Trans (Elaidic) Fatty Acids Adversely Affect the Lipoprotein Profile Relative to Specific Saturated Fatty Acids in Humans

Sundram, K., A. Ismail, et al. (1997). "*Trans* (elaidic) fatty acids adversely affect the lipoprotein profile relative to specific saturated fatty acids in humans." J. Nutr. **127**(3): 514S-20S.

ABSTRACT : Although dietary trans fatty acids can affect plasma lipoproteins negatively in humans, no direct comparison with specific saturated fatty acids has been reported, even though trans fatty acids were designed to replace saturates in foods and food processing. In this study, dietary trans 18:1 [elaidic acid at 5.5% energy (en)] was specifically exchanged for cis 18:1, 16:0 or 12:0 + 14:0 in 27 male and female subjects consuming moderate fat (31% en), low cholesterol (<225 mg/d) whole food diets during 4-wk diet periods in a crossover design. The trans-rich fat significantly elevated total cholesterol and LDL cholesterol relative to the 16:0-rich and 18:1-rich fats and uniquely depressed HDL cholesterol relative to all of the fats tested. Trans fatty acids also elevated lipoprotein (a) [Lp(a)] values relative to all dietary treatments. Furthermore, identical effects on lipoproteins were elicited by 16:0 and cis 18:1 in these subjects. The current results suggest that elaidic acid, one of the principal trans isomers produced during industrial hydrogenation of edible oils, adversely affects plasma lipoproteins. Thus, the negative effect of elaidic acid on the lipoprotein profile of humans appears to be unmatched by any other natural fatty acid(s).

Credit: Dr. K. Sundram, 2013

Characteristics of Volunteers Enrolled into the Study

- A crossover design
- 27 subjects (18men, 9women)
- Aged 29.4 4.6 years (range 19-39 y)
- Body mass index ,22.7 2.59 (range 18.6-29.6)
- Feeding period for 4 weeks
- Diet on trans-rich hydrogenated soybean oil, MONO-rich, palmitic-rich and lauric-myristic-rich
- Healthy, no taking medication affecting lipid metabolism, normolipemic
- Serum total cholesterol , 5.10 0.78 mmol/L (range 3.56-6.12)
- Serum triglycerides , 1.02 0.5 mmol/L (range 0.42-1.57)
- LDL cholesterol, 3.68 0.8 mmol/L (range 2.65-4.02)
- HDL cholesterol, 1.02 0.2 mmol/L (range 0.71-1.48)

Credit: Dr. K. Sundram, 2013

Daily Nutrient Intake During Habitual and Experimental Periods

	Habitual	Trans	MONO	POL (Palm olein)	LM (lauric-myristic)
Energy					
MJ/d	8.65	9.19	9.36	9.06	9.34
kcal/d	2068.00	2196.00	2237.00	2165.00	2232.00
Protein					
% en	14.60	14.80	15.20	14.90	15.50
g/d	75.00	81.00	85.00	80.00	87.00
Carbohydrates					
% en	59.00	53.60	53.70	53.40	51.80
g/d	305.00	294.00	300.00	289.00	289.00
Fat					
% en	26.40	31.60	31.10	31.70	32.70
g/d	60.00	77.00	77.00	76.00	81.00
Cholesterol, mg/d	230.00	210.00	219.00	207.00	197.00
Trans FA (% en)					
Total	ND	6.90	ND	ND	ND
t18:1 (n-9)	ND	5.50	ND	ND	ND
t18:1 (n-11)	ND	0.80	ND	ND	ND
t18:1 (n-13)	ND	0.37	ND	ND	ND

Continued

Unid cis/trans	ND	0.27	ND	ND	ND
P/S ratio	0.30	0.85	0.52	0.26	0.35
SFA (% en)					
Total	12.30	7.40	9.50	14.00	16.90
8:0 + 10:0	0.20	ND	ND	ND	0.40
12:00	1.80	0.50	0.30	0.50	5.90
14:00	1.50	0.30	0.20	0.40	3.30
16:00	7.50	4.60	7.30	11.40	5.80
18:00	1.10	1.80	1.40	1.60	1.40
20:00	0.10	0.10	0.10	0.10	ND
MUFA (% en)					
Total	10.40	11.00	16.70	14.00	9.90
16:1 (n-9)	0.20	0.20	0.30	0.20	0.30
18:1 (n-9)	10.20	10.80	16.40	13.70	9.60
PUFA (% en)					
Total	3.70	6.30	4.90	3.60	5.90
18:2 (n-6)	3.40	5.30	3.90	3.30	5.60
18:3 (n-3)	0.30	0.60	0.80	0.10	0.20
22:5 (n-3)	-	0.30	0.20	0.20	0.10
22:6 (n-3)	-	-	-	-	-

Fatty Acid Composition of Fat Blends Incorporated Into Diets

Fatty Acid	Trans-rich hydrogenated soybean oil[1]	MONO-rich[2]	Palmitic-rich[3] (16:0)	Lauric-myristic-rich[4] (12:0+14:0)
		g/100g of dietary oil		
SFA	17.76	23.56	44.56	60.01
8:00	ND	ND	ND	0.75
10:00	ND	ND	ND	1.91
12:00	ND	0.19	0.53	27.08
14:00	ND	0.46	0.84	14.61
16:00	11.60	19.08	38.94	10.84
18:00	5.62	3.14	3.96	4.58
20:00	0.24	0.34	0.29	0.23
22:00	0.30	0.35	ND	0.10
MUFA	33.20	61.01	44.36	20.87
16:1 (n-9)	ND	0.14	0.11	ND
18:1 (n-9)	33.20	60.87	44.25	20.87

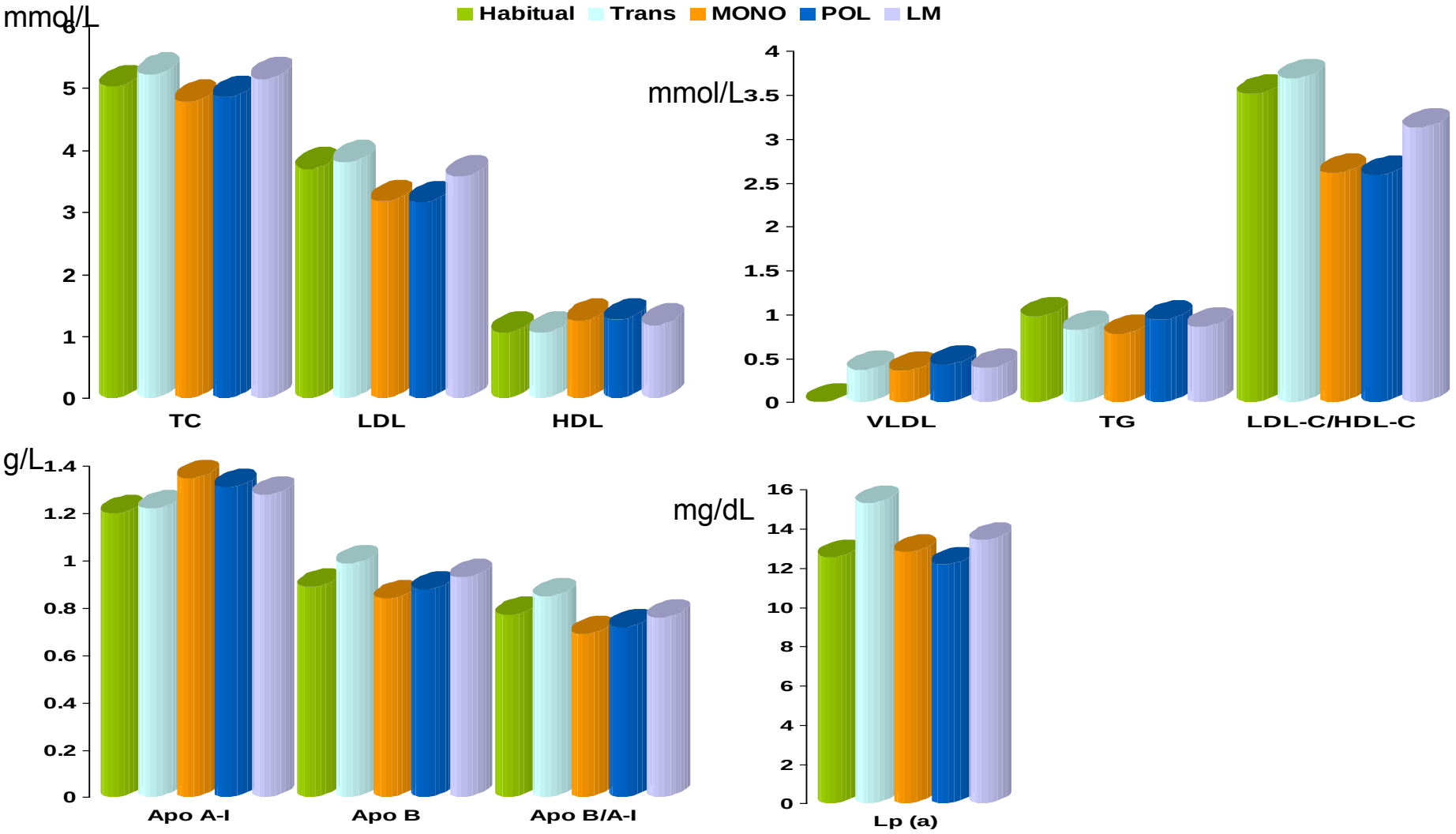
PUFA	19.83	14.90	10.89	18.83
18:2 (n-6)	17.60	13.63	10.74	18.60
18:3 (n-3)	2.23	1.27	0.15	0.23
Trans FA	29.21	ND	ND	ND
t18:1 (n-9)	23.11	ND	ND	ND
t18:1 (n-11)	3.40	ND	ND	ND
t18:1 (n-13)	1.55	ND	ND	ND
Unid cis/trans	1.15	ND	ND	ND
P/S ratio	1.12	0.63	0.24	0.31

1=70% hydrogenated soybean oil (melting point 35^{o}C), 30% soybean oil
2=30% rapeseed oil, 25% sunflower seed oil, 45% palm olein
3=100% palm olein
4=45% coconut oil, 15% palm kernel oil, 40% corn oil

ND=not detected, P/S=polyunsaturated/saturated ratio

Credit: Dr. K. Sundram, 2013

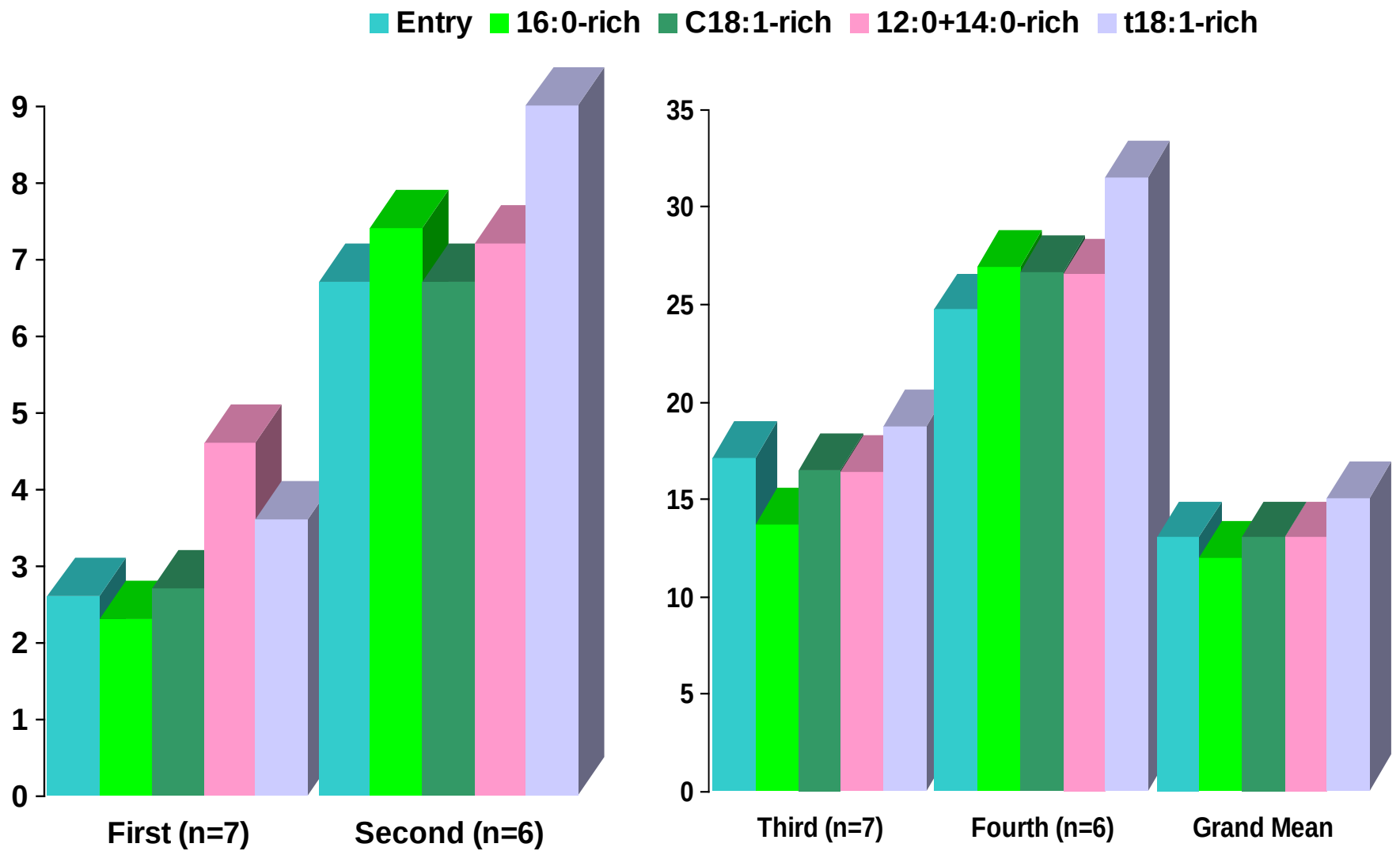
Effect of Dietary Fat on Plasma Lipids, Lipoprotein, Serum Apolipoprotein and Lp(a)



Trans INCREASED TC, LDL-C and Lp (a) but DECREASED HDL-C compared to the palm olein diet

Credit: Dr. K. Sundram, 2013

Lp (a) Response to Changes in Dietary Fatty Acids



16:0-rich and 18:1-rich DECREASED the Lp (a)

Credit: Dr. K. Sundram, 2013

Conclusion :

- Trans-rich fat significantly elevated total cholesterol and LDL cholesterol relative to the 16:0-rich palm oil and 18:1-rich fat and uniquely depressed HDL cholesterol relative to all of the fats tested.
- Trans fatty acids also elevated lipoprotein (a) [Lp(a)] values relative to all dietary treatments.
- Furthermore, identical effects on lipoproteins were elicited by 16:0 (palm oil) and cis 18:1 in these subjects
- Trans fatty acids are more deleterious to plasma lipoprotein profile than a natural fat such as palm oil rich in palmitic and oleic acids

Credit: Dr. K. Sundram, 2013