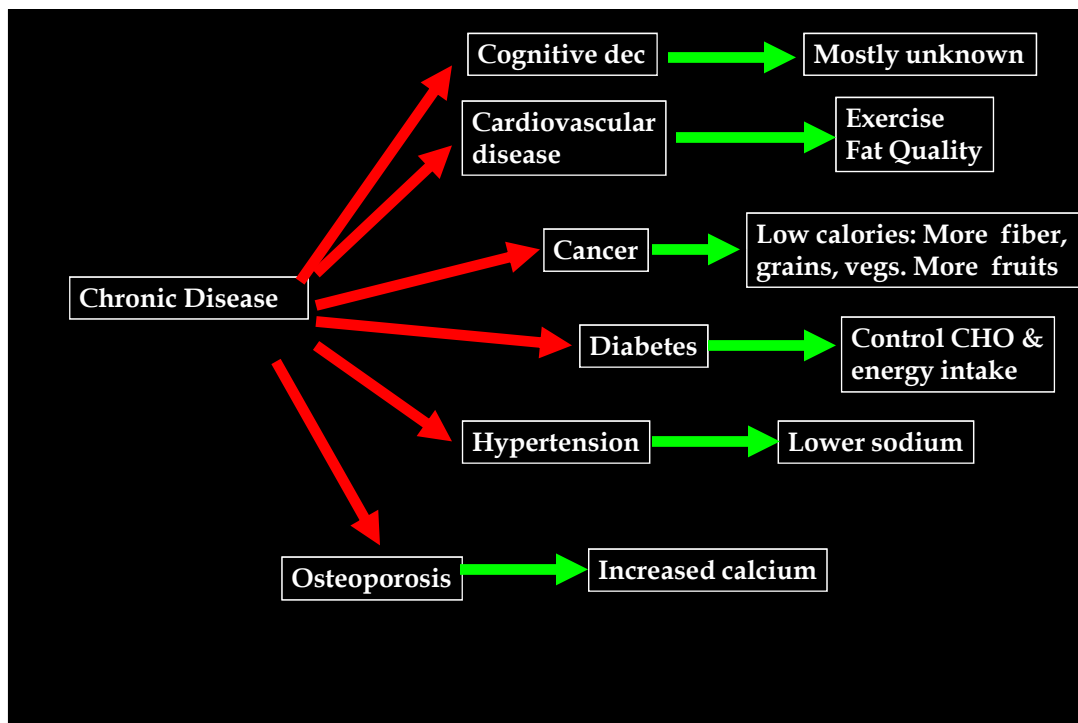


# Nutritional and Health Attributes of Palm Oil

**Pramod Khosla, PhD**

Associate Professor,  
Dept. of Nutrition & Food Science,  
Wayne State University,  
Detroit, MI 48202

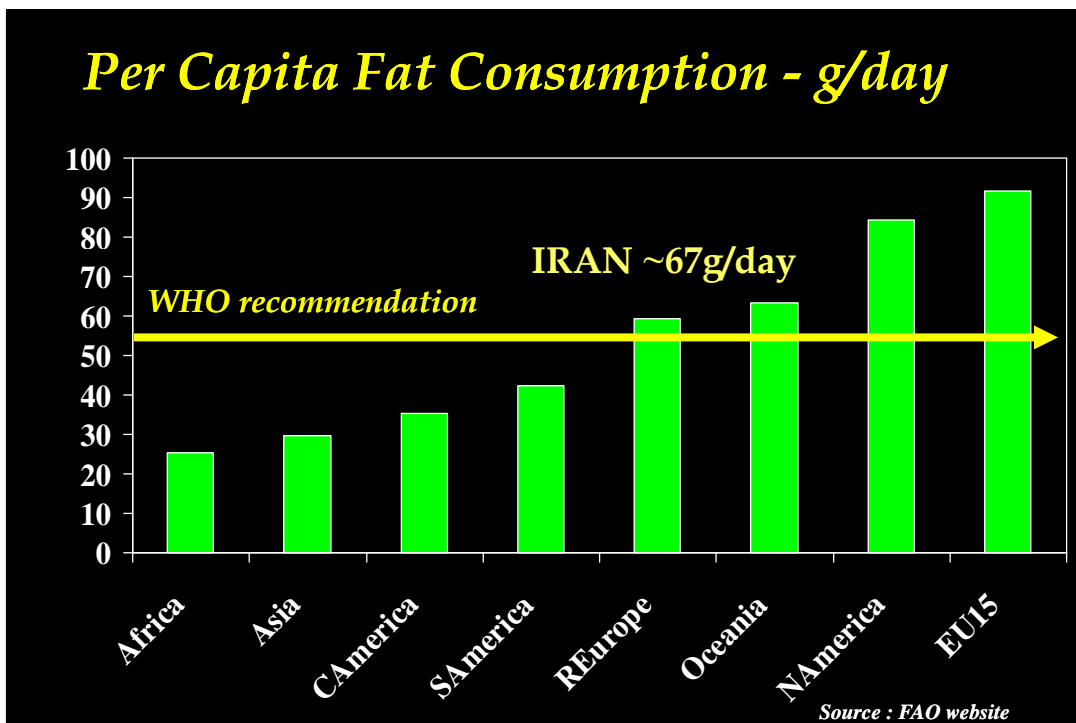


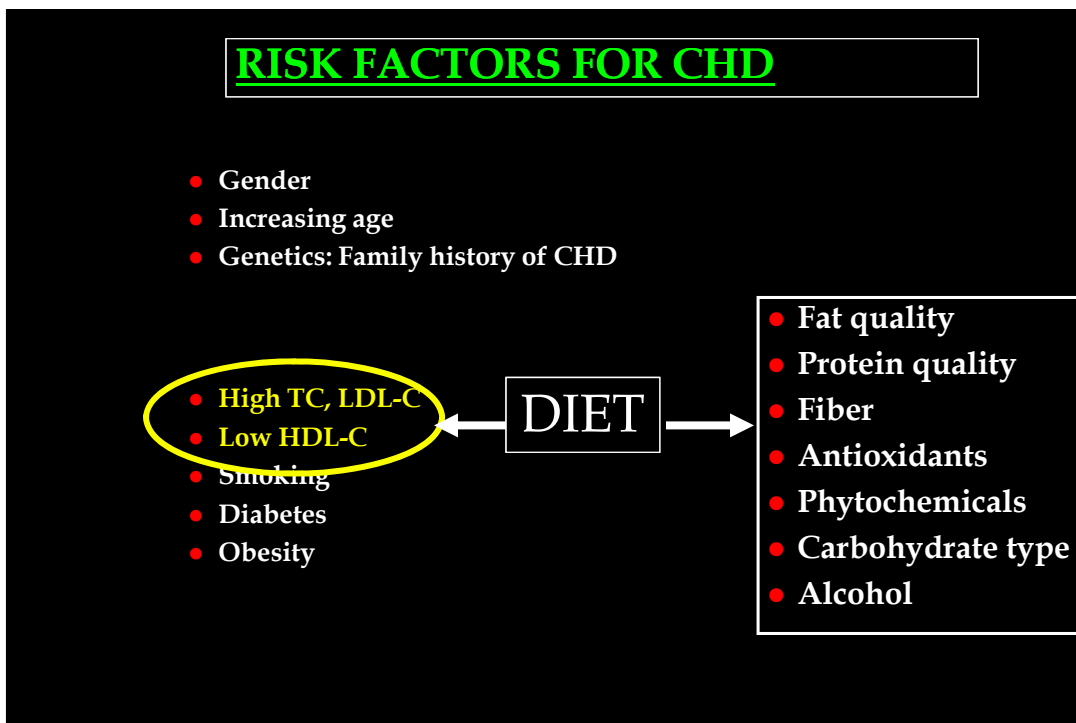
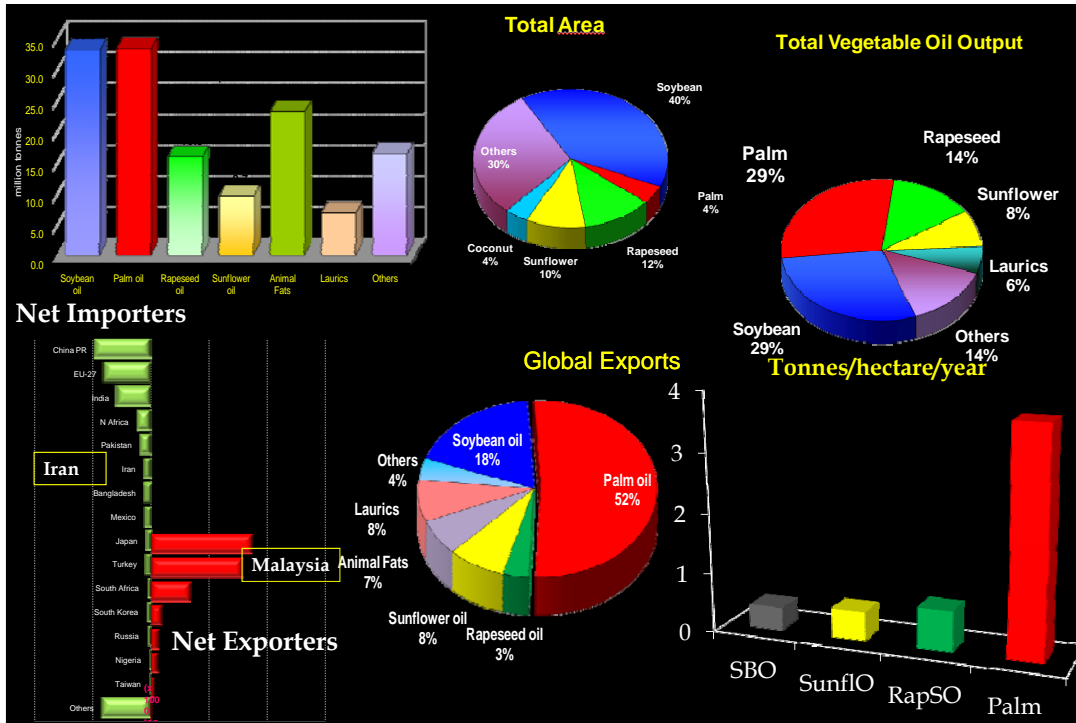
## *Diet and Lifestyle changes*

- **Fat quality**
- Protein quality
- Fiber
- **Antioxidants**
- **Phytochemicals**
- Carbohydrate type
- Alcohol

# OIL PALM

- No smoking
- Maintain a healthy body weight
- Low to moderate intensity exercise 30-45 mins/day



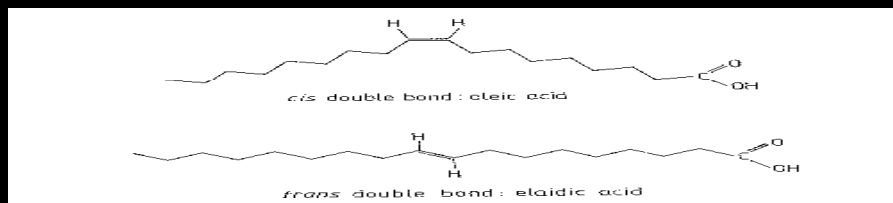


## Dietary fat composition: by fatty acid classes



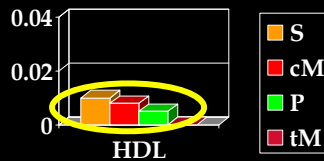
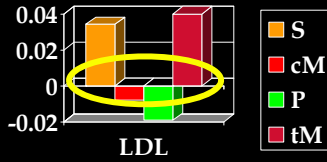
## ..we also have trans fatty acids

- Unsaturated fatty acids - at least one *trans* double bond

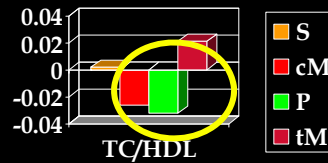


- Partial **hydrogenation** of polyunsaturated oils - isomerization and migration of double bonds - distribution of *cis* and *trans* double bonds (margarines, shortenings, salad & cooking oils)
- Partial hydrogenation → tFA. Full hydrogenation → SFA
- Major tFA - elaidic acid (t9 - 18:1)
- Dairy and meats have t9 - 16:1 and t11 - 18:1 (vaccenic acid)

**So what are the effects of fatty acids classes on lipoprotein cholesterol?**

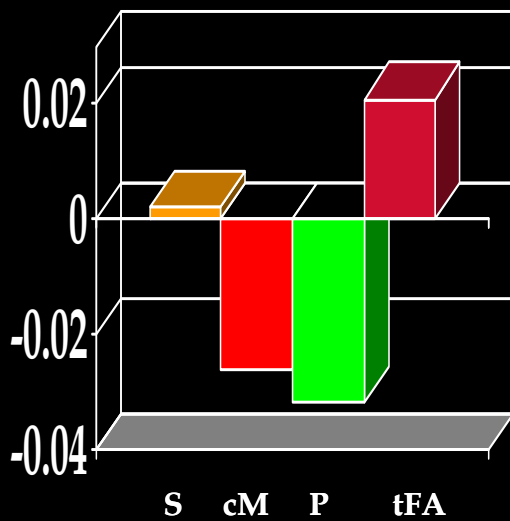


**MUFA & PUFA best.  
Trans worse than SFA**

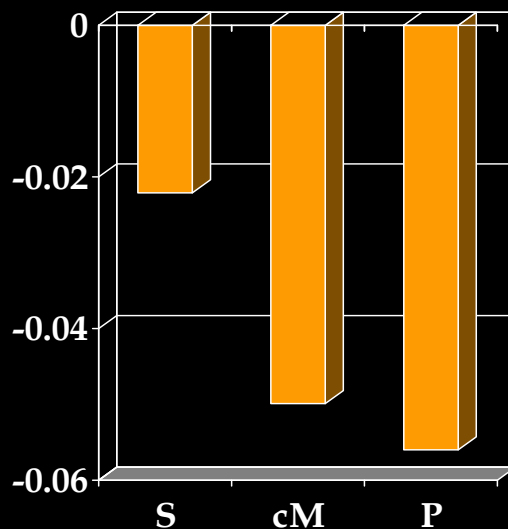


Changes shown in mmol/L for LDL and HDL. Adapted from Mensink et al Am J Clin Nutr (2003) 77: 1146-1155

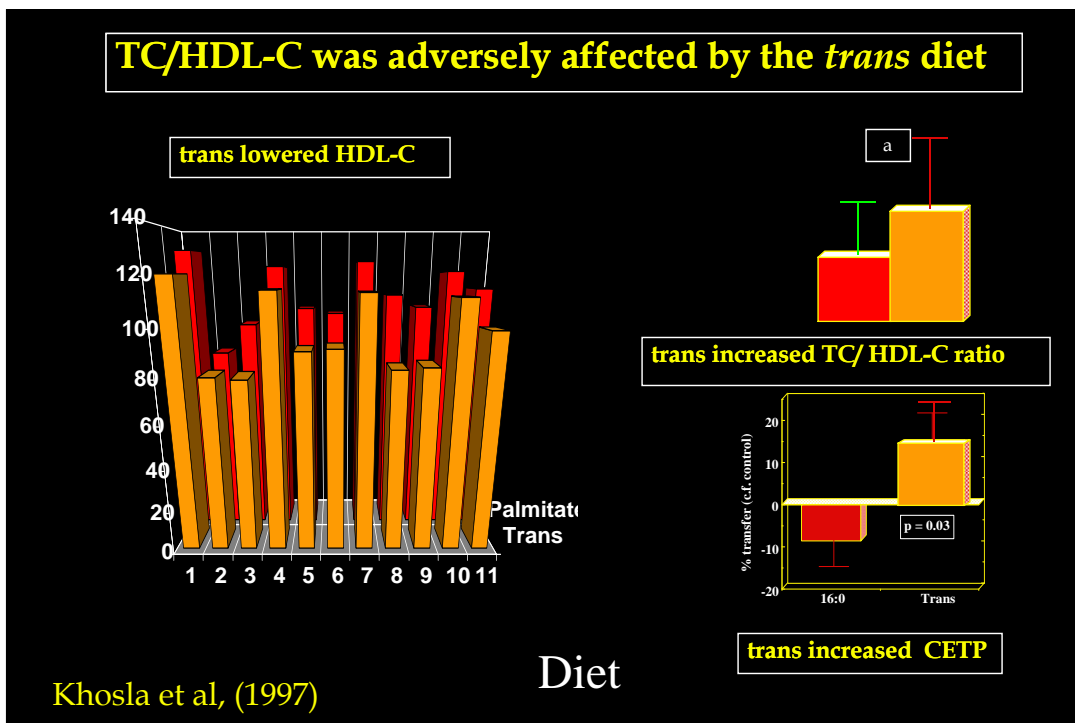
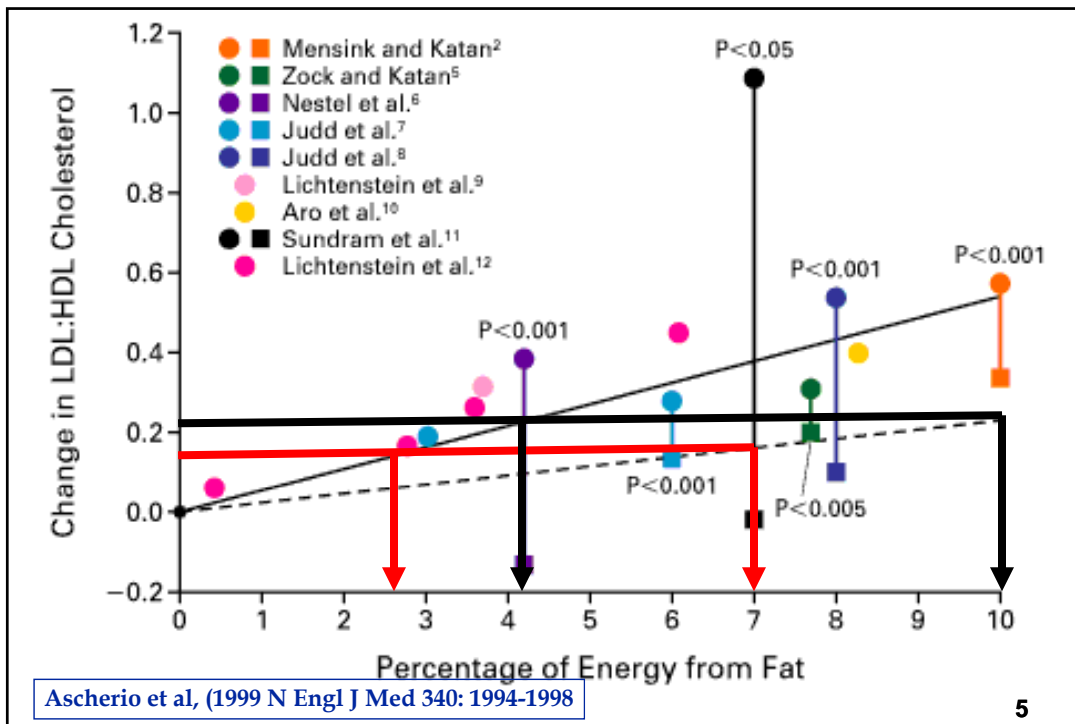
**Effects on the TC/HDL-C ratio**



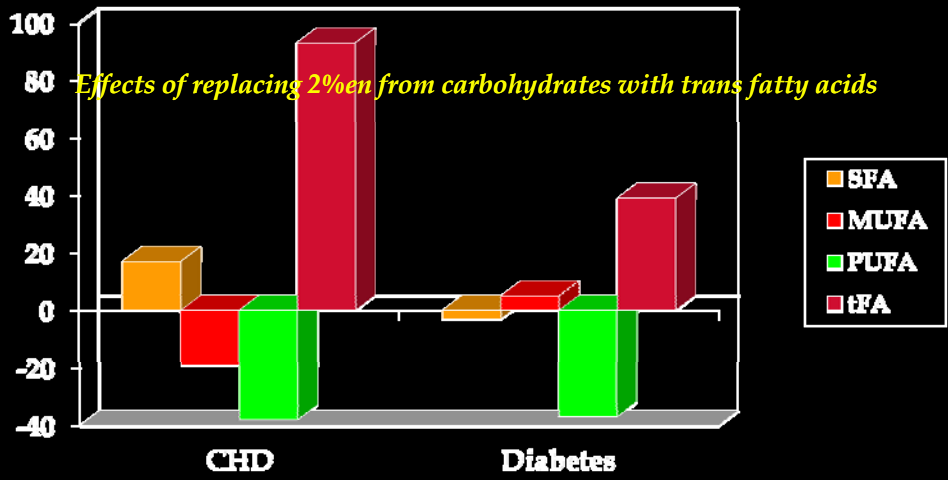
Am J Clin Nutr (2003) 77: 1146-1155



N Engl J Med (2006) 344: 1601-1613



### Dietary Fat intake and Risk of CHD and Type II Diabetes (TIID) in Women

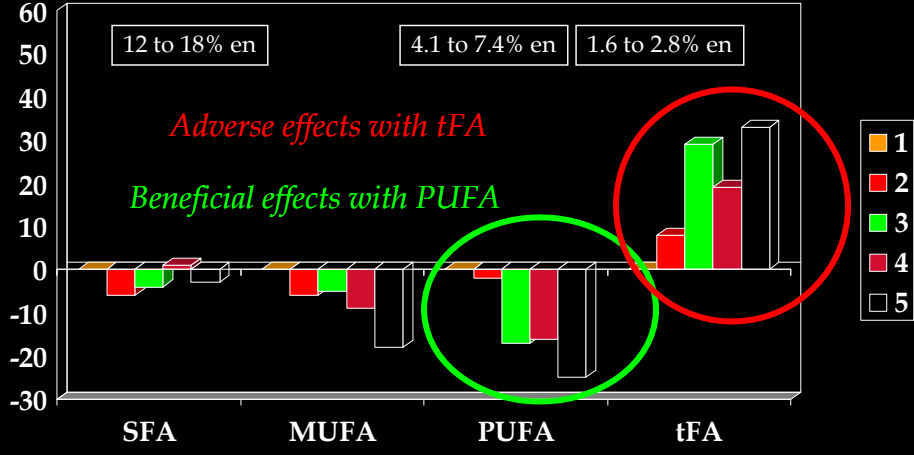


*Effects of replacing 5% en from carbohydrates with specific fatty acids*

CHD data - Hu et al, (1997) N Engl J Med, 337: 1491-1499

Type II Diabetes data - Salmeron et al, (2001) Am J Clin Nutr 73: 1019-1026

### Relative risk of CHD based on quintiles of dietary fatty acid intake (Multivariate analyses) 20 year follow-up data from the Nurses Health Study



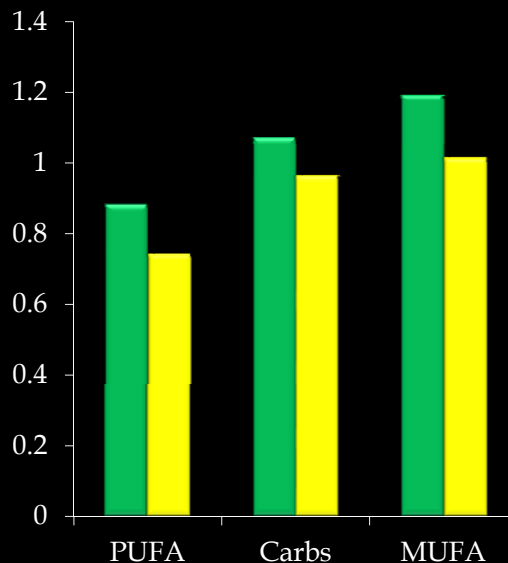
from Oh et al (2005) Am J Epidemiol, 161: 672-679

*Skeaff and Miller , (2009) Am. Nutr. Metab. 55: 173-201*

- A meta-analysis of 28 cohort studies – 6,600 CHD deaths, 280,000 participants, approx. 3.7 million person-years of follow-up. Duration of follow-up: 4 to 25 years. Most studies were from North America and Europe. Nineteen of the 28 cohorts included only men. The age at recruitment varied from 40 to 65 years.
- **When comparing low SFA intakes (7-11% total calories) to high SFA intakes (14-18% total calories), SFA intake was not associated with CHD mortality (RR - 1.14; p=0.43) or CHD events (RR - 0.93; p=0.27)**
- Additionally, with 5% energy increments from SFA there was no association with CHD mortality (RR - 1.11; p=0.59) or CHD events (RR - 1.03; p=0.72)

*Replacing SFA with different fatty acids or carbohydrates*

- Pooled analysis of 11 studies. 4-10 year follow-up
- Pooled RR evaluated in 344,696 subjects (5,249 coronary events, 2155 coronary deaths)
- Effect of 5% lower energy intake from SFA with a simultaneous higher energy intake from PUFA, carbs or MUFA is shown for **coronary events** and **coronary deaths**



*Jakobsen et al , (2009) Am J Clin Nutr 89: 1425 - 1432*

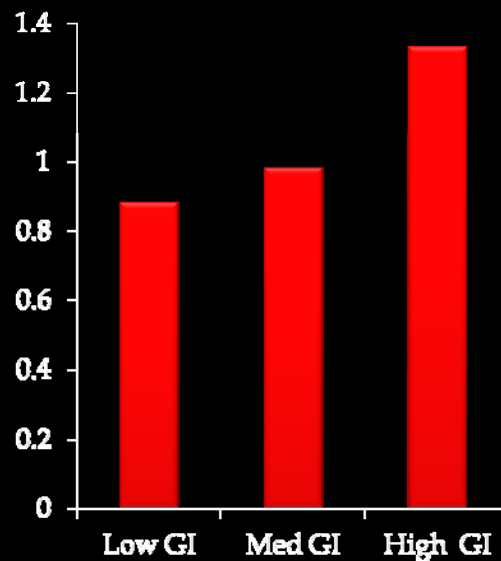


*Jakobsen et al , (2009) Am J Clin Nutr 89: 1425 - 1432*

- Overall , **significant inverse association** between substitution of PUFA and risk of coronary events and coronary deaths.
- Overall, indication of a direct association between substitution of MUFA and risk of coronary events – but not coronary deaths
- Overall, **significant direct association** between substitution of carbohydrates and risk of coronary events – but not coronary deaths
- Using substitution models the results suggest that replacing SFA with PUFA – not carbohydrates or MUFA - would be beneficial

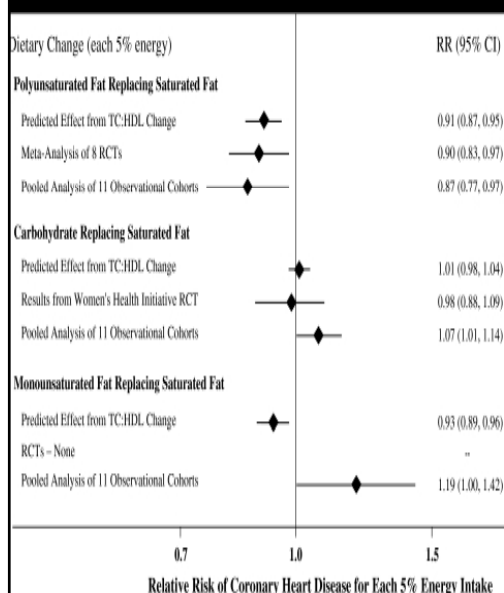
*Exchanging 5% calories from SFA with carbs of different GI values*

- Prospective cohort study. Median 12 year follow-up
- Hazard Ratio evaluated in 53, 644 subjects [1, 943 cases of incident myocardial infarction (MI)]
- For a 5% lower energy intake from SFA with a simultaneous higher energy intake from carbs with different GI values
- Significant association with high GI carbs



*Jakobsen et al , (2009) Am J Clin Nutr 89: 1425 - 1432*

## Effects on CHD risk of consuming PUFA, carbs , or MUFA in place of SFA



*Predicted effects are based on changes in the TC:HDL-C ratio*

*Evidence from a meta-analysis of eight randomized controlled trials*

*Evidence for observed relationships of usual dietary habits with CHD events comes from a pooled analysis of 11 prospective cohort studies.*

*Micha and Mozaffarian, (2010) Lipids. 45: 893-905*

## Meta-analysis of 21 prospective epidemiologic studies showed no significant evidence for concluding SFA are associated with increased CHD risk

- 5-23 year follow-up
- Pooled RR evaluated in 347, 747 subjects (11, 006 developed CHD or stroke)
- SFA intake was not associated with

CHD (Pooled RR - 1.07; 95% CI 0.96 - 1.19, p=0.22)

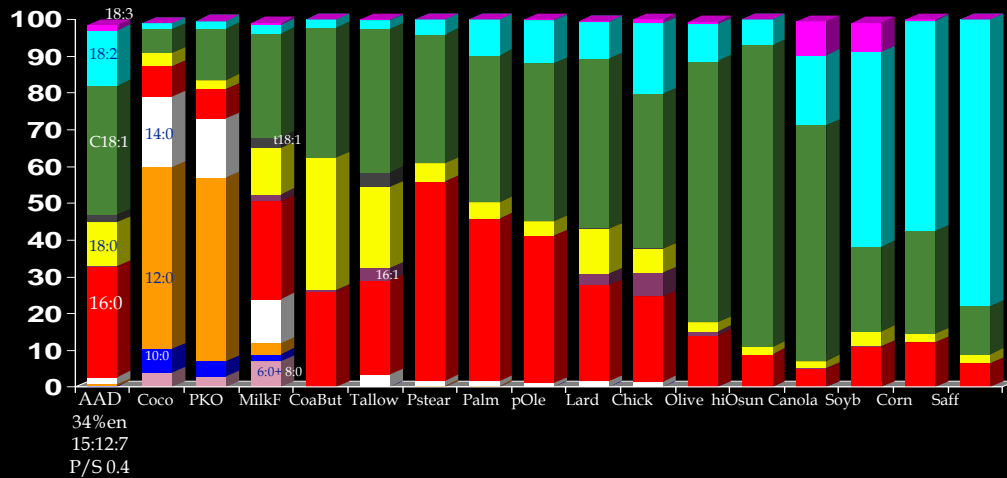
Stroke (Pooled RR - 0.81; 95% CI 0.62 - 1.05, p=0.11)

CVD - (Pooled RR - 1.00; 95% CI 0.89 - 1.11, p=0.95)

*Siri-Tarino et al , (2010) Am J Clin Nutr 91: 535 - 546*

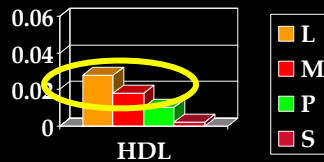
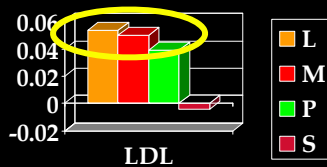
## Dietary fats comprised of individual fatty acids - especially important for SFA

Fatty Acid Classes

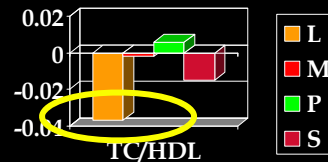


10/25

## Effects of individual SFA on lipoprotein cholesterol



*14:0, 16:0 no effect  
18:0, 12:0 beneficial*



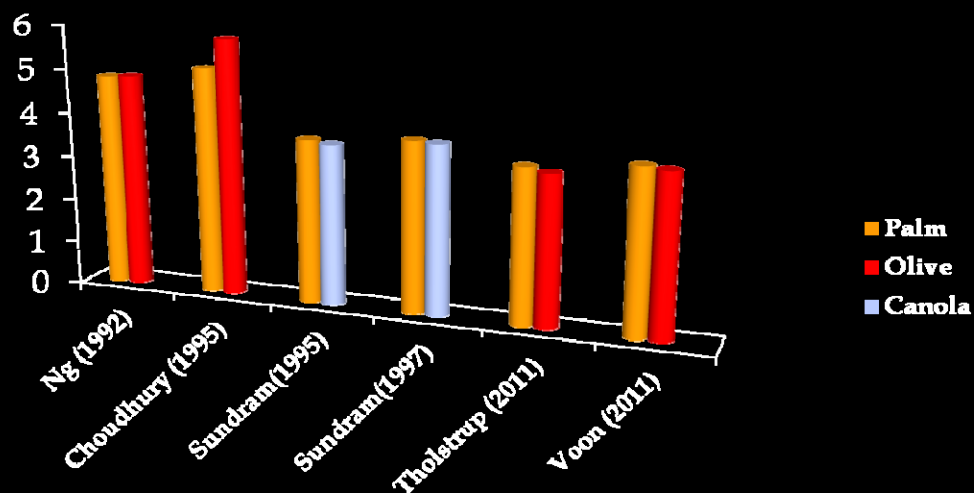
Changes shown in mmol/L for LDL and HDL. Adapted from Mensink et al Am J Clin Nutr (2003) 77: 1146-1155

*conservative -- based on current recommendations for SFA  
 --can calculate the amount of palm oil in a prudent diet that  
 satisfies various dietary guidelines*

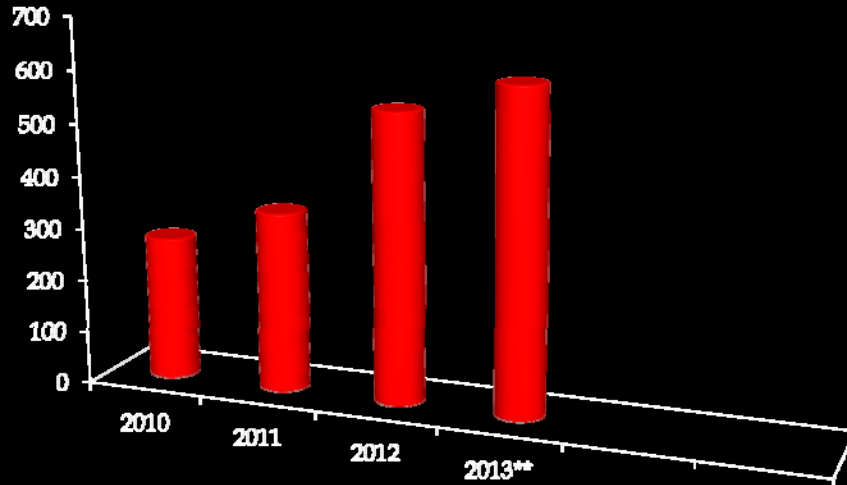
% calories from SFA	% calories from total fat				
	20	25	30	35	40
5	54	43	36	31	27
6	65	52	43	37	32
7	76	61	51	43	38
8	87	69	58	49	43
9	97	78	65	56	49
10	100**	87	72	62	54

Khosla (2006) J Agro Food Ind. 17: 21-23  
 Hayes and Khosla, Eur J Lipid Sci Tech (2007) 109: 453-464

*Palm Olein and MUFA-rich Oils exert similar effects on the ratio of  
 Total cholesterol to HDL cholesterol (TC/HDL-C) in human subjects*



### Irans' Imports of Malaysian Palm Oil (x 1000 tonnes)



\*\* Jan - Nov 2013

### ... .. practical aspects

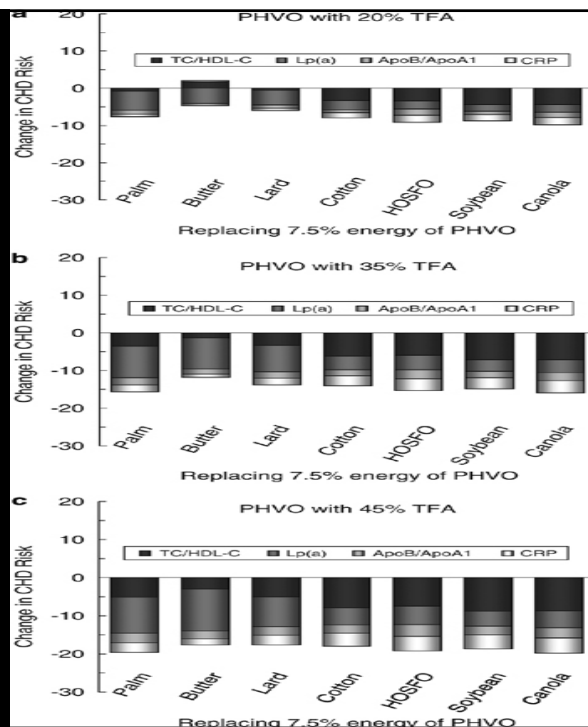
SFA vs tFA- not a realistic comparison

Look at specific fats/oils replacing PHVO containing tFA

CHD risk based not just on changes in plasma lipoproteins.

Report of [Mozaffarian and Clarke \(2009\)](#) is of interest

Also risk assessment papers ([Barraj et al 2008](#), [Mente et al 2009](#))



## Fatty acids in Iranian foods

### Fatty acids in fast-foods

- Sausage, calbas, hamburgers, pizza
- Stearic acid 14% to 21%
- Palmitic acid 2% to 14%
- Trans FA ~24% to 31%

- Elaidic acid most common tFA

### Fatty acids in edible oils

- PHVO, cooking oils (unhydrogenated), frying oils

	PHVO	CO	FO
SFA	28.4	9.4	18.9
TFA	35.2	0.9	2.6
C-unsat	34.9	83.4	72.3

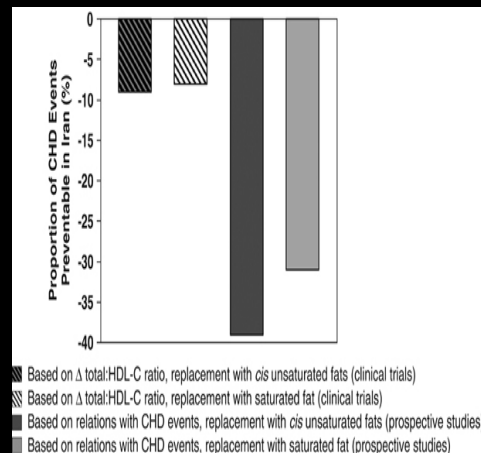
- Elaidic acid most common tFA

[Asgary et al. \(2009\)Asia Pac J Clin Nutr 18 \(2187-192](#) [Asgary et al. \(2009\) J Res Med Sci 14 \( 211-215](#)

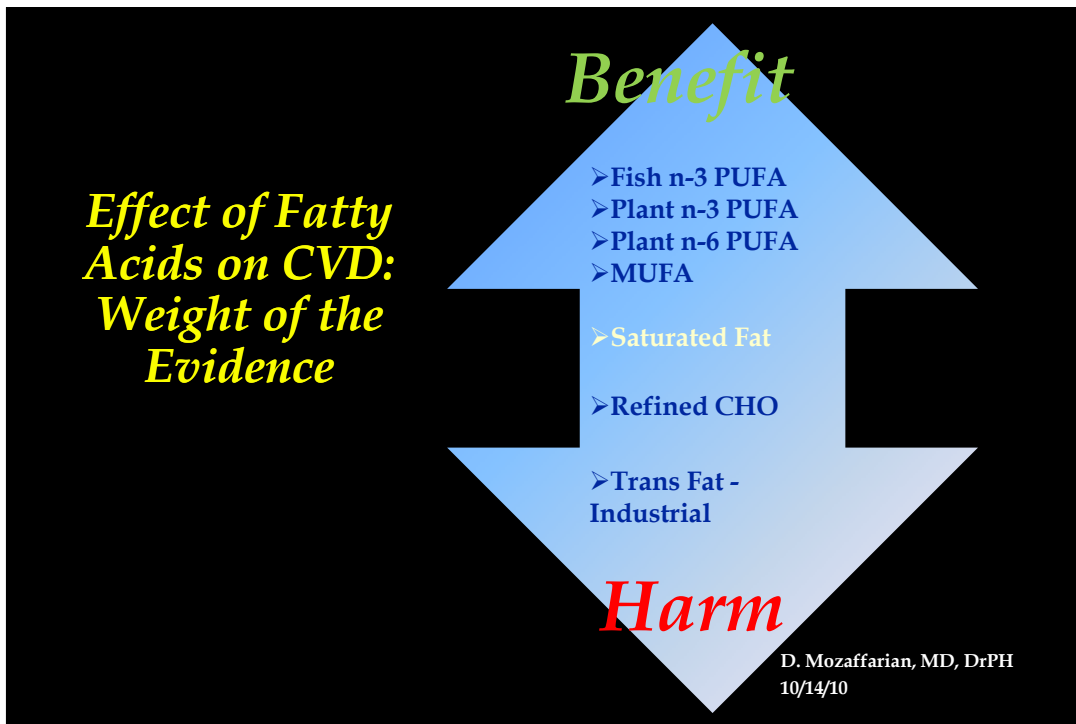
## Reductions in CHD by replacing TFA from PHVO with cis MUFA or SFA

### Home consumption 2001-2003

- 2636 kcal consumed
- 25% calories from fat (73g)
- 14g/1000 kcal of PH cooking oils
- 37 g PH cooking oils total (12.5% total calories)
- Typical tFA content of cooking oils ~ 33%
- tFA consumption ~4.2% of total calories (~12.3 g/day at home)



[Mozaffarian et al \(2007\) Eur. J. Clin. Nutr. 61, 1004-1010](#)



**Skeaff and Miller, (2009) Ann. Nutr. Metab. 55: 173-201**

	Fatal CHD	CHD events
Total Fat	C-NR	C-NR
TFA	<b>P</b>	<b>C</b>
SFA/CHO	P-NR	P-NR
MUFA/SFA		
PUFA/SFA	<b>C</b>	<b>C</b>
Linoleic acid		
Alpha Linolenic		
n3 LCPUFA	<b>P</b>	<b>C</b>

**Dietary Fatty Acids and CHD: Summary of the Evidence**

**C = Convincing evidence; P = Probable evidence; NR - no relation; Red denotes increased risk while Green denotes decreased risk**

## Diet and Lifestyle changes

- Fat quality
- Protein quality
- Fiber
- Antioxidants
- Phytochemicals
- Carbohydrate type
- Alcohol

OIL  
PALM

- No smoking
- Maintain a healthy body weight
- Low to moderate intensity exercise 30-45 mins/day

## "Vitamin A" activity of red palm oil

	RE Per 100 g	Relative quality (Times <red palm oil)
Red Palm Oil	30,000	-
Carrots	2,000	15
Leafy Vegetables	685	44
Apricots	250	120
Tomatoes	100	300
Bananas	30	1000
Orange Juice	8	3,750

Phytoene	2.0%
Phytofluene	1.2%
Cis-β- Carotene	0.8%
β - Carotene	47.4%
α- Carotene	37.0%
Cis- α- Carotene	6.9%
ζ- Carotene	1.3%
δ - Carotene	0.6%
γ - Carotene	0.5%
Neurosporene	Tr
β - Zeacarotene	0.5%
α - Zeacarotene	0.3%
Lycopene	1.5%

Numerous human studies showing efficacy of red palm oil in fighting Vitamin A deficiency



*...studies have adopted different methods to provide Vitamin A naturally*

- Children fed traditional Indian sweets made with redPO
- School children fed biscuits baked with redPO
- School children given 5 - 10 mL redPO daily
- Cooking green leafy vegetables in redPO
- Also Vitamin A status improved by feeding redPO to pregnant mothers at various stages of pregnancy.
- Also lactating mothers



*Numerous human studies showing efficacy of red palm oil in fighting Vitamin A deficiency*

## *Nutritional attributes of Palm Oil & Palm Olein*

- Variety of carotenoids (Vitamin A)
- Vitamin E (tocopherols and tocotrienols)

Oil	Tocopherols(ppm)				Tocotrienols(ppm)				Ppm T+T3
	$\alpha$ T	$\beta$ T	$\gamma$ T	$\delta$ T	$\alpha$ T3	$\beta$ T3	$\gamma$ T3	$\delta$ T3	
Red Palm Oil	152	-	-	-	205	-	439	94	890
Soyabean	101	-	593	264					985
Cornoil	112	50	602	18					782
Groundnut	130	-	216	21					367
Safflower	387	-	174	240					801
Sunflower	487	-	51	8					546

*Numerous in vitro studies showing efficacy of tocotrienols in inhibiting cancer cell proliferation and decreasing neurodegeneration.*

*A pilot human breast cancer clinical trial was not definitive*

*A series of studies show efficacy against lung cancer and Phase I human studies are the next logical step*

*Ongoing human stroke prevention trial is recruiting subjects. An earlier study from our lab helped establish the dose*

*Evidence that tocotrienols may lower blood lipids - and possible synergy with statin drugs has been suggested??*

*Recent study in dialysis patients from our laboratory*

## *Summary*

In Iran - even though total fat intake is within WHO parameters, trans fatty acid consumption is substantially higher .

With high imports of palm oil, Iran can eliminate trans with appropriate labeling and policy decisions

Palm Oil can serve a multitude of nutritional needs

Supply of palm oil makes it *the* important player globally

Fatty acid profile of palm eliminates need for hydrogenation

Minor components (antioxidant/phytochemicals) help alleviate micronutrient deficiencies using food-based approach AND show promise for preventative route in certain chronic disease

Additional details: [J. Am. Coll. Nutr. \(2010\), 29 \(3S\) 237-340](#)