Fat Blends on the Base of Structural Triglycerides

V. FILIP, M. ZÁRUBOVÁ, I. PISKA and J. ŠMIDRKAL*

*Department of Dairy and Fat Technology, Institute of Chemical Technology, Prague, Czech Republic, *E-mail: filipv@vscht.cz*

Abstract: Fat blends for manufacture of *trans* isomer-free emulsified fats are prepared by blending of 20–30% of structured fat with vegetable oil. Structured fats on the base of trisaturated triglycerides are produced by basic or enzymatic catalyzed transesterification of fully hydrogenated coconut oil with fully hydrogenated palmstearine or low erucic rapeseed oil. Physical properties of transesterificated structured fats produced by enzymatic reaction using immobilized *sn*-1,3 specific lipase Lipozyme TL IM or by randomization are similar. The replacement of palmitic acid with stearic acid without any changes in the ratio between medium chain FA and long chain FA was observed too. Fat blends contain mixture of β` and β crystals, the replacement of palmitic acid with stearic acid in structured fat does not influence neither crystalline modification nor SFC profiles but it has a significant effect on fat blend consistency.

Keywords: fat blends; transesterification; lipase; SFC; consistency

INTRODUCTION

Recently there has been increasing demand for lowering of the *trans* isomer content in fat blends and margarines [1, 2]. Although there is an effort to eliminate partially hydrogenated fats from fat products, this process is still used in industry. Basic catalyzed transesterification has become the main alternative method for structured fat manufacture [3, 4]. Structured fats are usually produce from fully hydrogenated fats and from fats or their fractions that contain only *cis* monoenic fatty acids. Fat blends are manufactured in the same way as in the case of hydrogenated fats- the physical blending of structured fats with refined vegetable oil is used.

Especially *sn*-1,3 specific lipases are used for enzymatic catalyzed transesterification of fats [5, 6]. The industrial procedure of fat transesterification was proposed in immobilized form in fixed bed [7].

EXPERIMENTAL

Fully hydrogenated oils, namely coconut oil (FHCO), low erucic rapeseed oil (FHLERO) and palmstearine (FHPSt) with following fatty acid composition (Table 1) were used for transesterification.

Structured fats preparation. Two types of transesterificated fats were prepared using both types of catalysis:

FHCO : FHLERO = 84:14 (PE 55)
FHCO : FHPSt = 84:14 (PE 56)

Basic catalyzed transesterification (randomization) was carried out at the temperature of 100°C, sodium methoxide (0.4% w/w) was used as a catalyst. Time of the reaction was 60 min. The mixture was stirred under argone atmosphere at a rate of 200 rpm.

Enzymatic catalyzed transesterification was carried out at 70°C using 10% w/w of immobilized *sn*-1,3 specific lipase Lipozyme TL IM (Novoenzym A/S, DK) [7]. Time of the reaction was 6 h. The mixture was stirred under argone atmosphere at a rate of 200 rpm.

The course of transesterification was evaluated indirectly from the changes in melting points and capillary HTGC method determined TAG composition according to carbon numbers (CN). The content of solid fat content was determined in transesterificated fats.

Fat blends were prepared by blending of structured fats PE 55 and PE 56 with refined low erucic

Table 1. Fatty acid composition of fully hydrogenated oils

	C 8:0	C 10:0	C 12:0	C14:0	C 16:0	C 18:0	C 18:1	C 20:0	C 22:0
Coconut oil	6.0	4.7	37.5	15.6	9.8	23.1	0.0	0.4	0.0
Low erucic rapeseed oil	0.0	0.0	0.0	0.0	7.1	91.1	0.0	0.0	1.8
Palmstearine	0.0	0.0	0.2	1.4	60.3	37.1	0.2	0.6	0.1

rapeseed oil in a ratio of (22.5–30.0)/(77.5–70.0)% w/w and subsequent controlled crystallization. Solid fat content, consistency parameters by rotatory rheometry (static yield value is presented) and crystalline modifications (infrared spectroscopy) were observed.

RESULTS AND DISCUSSION

Basic catalyzed transesterification

The decrease in melting points (26°C for PE 56 and 20°C for PE 55) is characteristic for both transesterificated fats. This corresponds to the decrease in concentration of TAG with CN 50-54 that are typical for fully hydrogenated palmstearin (Figure 1) and triglycerides with CN 52-54 that are typical for fully hydrogenated low erucic rapeseed oil, respectively. On the other hand the concentration of TAG with CN 30-38, which form the main reaction product in both cases, increases. It is obvious (Figure 1) that the equilibrium of the reaction occurs after approximately 20–30 min.

It is satisfactory to follow the decrease in concentration of TAG with CN 54 in the case of randomization of structured fat PE 55. This decrease corresponds to tristearoylglycerol. In PE 56 the decrease in the concentration of TAG with CN 50 and 52 is directly connected with dipalmitoylstearoylglycerol (CN 50) and palmitoyldistearoylglycerol (CN 52).

Enzymatic catalyzed transesterification

The course of the reaction is similar to randomization (Figure 2) but it differs in reaction equilibrium that occurs after 100 min in the case of enzymatic catalysis. HTGC method is not suitable for evaluation if the enzyme is *sn*-1,3 specific. The other difference represents increase in DAG and fFA content above 10%. Immobilized enzyme is very sensitive to water attendance. Even in the present

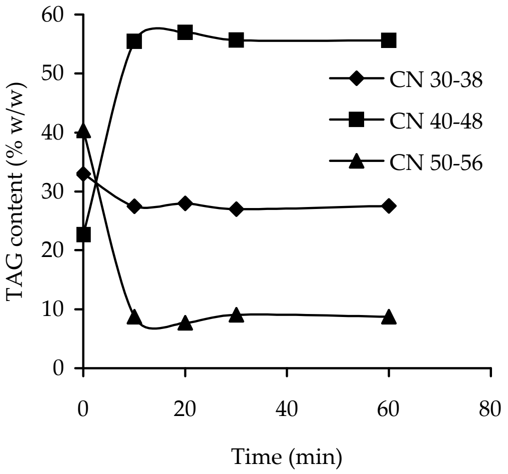

Figure 1. The change in the composition of TAG (according to the CN sums) in the course of transesterification of fully hydrogenated coconut oil and palmstearine under the conditions of basic catalysis

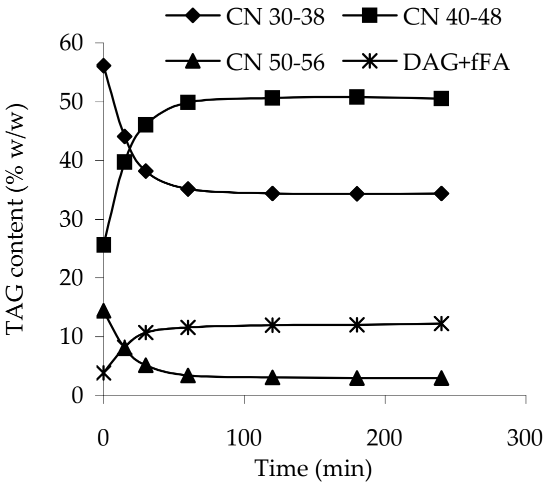

Figure 2. The change in the composition of TAG (according to the CN sums) in the course of transesterification of fully hydrogenated coconut oil and palmstearine under the conditions of enzymatic catalysis

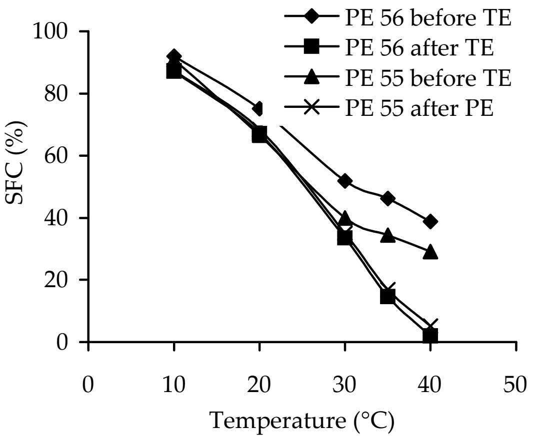

Figure 3. SFC profile of structured fats PE 55 and PE 56 before and after transesterification (basic catalyzed reaction)

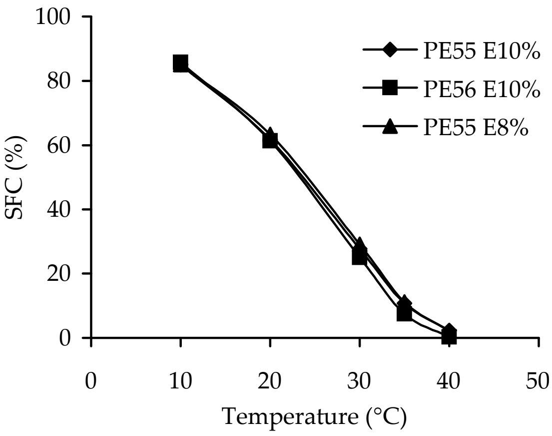

Figure 4. SFC profile of structured fats PE 55 and PE 56 after transesterification (enzymatic catalyzed reaction)

of water traces in fat it immediately enforces its primary hydrolytic activity.

Structured fats

The change in concentration of trisaturated TAG before and after transesterification has a huge influence on the dependence of solid fat content on temperature (Figure 3). It is very important that the SFC curves for both structured fats are almost identical, although they significantly differ in concentrations of palmitic and stearic acid. The dependences of SFC on temperature for both enzymatic transesterificated structured fats were almost identical as after randomization (Figure 4). Both described structured fats crystallize relatively independently on the cooling rate in the β` modification.

Fat blends on the base of structured fats PE 55 and PE 56

SFC and consistency of fat blends. Quite gradual decrease in SFC between 10 and 20°C means that the prepared fat blends have convenient properties, which are required for soft margarines (Figure 5). It is also positive that the 10% increase in the concentration of structured fat increases SFC at the

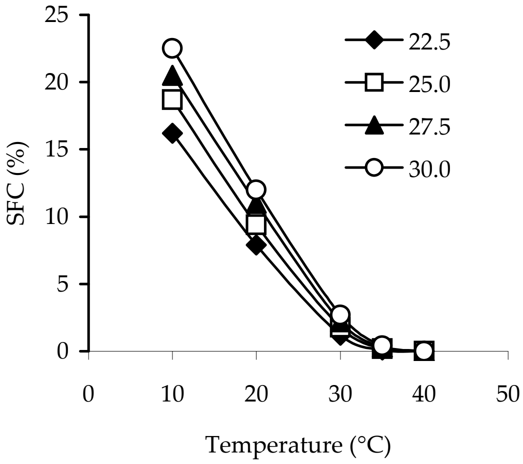

Figure 5. The dependence of SFC on temperature for different concentrations of structured fat PE 56 (basic catalyzed reaction)

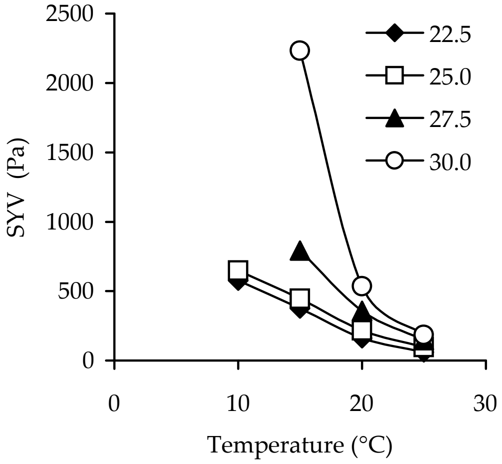

Figure 6. The dependence of static yield value on temperature for different concentrations of structured fat PE 56 (basic catalyzed reaction)

Table 2. Crystalline modifications of model fat blends with PE 55 a PE 56 (c – concentration of structured fat in blend)

c (% w/w)	Fat blend – on the base of PE 55		Fat blend – on the base of PE 56	
	after 24 hours	after 12 days	after 24 hours	after 12 days
22.5	β` + (β)	β` + (β)	β` + β	β` + β
25.0	β` + β	β` + β	β` + (β)	β` + β
30.0	β` + β	β` + β	β` + β	β` + β

temperatures between 10 and 20°C but the solid fat content at 35–40°C is close to 0%. Fat blends containing structured fat PE 55 showed very similar results. Static yield value (Figure 6) is much more dependent on the structured fat concentration. When the increment of structured fat in fat blend is higher than 27% the consistency is more significantly dependent on temperature when compared to the SFC. This trend is even more obvious in the case of structured fat PE 55. Replacement of palmitic acid with stearic acid in structured fat does not significantly influence solid fat content but it has an effect on fat blend consistency.

Crystalline modifications of fat blends. Crystalline modifications of fat blends stored at 15°C were measured after 24 h and after 12 days. Fat blend crystallize in the mixture of crystalline modifications β` and β (the ratio between both phases is not possible to determine when infrared spectroscopy is used).

CONCLUSIONS

Structured fats prepared by basic and enzymatic transesterification of fully hydrogenated coconut oil with fully hydrogenated palmstearine or low erucic rapeseed oil are suitable for manufacture of fat blends for trans isomer-free emulsified fats. Model fat blends containing 20–30% of structured fats consist of mixture of β` and β crystals. The replacement of palmitic acid with stearic acid in structured fat influences fat blend consistency.

References

[1] Fritsche J., Steinhardt H. (1997): Fett/Lipid, **99**: 214.

[2] Mag T.K. (1997): Inform, **5**: 1350.

[3] Lansbergen A.J., Schijf R. (1991): Eur. Pat. Appl., **455**: 278 A2.

[4] Maguire J. (1995): UK Pat. Appl., **2**: 281.

[5] Xuebing X. (2000): Eur. J. Lipid Sci. Technol., 287.

[6] Huiling M., Paavo K., Xuebing X., Hoy C.E. (2000): Eur. J. Lipid Sci. Technol., **101**: 202.

[7] Pedersen L.S., Nielsen P.M. (2002): Bulk Fat Manual, Novozymes.