Melting and polymorphic behavior of binary and ternary blends made of palm oil or its fractions and other fats.

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Introduction

Studies of phase behavior help to provide a better understanding of the ways in which fat blends interact, an important aspect since the large-scale industrial production of shortenings and other fat-containing products often requires blending of lipids from many different sources.

Palm Oil is without doubt the most fractionated oil. Multi-step dry fractionation gives rise to soft fractions (Oleins, Superoleins and Topoleins) that are used as salad, cooking and frying oils, and to harder fractions (Stearins and Palm Mid Fractions) finding applications in frying fats, margarines, shortenings and speciality fats. Anydrous milk fat (AMF) is also widely fractionated.

This is why those oils and their fractions have been selected as model fats for this basic study.

Objectives

GOAL: The objective of this work is to study physical characteristics and interactions that occur in binary systems models made of oils and fats commonly used in European shortenings (for ex. palm oil). Physical properties such as solid fat content (SFC) by pulsed nuclear magnetic resonance (pNMR), melting profile by differential scanning calorimetry (DSC) and polymorphism by powder X-ray diffraction analysis (XRD) under dynamic conditions and after a tempering procedure are studied. Isosolid diagrams are drawn based on pNMR data. Dynamic phase behavior diagrams of the binary systems are established from DSC and XRD data.

Methods:

• DSC :

• Powder X-Ray diffraction :

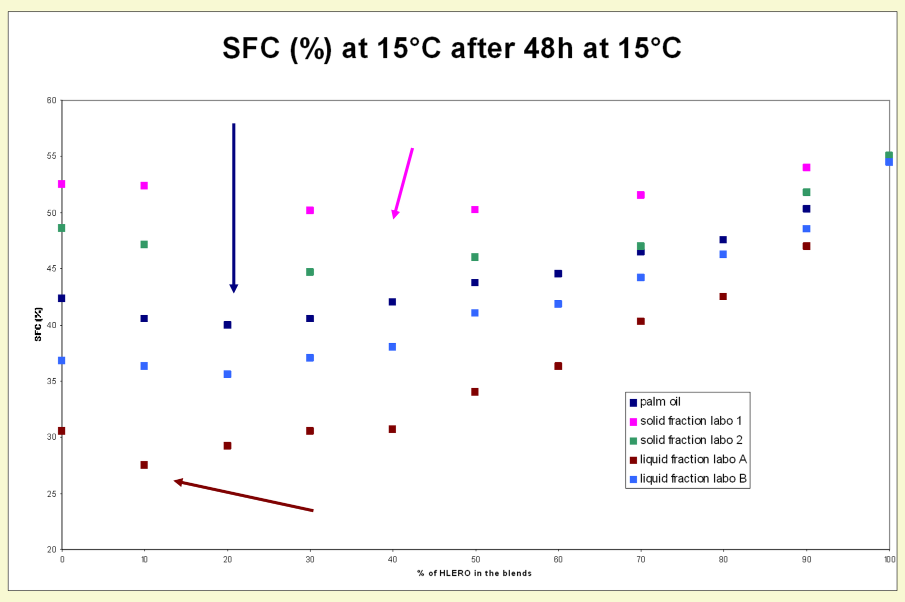
Melting, Cooling., Heating 5 C/min.

• NMR:

AOCS Method
IUPAC Method

Particular method after tempering

Palm oil or some of its fractions and HLERO : Tempered conditions (48h at 15 C)



After the tempering procedure, the minimum of SFC is observed for higher HLERO content in the case of blends involving « solid fractions » and for lower HLERO content in the case of blends involving « liquid fractions » compared to blend made of full palm oil.

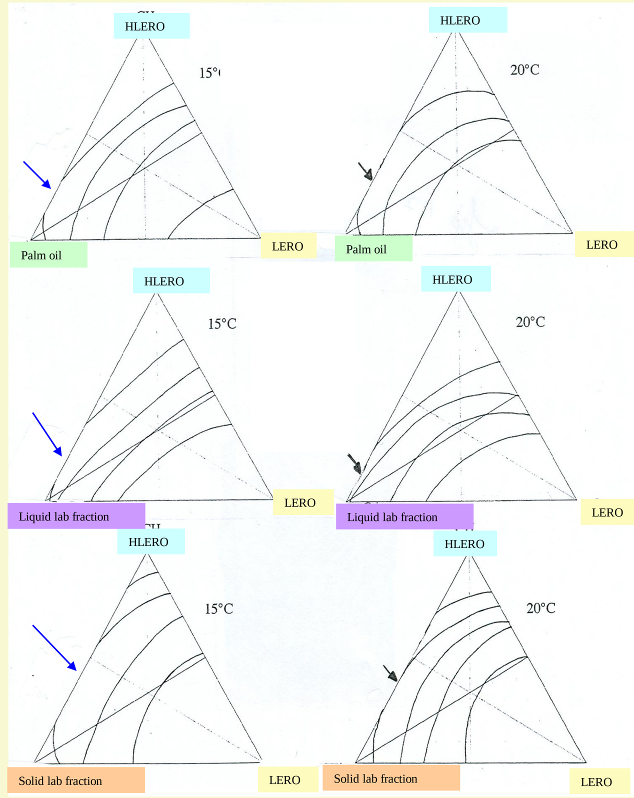
Isosolid diagrams at 15 and 20 C, after a tempering procedure of 48h at 15 C :

(a) blends involving palm oil

(b) blends involving a liquid lab fraction of palm oil,

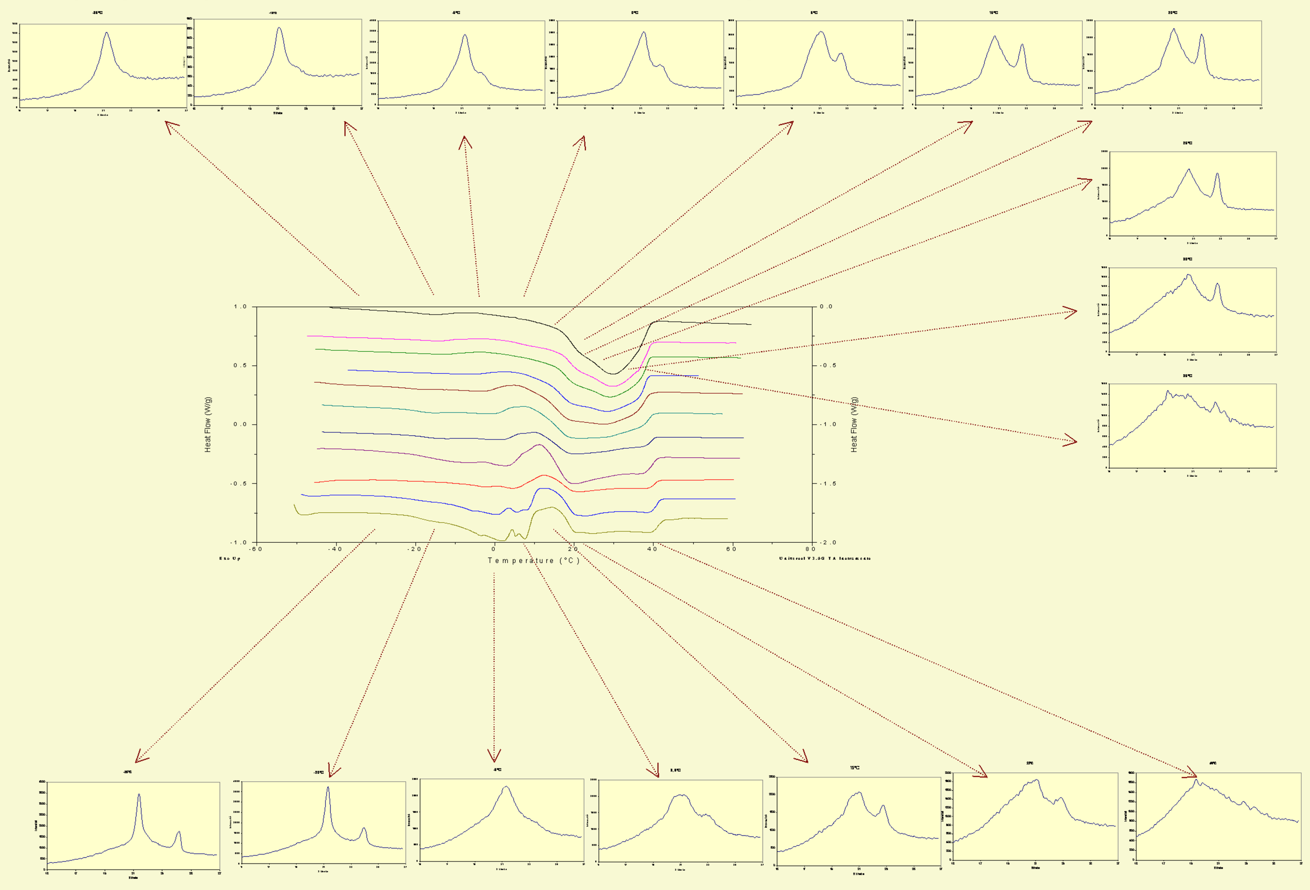
(c) blends involving a solid lab fraction of palm oil

Arrows indicate eutectic interactions.

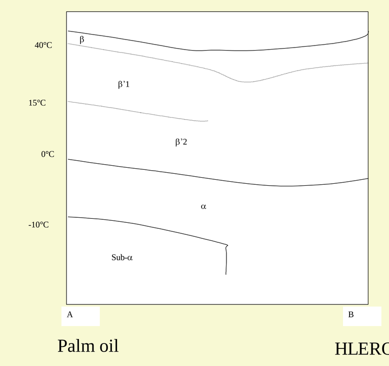


Palm oil and HLERO : Dynamic conditions

This figure illustrates the correspondence between DSC melting profiles and polymorphic behavior of the extreme samples.

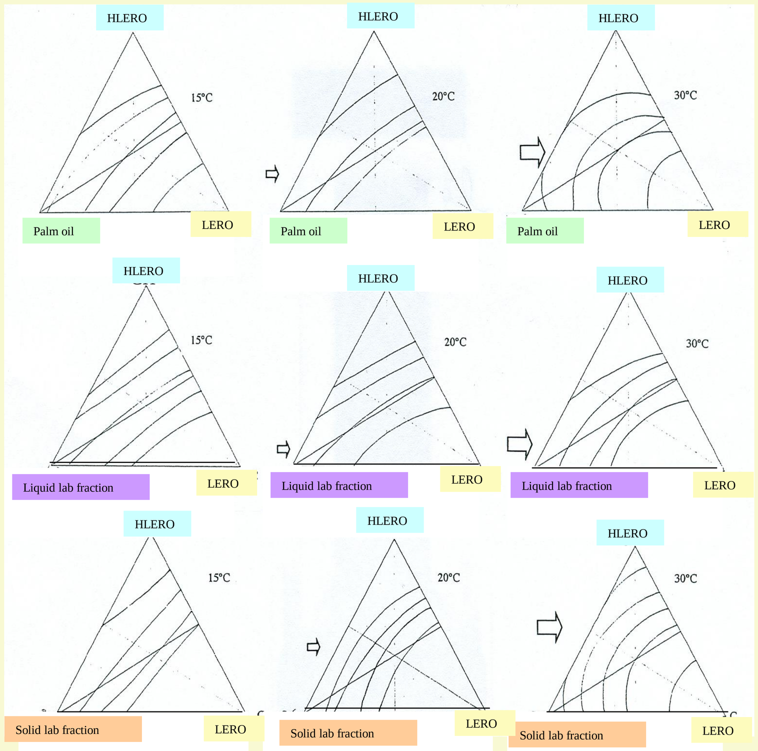


Dynamic phase behavior constructed from DSC and Powder X-ray data :



Palm oil or some of its fractions blended with HLERO and LERO: Dynamic conditions (AOCS method)

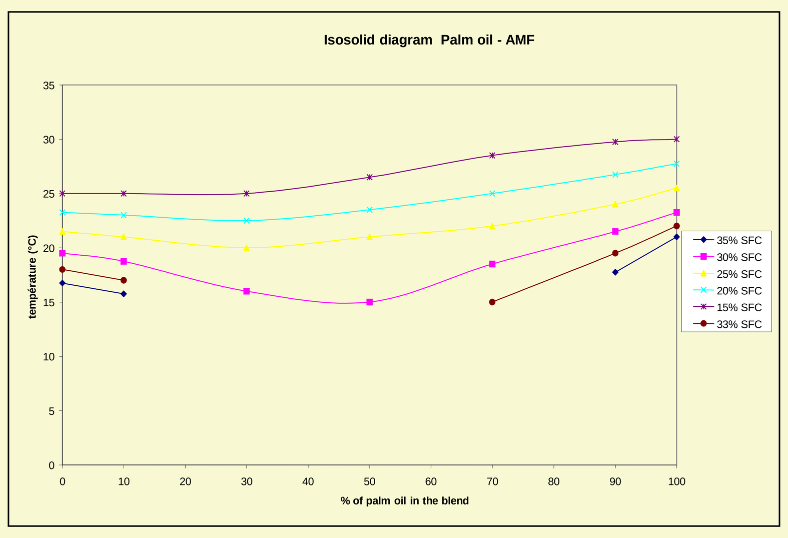
Isosolid diagrams at 15, 20 and 30 C C (AOCS method):



Under dynamic conditions,

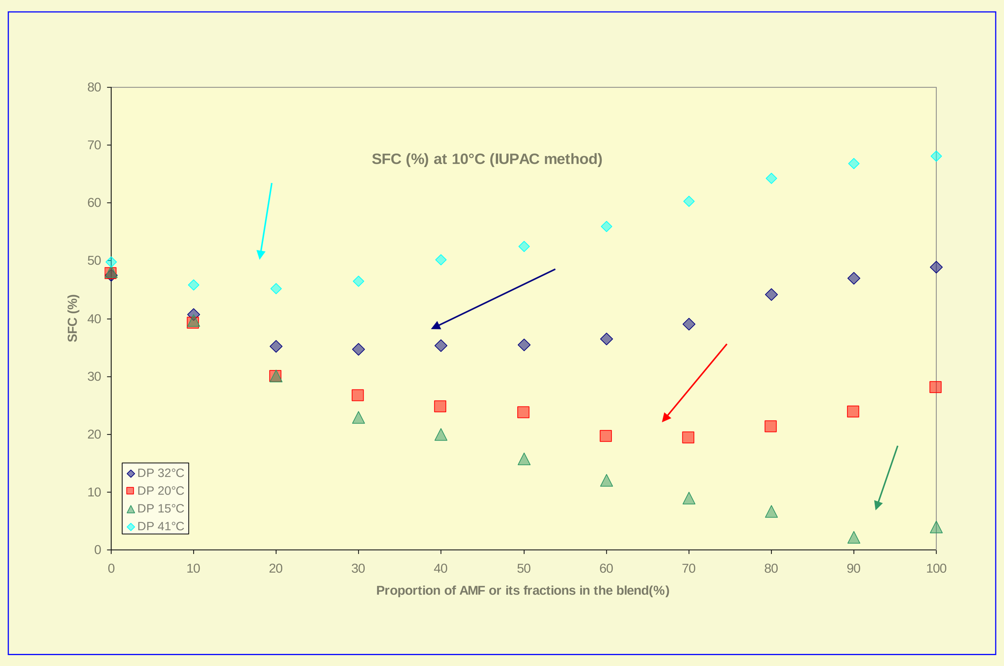
- at low temperature : nearly ideal behavior
- At higher temperature : isosolid lines : curves : eutectic interaction

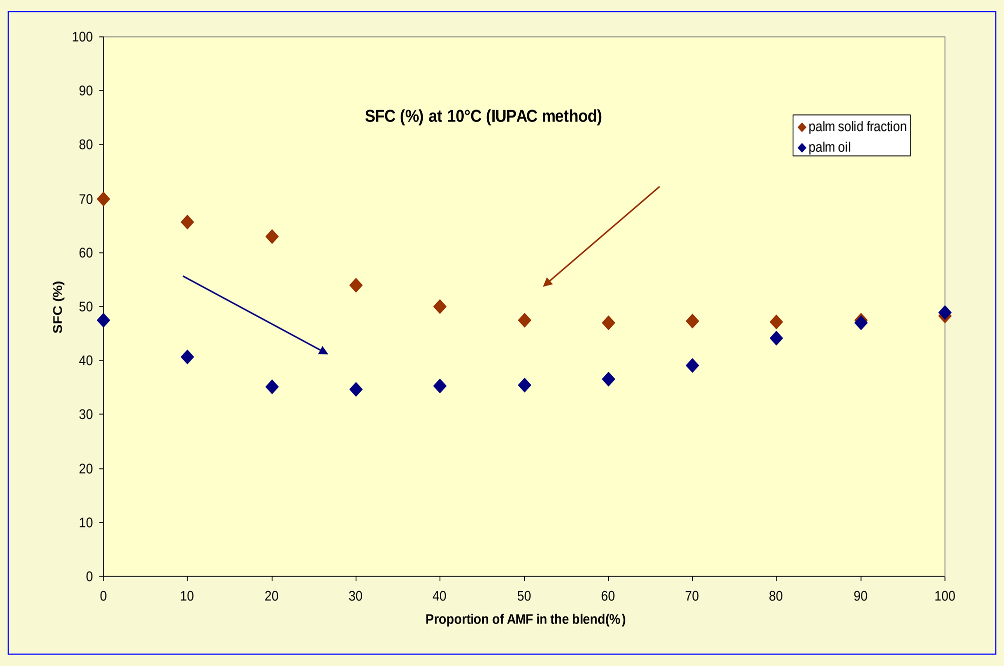
Palm oil blended with AMF : Tempered conditions



After a tempering procedure, Isosolid lines corresponding to lower SFC (upper lines) increase with increasing content of palm oil in the blend (specially palm oil content > 30%). Isosolid lines corresponding to higher SFC (lower lines) don't follow that behavior : a minimum is observed for the 50-50% composition (eutectic interaction)

Palm oil blended with AMF or AMF fractions: Dynamic conditions (IUPAC method)





Under dynamic conditions, a minimum is observed (eutectic interaction) within the SFC-lines as a function of composition, for all the blends.

This minimum is shifted to higher Palm oil contents for blends made of AMF fractions with high DP and to lower Palm oil content for blends made of AMF fractions with low DP.

Regarding blends made of AMF and a solid fraction of palm oil, the minimum is shifted to higher AMF contents.

Conclusions:

Molecular interactions have been observed for all the studied blends.

Compositions at which molecular interactions are detected are dependent on TAG compositions of the fat fractions involved in the blends.

Further studies are being conducted in our lab on this topic, with *trans-free* fats.