

## Crystallization: practices and future developments

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The fractional crystallization process is mainly based on the ability of fats to produce crystals. On an industrial scale, crystals can be obtained according to three main technologies: detergent fractionation, solvent fractionation and dry fractionation. In 1905, Lanza patented the adding of a detergent to “wet” the crystals which are consequently transferred in the aqueous phase; the mixture is then easily separated by centrifugation (Lipofrac concept). In solvent fractionation, the fat is dissolved in a solvent and the dilute solution is cooled to initiate the crystallization of the highest melting triacylglycerols. Crystals are consequently separated by filtration and the fractions are recovered by solvent evaporation. Dry fractionation is the simplest and cheapest fractional crystallization process qualified as “natural” or “green” technology. In contrast to detergent or solvent fractionation, dry fractionation does not require any additional substance. It simply consists in a controlled crystallization of the melted oil, conducted according to a specific cooling program followed by separation of solid from liquid fraction. Due to the continuous developments of the dry fractionation process, a whole variety of products normally produced by solvent fractionation can now be obtained with a high degree of selectivity with dry fractionation (multi-stage).

The dry fractionation process consists of two steps: the crystallization stage that produces solid crystals in a liquid matrix and the separation stage where the liquid phase is separated from the crystals. Several cooling modes are possible that will mainly depend on the supplier of the dry fractionation technology. Those differences in the cooling scheme result in technological variations essentially expressed in the geometry of the cooling surfaces and in the type of agitation.

The efficiency of dry fractionation is greatly determined by the quality of the crystallization: the best separator fed with bad crystals may become a nightmare. At the end of the crystallization process, triacylglycerols are distributed in three locations: 1) as solids in the form of co-crystals, 2) as liquids, and 3) as liquids physically trapped on the surface of the crystals. This distribution is closely linked to the cooling mode. Consequently, different separation equipments (vacuum systems, membrane filter-presses, centrifuges) are available in accordance with the product specifications and with the efficiency of the separation required.

Two applicative cases are selected to illustrate the central role of the crystallization step in a dry fractionation operation. The first case proves the benefits of a slow cooling time (where the crystallization takes place in conditions close to equilibrium) on the production of “top quality” fractions (Hard Palm Mid Fraction). The second case proves that slow cooling processes combined with seeding technology (induction of crystallization) become a necessity to reduce cycle times of unsaturated oils and assure selected end products.

For economic and ecological reasons, dry fractionation has acquired a place of choice in the oils and fats industry. A high degree of selectivity (close to solvent fractionation) can be achieved if sufficient attention is turned to the crystallization stage. In the low trans world, this technology is now a solution impossible to circumvent.