RAPESEED OIL AS A SOURCE OF THE ESSENTIAL LINOLEIC AND α-LINOLENIC ACIDS

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ABSTRACT

The essential linoleic (LA, 24 %) and α-linolenic acids (α-LLA, 10 %) derived from rapeseed oil are preferentially incorporated in plasma phospholipids (PL) through competition and further converted to longer-chain PUFAs by the body even after a moderate reduction of saturated fat intake. The increases in PL LA and α-LLA rather than in oleic acid (OA) levels were closely related to the decrease in serum total or LDL cholesterol. Comparison with olive oil showed that the effects of these two high-monoenoic oils on plasma PL fatty acid composition are clearly different.

INTRODUCTION

Zero-erucic acid rapeseed oil is a monoenoic vegetable oil with moderate contents of LA and α-LLA. Rapeseed oil has a favourable impact on serum lipid levels and on the fatty acid composition of plasma PL (Seppänen-Laakso *et al.*, 1992 & 1993). The increase in long-chain n-3 fatty acids in PL derived from α-LLA is responsible for the antithrombotic effects found during rapeseed oil substitution (McDonald *et al.*, 1989, Weaver *et al.*, 1990). α-LLA is also considered to be a safer source of n-3 fatty acids in the diet than the longer chain n-3 PUFAs from marine oils, which are highly susceptible to oxidation. In this study, the effects of LA, α-LLA and OA on plasma PL fatty acid composition and serum lipids were compared during rapeseed oil, margarine and olive oil substitutions.

EXPERIMENTAL

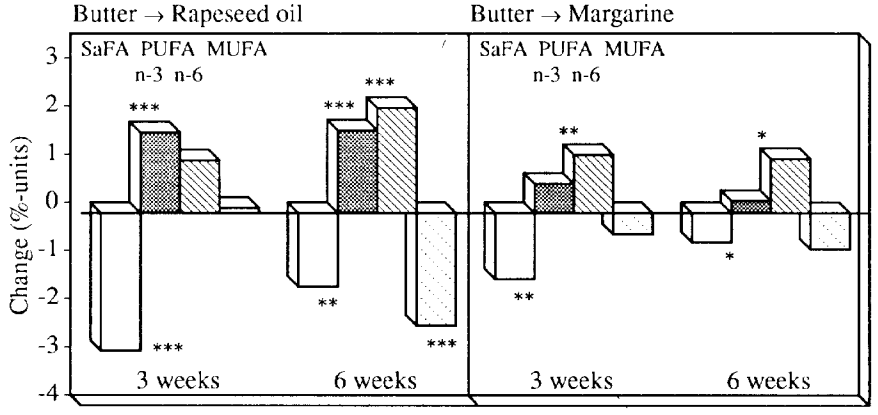
Finnish subjects (89) consisting of both men and women of working-age (mean 45 years) replaced butter or margarine on their bread (Table 1) by rapeseed oil (57 % OA, 24 % LA, 10 % α-LLA), rapeseed oil-containing margarine (31 % 18:1*cis*, 16 % 18:1*trans*, 28 % LA, 3 % α-LLA) or olive oil (75 % OA, 9 % LA, 1 % α-LLA) for 6 weeks.

TABLE 1. Groups and substitutions during the 6 weeks' dietary period.

Group		Number of subjects	Substitution (g/day)				LA / α-LLA ratio
			LA	α-LLA	OA	18:1*trans*	
Butter	→ Rapeseed oil	20	4.3	1.8	10.4	-	2.4
	→ Margarine	23	6.3	0.6	7.0	3.7	10.4
Margarine	→ Rapeseed oil	23	3.8	1.6	9.7	-	2.4
	→ Olive oil	23	1.7	0.2	13.9	-	7.6

During rapeseed oil substitution, the increase in the level of total plasma α-LLA was dose-dependent ($r = 0.60$, $p < 0.001$, $n = 43$) and better reflected the use of rapeseed oil than the more abundant linoleic and oleic acids.

FIGURE 1. The change in plasma PL fatty acid composition when butter was replaced by rapeseed oil or margarine. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ compared to the baseline.



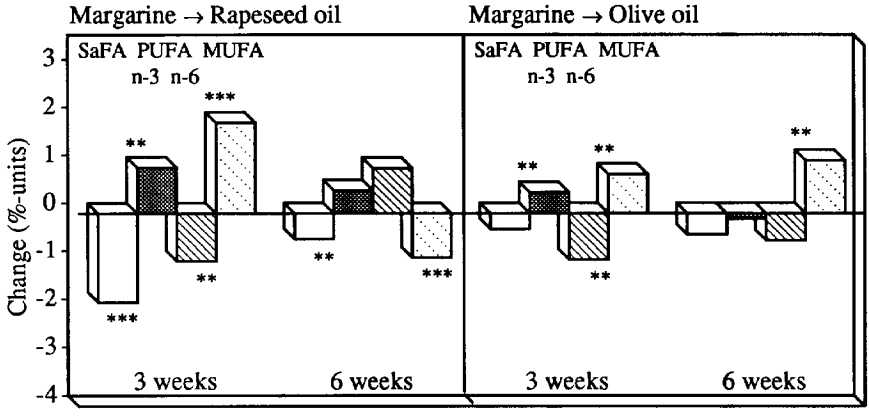
Rapeseed oil first causes an increase in n-3 PUFA at 3 weeks (see also Table 2), then an increase in n-6 PUFA at 6 weeks at the expense of MUFA. This occurs according to the competitive order n-3 > n-6 > n-9. These results indicate that rapeseed oil (10 % α-LLA and 24 % LA) is primarily a source of essential fatty acids in the diet of butter users. During margarine substitution, 28 % LA increased the n-6 PUFA level, whereas 3 % α-LLA had no effect. In both groups, the reduction in stearic acid and the rise in LA were closely related to the decrease in serum total cholesterol (TC) levels (Seppänen-Laakso *et al.*, 1992).

TABLE 2. Changes (%-units) in n-3 fatty acids in PL caused by rapeseed oil substitutions.

Replaced fat / Weeks	α-LLA		EPA		DPA		DHA	
	3	6	3	6	3	6	3	6
Butter	0.25 ***	0.02	0.39 **	0.42 **	0.11 *	0.11 *	0.92 ***	1.16 ***
Margarine	0.29 ***	-0.08 ***	0.54 **	0.31	0.02	0.06	0.12	0.22

Table 2 shows that α-LLA derived from rapeseed oil is effectively converted to longer-chain n-3 PUFAs up to docosahexaenoic acid (DHA) in the group of butter users.

FIGURE 2. The change in plasma PL fatty acid composition when margarine was replaced by rapeseed or olive oils. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$ compared to the baseline.



When replacing margarine by rapeseed oil the reductions in LA and SaFA are compensated by the increases in n-3 PUFA and MUFA, respectively. However, the n-6 PUFA level is restored by rapeseed oil (24 % LA) but not by olive oil (9 % LA). The increase in PL α-LLA in the rapeseed oil group was associated with a decrease in LDL-C and also with an increase in the HDL-C / TC ratio. As expected, the increase in PL OA correlated with the reduction in LDL-C. These results show that the effects of these two high-monoenoic oils on plasma PL fatty acids are clearly different.

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