are examples of outputs of the project that will improve the competitiveness of the sector and consequently will benefit the role of SME associations in serving their members. Furthermore, a thorough understanding of the factors governing product quality and the new methods developed will improve and speed up the development process for novel products. The improved production methods have been adjusted to be easy and rapid to implement at SMEs using existing equipment, and hence time-to-market for improved products is anticipated to be short.

- *Europe will benefit in addition to the partners*

Europe's chocolate industry is world leading and regarded as a heritage. It is important to maintain the standards through innovation and constant development to ensure that we are at the forefront of manufacture, hence the need to forge industrial-academic collaborations. Five PhDs have been educated within chocolate research and will therefore contribute to increased personal resources and competence in the sector.

- *ProPralines has advanced the State of the art*

The advancements made during the ProPraline project with regard to the understanding of how and under what conditions fat bloom and cracking of chocolate occurs, and the new methodology developed has significantly contributed to improving the research capacity in an important sector in Europe. The streamlining of research activities focused on development of techniques/methods suitable for SMEs, showed the possibilities of performing high quality research followed by converting the knowledge obtained into business ideas and specific industrial applications. The project has also extended the participants' network in science and application, and strengthened the SMEs' links with the research performers.

Quality	Europe's chocolate producers are keen to reduce the amount of aesthetically poor chocolate (fat bloom & cracking) as it detracts from their products which can lead to a loss in confidence and ultimately sales revenue. Europe's SME chocolate industry currently has a total turnover of €10 billion annually.
Cost	15% amount of rework or waste in the form of raw materials and production costs is associated with aesthetically poor chocolate (fat bloom & cracking). The solutions developed in ProPraline will enable end-users to refine their production techniques based on the knowledge gained to increase their productivity . If ProPraline reduces waste or rework by 10% this will lead to considerable savings.
Performance	The ability to produce high-quality chocolate with aesthetic consistency will promote Europe's chocolate producers and help maintain their high industry standard. The 10% savings from waste reduction are seen as an improvement in productivity and therefore manufacturing performance.
Flexibility	It is expected that the knowledge gained from the ProPraline project will not only be applied to pralines but be extended to investigate a number of other confectionary products. It is also expected that the techniques and processes developed during the project will be used to enable/encourage Europe's chocolate manufacturers to develop new products with minimised risk of rework and losses.
Environment	Less pralines rejected by the consumers leads to better utilisation of raw materials and therefore less environmental impact.

5. Dissemination of results

Project information

An external project website (www.sik.se/propraline) has been updated with the major results from the ProPraline project that can be freely downloaded. An overview of the opening page of the website can be seen below:

In addition, information about ProPraline was presented by *Choprabisco at::*

- Choprabisco performed a testimonial presentation about the ProPraline project at a seminar on "FP7 Food, Biotechnology & Health 2010 Calls for proposals" organised by the Brussels Enterprise Europe Network, 24/09/09
- Choprabisco explained ProPraline research during a meeting between artisanal Norwegian and Belgian chocolatiers organised by Enterprise Europe Network on 23/09/10
- Chokofa held a presentation of ProPraline at a seminar on "FP7 Food, Biotechnology & Health 2010 calls" organized by the Brussels Enterprise Europe Network on 29/04/09
- Chokofa presented Propraline at the EUROPEAN AGRO-FOOD CONFERENCE in Malmö October 15 - 16, 2009 PROMOTING AND SUPPORTING ENTREPRENEURSHIP

Actions towards a wide number of SMEs

A major objective was to disseminate the results of the project to the SMEs. The Associations participating in the project had a very important role in this task by giving a slot to present the results of Propraline project in their board meetings. Specific actions included:

- Progress reports about ProPraline presented at Chokofa Board meetings
- Progress reports about ProPraline presented at Choprabisco board meetings
- Progress reports about ProPraline presented at FFDI board meetings

In addition ETH and SIK has a Chocolate network where results were also continuously presented to SMEs:

- Bi-annual Swiss chocolate meeting organized by ETH, updates and news (including results) were presented at six meetings
- Updated at the Chocolate six confectionary network organised by SIK

Furthermore:

- Two presentations of the project have been done at CAOBISCO General Assembly in September 2010 and September 2011. Caobisco is composed of 22 European industrial associations, representing the majority of chocolate producers in Europe.

15 publications have been presented in industrial magazines in English, Swedish, French and Dutch. Some examples can be found in the figure below.

Communication of scientific and technical results through conferences and journals

Dissemination of scientific and technical results to a wide audience of scientists and end-users has also been successfully achieved in ProPraline. Below is a summary of the activities:

Five Scientific Publications are already published:

- Svanberg, L., Ahrné, L., Lorén, N., and Windhab, E., 2011, Effect of Sugar, Cocoa Particles and Lecithin on Cocoa Butter Crystallisation in Seeded and Non-Seeded Chocolate Model Systems, Journal of Food Engineering 104, pp. 70-80.
- Svanberg, L., Ahrné, L., Lorén, N., and Windhab, E., 2011, Effect of pre-crystallization process and solid particle addition on microstructure in chocolate model systems, Food Research International, 44, 1339-1350.
- H Dahlenborg, A. Millqvist Fureby, B Bergenståhl, D. Kalnin (2011) Investigation of chocolate surfaces using profilometry and low vacuum scanning electron microscopy. Journal of the American Oil Chemists' Society , Volume 88 (6) Springer Journals – Jun 1, 2011 DOI information:10.1007/s11746-010-1721-8
- Svanberg, L., Ahrné, L., Lorén, N., and Windhab, E., 2011,Effect of pre-crystallisation process and solid particle addition on cocoa butter crystallisation and resulting microstructure in chocolate model systems, Proceedings – Food Science, 11th International Congress on Engineering and Food (ICEF11), Athens, Greece.
- Svanberg, L., Ahrné, L., Lorén, N., and Windhab, E., 2011, A Novel Method to Assess Mechanical Properties in Confectionery Systems during Storage, Manuscript accepted for publication in Journal of Texture Studies Aug 9.

Fifteen Oral presentations at scientific conferences:

- ISFRS 2009, 5th International Symposium on Food Rheology and Structure, Zurich
- Interpraline 2009, December 2009
- 8th Euro Fed Lipid Congress Graz, Austria, May 2010 (2 presentations)
- *Schokotechnik 2010*, December 2010: 3 oral presentations
- ICEF11 Greece, May 2011
- 101th AOCS Meeting and Expo. May 2010, Arizona, United States
- *IFT, New Orelans, July 2011*
- *9th EuroFed Lipid 2011*, Rotterdam, The Netherlands, September 2011
- InterPore 2011, 3rd International Conference on Porous Media, 29-31 March 2011, Bordeaux, France
- Food Colloids 2010. On the road… from food colloids to consumers, Granada
- Food Factory for the Future, Gothenburg, Sweden
- MATÉRIAUX 2010, Nantes
- Forum for Environmental Research –Food, Uppsala, Sweden.
- Advanced Light Microscopy Symposium, 22-24 September 2010, Ghent, Belgium.
- Material Seminar, Chalmers Areas of Advance, Gothenburg, Sweden

Twenty-five Posters presented at scientific conferences:

- IUFOST, August 2010, South Africa

- 8 poster presentation at Schokotechnik /Chocolate Technology International Conference

- EFFoST- The European Federation of Food Science and Technology, 09-12 November 2010, Dublin, Ireland
- *EuroSense 2010*
- *Food Factory, Gothenburg, Sweden*
- *Pangborn 2011*
- *EuroFed Lipid 2011*
- *Formula VI. Formulations for the future* - from fundamentals to processing, Stockholm
- MATÉRIAUX 2010, Nantes

Twelve MSc / BSc Thesis have been performed

Galler, M., 2011, *Solidification of chocolate using novel in-line measuring techniques and its relation to product shelf-life*, MSc Thesis, Eth Zurich, Switzerland.

Hellmansson, M., 2010, *Effect of filling on the mechanical properties in chocolate*,MSc Thesis,Chalmers University of Technology, Gothenburg, Sweden.

Marchal, E., 2011, *Impactof pre-crystallization process on chocolate solidification behavior,* MSc Thesis, Agrosup Dijon, France.

Möller, M., 2011, *Effect of pre-crystallization process on structure formation during cooling in dark chocolate,* BSc Thesis, Hochschule Osnabruck, Germany.

Nestius Svensson, L., 2011, *Novel tools to monitor the solidification process in chocolate*, MSc Thesis,Chalmers University of Technology, Gothenburg, Sweden.

San Choi, A., 2010, *Evaluation of fat bloom and cracking in chocolate by digital color imaging system*,Chalmers University of Technology, Gothenburg, Sweden.

Sanchez-Lopez, C., 2010, *Expansion in confectionery systems as a function of migration from filling*, MSc Thesis, Agrosup Dijon, France.

Slettengren, K., 2010, *Crack formation in chocolate pralines,* MSc Thesis, Chalmers University of Technology, Gothenburg, Sweden.

Nilsson, J. 2011, Evaluation of chocolate microstructure. MSc Thesis, Chalmers University of Technology, Gothenburg, Sweden.

Amanda Rosberg Englund (2011) The influence of emulsifiers on fat bloom development on chocolate, MSc Thesis, Lund University (LTH), Lund, Sweden

Verstringe, S., 2010, *The effect of various post-treatments on the crystallization behaviour, microstructure and fat bloom development in complex chocolate systems*, MSc Thesis, Ghent University, Belgium.

Tas, K., 2011, *The influence of thermal treatments on oil migration and fat bloom development in filled chocolates,* MSc Thesis, Ghent University, Belgium.

Five PhD students were involved in the ProPraline project and will include results from the project into their PhD thesis:

- Lina Svanberg, 2012. Structure-process relations in seeded and non-seeded confectionary systems. PhD Thesis, ETH Zurich. (in preparation, tentative date of finish the PhD March 2012)
- Hanna Dahlenborg "Fat bloom development in chocolate - routes for investigation and effects of microstructure" (in preparation, tentative date of finish the PhD: 2012)
- Claudia Delbaere: "Crystallization behaviour, microstructure and sensory properties in complex chocolate systems" (In preparation, tentative date of finishing the PhD: June 2013)
- Sara De Pelsmaeker: "Including Sensory Analysis in Conjoint Analysis as a tool for new product development and the improvement of existing products. Investigating the influence of taste or tasting of the product has on the purchase intention." (In preparation, tentative date of finishing the PhD: October 2013)
- Daniel Ehlers, Process controlled crystallization behaviour and structure development of chocolate fat systems (In preparation, tentative date of finishing the PhD: 2012)

More than 10 publications are planned for the coming years.

6. Exploitation of results

Questions in relation to Intellectual Property Rights (IPR) were discussed in all meetings of the PMC with the SME associations holding the right to take final decisions. The results are jointly owned by the three national associations Belgian Federation Choprabisco (BEC), CHOKOFA (SWC) and Federation of the Food and Drink Industries of the Czech Republic (FFDI).

It has been considered that AGs could sell the four books developed in the project (Book of Methods, Handbook, Routes to prevent fat bloom and cracking and course material) to the companies that were not their members. However, the Associations have realised that they do not have structures to do it and therefore they have decided to make all the results of the project available to all SMEs.

A business idea - ChocoWinS - was developed within the ProPraline project. The idea have competed in the regional Swedish Venture cup and got a 3rd prize and a place on the Swedish final. The AGs were asked to drive the future company but they do not have resources or competence to do it. They give the RTDs involved (ETH and SIK) the possibility to go ahead with the idea and the AGs will be in the advisory board. ETH is now planning to go ahead with the idea.

The main exploitable knowledge developed in the project can be found in the following tables.

Exploitable knowledge (description)	Exploitable product(s) or method(s)	Timetable for commercial use	Patents or Other IPR protection	Owner (O) & Other Beneficiary(s) (OB) involved
Crystallisation can be controlled by seed tempering. This process has been adjusted to suit SMEs.	Fat seeds and know-how	2012	Under discussion	Owners: Chokofa, Choprabisco, FFDI OB: ETH, Buhler, SIK
Assessment of early bloom development can be achieved by measurement of surface roughness using profilometry	Methodology and Know-how	2011	Not applicable/available for implementation	O: Chokofa, Choprabisco, FFDI OB:YKI
Fat migration profiles in chocolate/chocolate pralines using brominated TAGs as tracer and ESEM-EDS for detection and correlation to oil migration detected by HPLC	Methodology and know-how	2011	Not applicable/available for implementation	O: Chokofa, Choprabisco, FFDI OB: YKI,GHU
Equipment and methodology to monitor crystallization in process during cooling	DetachLog II	2011	Under discussion	O: Chokofa, Choprabisco, FFDI OB: ETH
Assessment of structure density can be done by FRAP methodology, which measures the mobility of small molecules in a structure	methodology and know-how	2011	Not applicable/ available as service	O: Chokofa, Choprabisco, FFDI OB: SIK
A new methodology was developed to measure contraction in chocolate	Methodology and Know-how	2011	Not applicable	O: Chokofa, Choprabisco, FFDI OB: SIK
Methodology to evaluate sensorial preferences in chocolate products	Know how	2011	Not applicable	O: Chokofa, Choprabisco, FFDI OB: CCH, GHU
Knowledge about the preferences and acceptances of Hungarian and Belgium consumers	Methodology & Know-how	2011	Not applicable	O: Chokofa, Choprabisco, FFDI OP: CCH, GHU
NMR method to measure fat migration	Methodology and Know-how	2011	Not applicable/available for	O: Chokofa, Choprabisco, FFDI

			implementation	OP: GHU
Methodology to measure mechanical properties of chocolate	Methodology and know-how	2011	No applicable/ available for implementation	O: Chokofa, Choprabisco, FFDI OB: SIK
Optimisation of the cooling process towards better praline quality	Know-how	2011	Not applicable/available for implementation	O: Chokofa, Choprabisco, FFDI OB: ETH
Control of water activity in the fillings as a way to reduce cracking in pralines	Know-how	2011	Not applicable/available for implementation	O: Chokofa, Choprabisco, FFDI OB: SIK
Book of methods to assess praline quality	Book	2011	Not applicable/available for SMEs	O: Chokofa, Choprabisco, FFDI OB: all
Handbook to manufacture pralines without fat bloom and cracking	Book	2011	Not applicable	O: Chokofa, Choprabisco, FFDI OB: all
Routes to prevent fat bloom and cracking	Book	2011	Not applicable	O: Chokofa, Choprabisco, FFDI OB: SIK, ETH, YKI, GHU, PERA, AAK, BUL
Course material containing solutions to improve fat bloom and cracking	book	2011	Not applicable	O: Chokofa, Choprabisco, FFDI OB: all
Post-treatments can make chocolate more resistant towards oil migration	know-how	2011	Not applicable	O: Chokofa, Choprabisco, FFDI OB: GHU
Particle size of chocolate have an effect on fat bloom	know-how	2011	not applicable	O: Chokofa, Choprabisco, FFDI OB:YKI
Moulding technologies (conventional moulding, frozen cone moulding and one-shot moulding) have effect on fat bloom	know-how	2011	not applicable	O: Chokofa, Choprabisco, FFDI OB:ETH
House of quality is a useful tool for SMEs to detect the problems with their products in relation to in-house products or competitor products.	know-how	2011	not applicable	O: Chokofa, Choprabisco, FFDI OP:GHU, CCH

7. Website and contact details.

Public website www.sik.se/propraline

Contact details

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