Thermal and structural behavior of two lauric fats compared to AMF in bulk and oil-in-water emulsion states

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INTRODUCTION

The fat phase strongly influence the physicochemical properties and stability of different food matrices such as whipped toppings, ice cream, margarine, dressings and other emulsion systems. Fat crystallization, in particular, may affect the mouth feel, stability, texture and appearance of oil-in-water emulsions. While in some food applications fat crystallization is detrimental to quality, for other such as whipped cream, ice cream, margarine it is an essential step in the production. Due to its practical importance, the relationship between fat in bulk and emulsified state in terms of crystallization needs to be understood. The objective of this study was to point out the differences in the crystallization and polymorphic behavior between bulk and emulsified fat of two vegetable fats and AMF.

MATERIAL AND METHODS

Two industrial palm kernel oil products (coded **F1** and **F2**) provided by Puratos Group and an anhydrous milk fat (**AMF**) supplied by CORMAN S.A. were used in this study.

Fatty acid compositions were determined using a HP 6890 Series GC System gas chromatograph (USA).

DSC melting profiles using a Q1000 DSC (TA Instruments, USA), after cooling and tempering at 4ºC for 24h.

Polymorphism by XRD using a Bruker D8-Advance Diffractometer (Bruker, Germany) : short and long spacings, after cooling and tempering for 24 h at 4ºC. Fats polymorphism was also studied in dynamic mode in order to observe the polymorphic evolution and phase transitions (using the same temperature program as in DSC) .

RESULTS

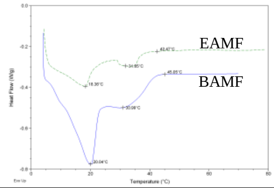
1. Fatty acid compositions

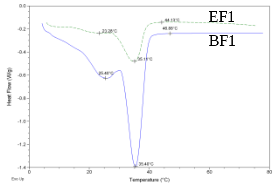
	C6:0	C8:0	C10:0	C12:0	C14:0	C16:0	C18:0	C18:1	C18:2
F1	-	3.2 ± 0.1	3.0 ± 0.0	41.1 ± 0.1	14.1 ± 0.0	9.6 ± 0.0	28.8 ± 0.1	0.5 ± 0.0	-
F2	-	3.4 ± 0.0	3.3 ± 0.0	46.8 ± 0.1	16.0 ± 0.0	8.8 ± 0.0	21.7 ± 0.1	0.2 ± 0.0	-
AMF	2.1 ± 0.0	1.1 ± 0.0	2.5 ± 0.0	2.9 ± 0.0	10.0 ± 0.0	29.0 ± 0.0	10.7 ± 0.0	25.6 ± 0.0	2.9 ± 0.0
PKOa	ND - 0.8	2.4 - 6.2	2.6 - 5.0	45 - 55	14 - 18	6.5 - 10	1.3 - 3.0	12.0 - 19.0	1 - 3.5

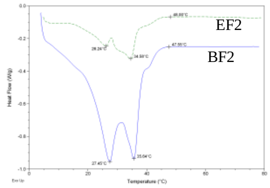
a) Standard palm kernel oil

F1: higher stearic acid content, while **F2**: higher lauric and myristic acids contents and **AMF**: higher palmitic and unsaturated fatty acids content.

2. DSC profiles (after 24 h tempering at 4ºC)



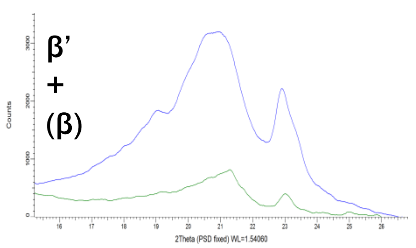


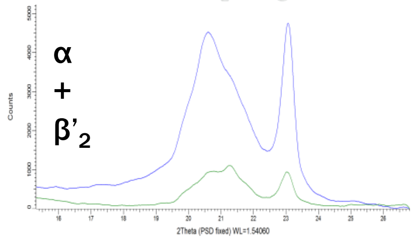


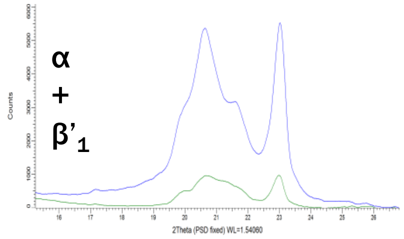
F2 has higher content in lower and middle melting points triacylglycerols than F1, while AMF has a considerably lower content of high melting point triacylglycerols than the vegetable fats. The temperature at the end of complete melting is the same for both states (bulk and emulsified).

4. Polymorphism

4. 1. After 24 h tempering at 4ºC



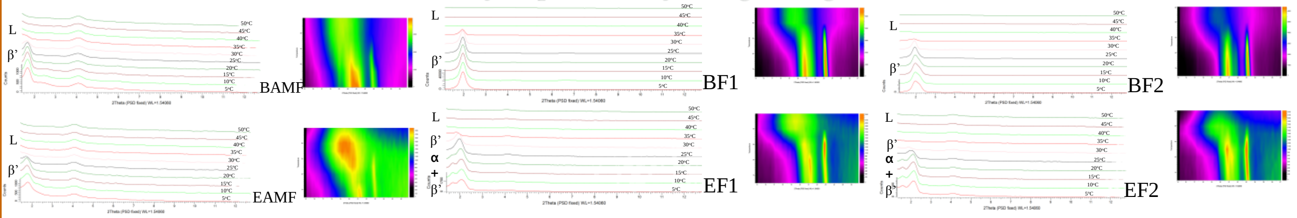




Bulk & Emulsified AMF: **2Lβ’+ traces of β**

Bulk Fat 1 & Fat 2: **2Lβ’** Emulsified Fat 1 & Fat 2: **2Lα + 2Lβ’**

4. 2. Polymorphic stability during heating



The passage to the liquid state is performed without the occurrence of β form for both vegetable fats

CONCLUSIONS

The proportion of medium-chain FAs to long-chain FAs seems to determine the variant of existing β’crystal forms. These differences could have major implications on products containing such fats, e.g. emulsions. The crystallization of the two vegetable fats studied takes place differently in bulk than emulsified state. A different polymorphic and nucleation mechanism can be implied for bulk and emulsified state of the two vegetable fats, not only due to the melting profiles, but also due to the different crystal varieties observed in the two states. This is not the case of AMF, where the same polymorphic behavior was observed for both, bulk and emulsion, states. The low and middle melting TAG sites are enhanced for the emulsified fat, hence the crystallization of these fraction can be favored within the emulsion system. The bulk state for the studied fats is characterized by a β’ crystal form population, with a double chain lamellar structure (2L) (some traces of β are observed for AMF). Apart from the β’ crystals, in the emulsified vegetable fats α form crystals are observed. Similar polymorphic evolution was observed for all three fats upon heating, with no β’ to β transition before complete fat melting, for the vegetable fats, neither in the case of bulk or emulsified state.