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Investigation of the thermal and structural behavior of two lauric fats in bulk and oil-in-water emulsion states

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INTRODUCTION

The physicochemical properties and stability of different food matrices such as whipped toppings, ice cream, margarine, dressings and other emulsion systems are strongly influenced by the fat phase. 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.

MATERIAL AND METHODS

Two industrial palm kernel oil products (coded **F1 and F2**) provided by Puratos Group 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 4°C 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 4°C. After the same cooling and tempering conditions, fats polymorphism was also studied in dynamic mode, between 5-50°C to observe the polymorphic evolution and phase transitions.

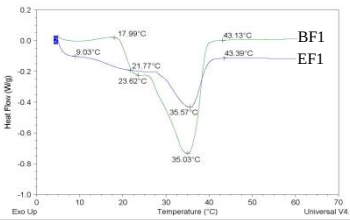
RESULTS

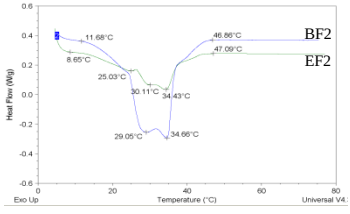
1. Fatty acid compositions

	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	-
PKO[a]	ND-0.8	2.4-6.2	2.6-5.0	45-55	14-18	6.5-10	1.3-3.0	12-19	1-3.5

a) Standard palm kernel oil

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



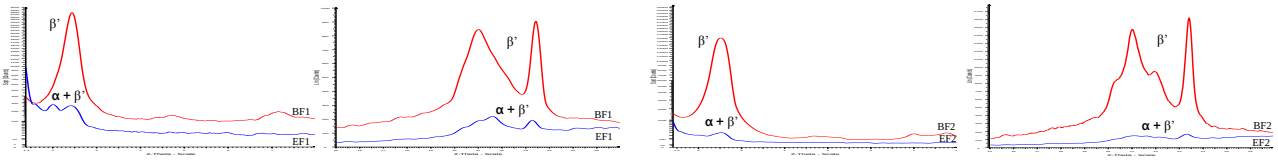


F1: higher stearic acid content while F2: higher lauric and myristic acids contents

F2 has higher content in lower and middle melting points triacylglycerols than F1. The temperature at the end of complete melting is the same for both states (bulk and emulsified)

4. Polymorphism

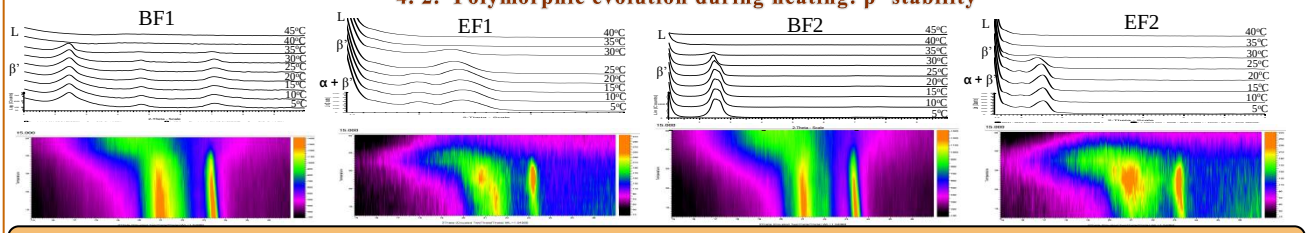
4. 1. After 24 h tempering at 4°C



Bulk Fat 1: **2Lβ'$_2$** Emulsiefied Fat 1: **2Lα + 2Lβ'$_2$**

Bulk Fat 2: **2Lβ'$_1$** Emulsiefied Fat 2: **2Lα + 2Lβ'$_1$**

4. 2. Polymorphic evolution during heating: β' stability



For the emulsified fats, above 25°C, the transition of α + β' to β' takes place, due to the melting of α form. After this no further transitions are being observed until complete transformation to liquid state. The passage to the liquid state takes place without the occurrence of β form, for both fats in both states.

CONCLUSIONS

The proportion of medium-chain FAs to long-chain FAs (especially lauric and stearic acids) 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 fats studied, takes place differently in bulk than emulsified state. A different polymorphic and nucleation mechanism can be implied for bulk and emulsified state, not only due to the melting profiles of fats, but also due to the different crystal varieties observed in the two 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 fat is characterized by a β' (β'$_1$ for Fat 2 and β'$_2$ for Fat 1) crystal form population, with a double chain lamellar structure (2L). Apart from the β' crystals, in the emulsified fat α form crystals are present. Similar polymorphic evolution was observed upon heating, with no β' – β before complete fat melting, neither for bulk or emulsified state.