Predictive Model to Estimate Potential Impact of High Oleic Oils on Dietary Fatty Acid Intakes in Adult Americans

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Introduction

Food production affords opportunities to select from a variety of commercially available, including trait enhanced, fats/oils to achieve specific functional product characteristics. These choices may also impact consumers' dietary fat intakes and related health outcomes. A replacement scenario was created to simulate increased use of high oleic oils and estimated impact on cardiovascular disease (CVD) risk.

Methodology

Consumption data for individuals 20+ years of age from the National Health and Nutrition Examination Survey (NHANES) 2011-2012 were used. Fatty acid composition was obtained from USDA Standard Reference Database 26 (SR26) [1] and high oleic oil experts (Table 1.). Soybean, canola and sunflower oils, as reported, were replaced 1:1 by their high oleic oil counterparts. Each eligible eating event had an 80% probability of being replaced (Figure 1.) because it was assumed that product functionality and other factors will limit the extent to which trait-enhanced high-oleic commercial oils are incorporated into the food supply.

Table 1. Energy values (kcal/100 g) and fatty acid profiles (g/100 g of oil) of the original oils as defined by SR26 and of HOO

		SR26 Oils		HOO	
Fatty acid names according to SR26	Scientific name	"Oil, canola"	"Oil, soybean, salad or cooking"	HO Canola Oil	HO Soybean Oil
16:00	16:0, palmitic acid	4.30	10.46	3.57	6.00
16:1 undifferentiated	16:1n-7, palmitoleic acid	0.21	0	0	0.10
17:00	17:0,margaric acid	0	0.03	0	0.68
17:1		0	0	0	1.45
18:00	18:0, stearic acid	2.09	4.44	1.69	4.06
18:1 undifferentiated		61.74	22.55	72.40	73.30
18:1 c	18:1n-9, oleic acid	61.71	22.55	0	0
18:1 t		0.03	0	0	0
18:2 undifferentiated		19.01	50.95	15.57	7.64
18:2 n-6 c,c	linoleic acid	18.64	50.42	0	0
18:2 t,t		0.37	0.53	0	0
18:3 undifferentiated		9.14	6.79	3.07	2.32
18:3 n-3 c,c,c (ALA)		9.14	6.79	0	0
20:00	20:0, arachidic acid	0.65	0.36	0.89	0.39
20:1		1.32	0.23	1.49	0.29
22:0	behenic acid	0.33	0.37	0.50	0.39
24:00	24:0, nervonic acid	0	0	0	0.10
Fatty acids, total monounsaturated		63.28	22.78	73.89	75.04
Fatty acids, total polyunsaturated		28.14	57.74	18.65	9.96
Fatty acids, total saturated		7.37	15.65	6.64	11.60
Fatty acids, total trans		0.40	0.53	1.00	0
Energy		884	884	884	884

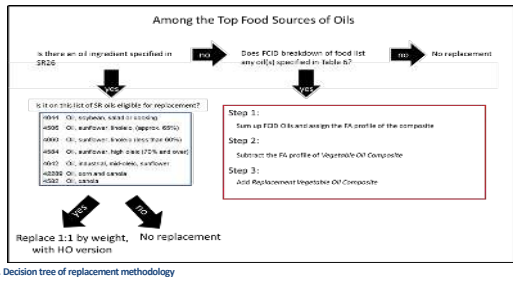

Figure 1. Decision tree of replacement methodology

In addition to only having an 80% chance of being replaced, only foods within specific food groups were eligible for replacement. Specifically, the Food Groups that are the highest contributors to oil intakes in the U.S. diet were considered eligible for replacement. To determine what group to include, the Food Groups were ranked in terms of their contribution to oil consumption according to the WWEIA NHANES 2011-2012 Survey [2] as follows:

Foods consumed were replaced by the individual raw agricultural commodities according to the Food Commodity Intake Database (FCID) [3] and the consumption of each of these FCID components or commodities was calculated using the Creme Nutrition® Intake model. Of these food commodities, the intakes of each of the vegetable oils per Food Group were assessed for the total population. The value of each oil intake was summed per Food Group and expressed as a percentage of total oil consumption. The groups were arranged in descending order of their percentage of total oil consumption. Food Groups at the 3-digit food code level were selected covering 3/4th of the oils consumed, in addition to these, the next two top contributing Food Groups were also selected as they were direct substitutes for Food Groups already included (e.g., added 715 White potatoes, mashed, stuffed, puffed to complete the primary potato sources and 513 Wheat, cracked wheat breads, rolls as they are substitutes for white bread versions). The result of adding these two Food Groups was coverage of 78.32% of oil intake (Table 2). This selection of Food Groups created a subset of Food Groups which was eligible for replacement.

Table 2. Top ranking Food Groups in terms of oil contribution to the US diet

Group Code	Group Name	% Contribution	Contribution (g/day)
581	Mixtures, mainly grain, pasta, or bread	12.49	3.80
831	Regular salad dressings	11.35	3.45
714	White potatoes, fried	6.47	1.97
544	Salty snacks from grain products	5.63	1.71
532	Cookies	5.48	1.67
712	White potatoes, chips and sticks	4.34	1.32
241	Chicken (breast; leg; drumstick; wing; back; neck or ribs; misc.)	4.00	1.22
511	White breads, rolls	3.84	1.17
275	Sandwiches with meat, poultry, fish	3.51	1.07
531	Cakes	2.85	0.87
811	Table fats	2.40	0.73
535	Danish, breakfast pastries, doughnuts	2.32	0.71
274	Meat, poultry, fish with vegetables (excluding white potatoes)	2.12	0.65
543	Nonsweet crackers	1.98	0.60
122	Cream substitutes	1.67	0.51
261	Finfish	1.46	0.44
751	Other vegetables, raw	1.32	0.40
533	Pies (fruit pies; pie tarts; cream and custard pies; miscellaneous pies; pie shells)	1.30	0.40
521	Biscuits	1.28	0.39
715	White potatoes, mashed, stuffed, puffs	1.27	0.39
513	Wheat, cracked wheat breads, rolls	1.24	0.38
Subtotal		78.32	23.82
Excluded Groups			
412	Egg dishes (mixtures made with whole eggs)	1.17	0.36
531	Cornbread, corn muffins, tortillas	1.04	0.32
573	Vegetable oils	0.95	0.29
634	Potato salad	0.92	0.28

Table 3. Oil contributors and their respective quantities in the Vegetable Oil Composite

SR code	Vegetable Oil Composite*	Replacement Vegetable Oil Composite	% of recipe
	SR description		
4044	Oil, soybean, salad or cooking	HO Soybean oil	47
4582	Oil, canola	HO Canola oil	25
4518	Oil, corn, industrial and retail, all purpose salad or cooking	Unchanged	12
4053	Oil, olive, salad or cooking	Unchanged	12
4042	Oil, peanut, salad or cooking	Unchanged	4

*The Vegetable Oil Composite from the USDA [7] when a food commodity was described as "Vegetable Oil, NFS", NFS meaning not further specified.

Results

Differences in mean daily intakes after substituting in high oleic oils for oils listed in SR26 (modelling scenario intakes – baseline intakes) are as follows: MUFA +4.3 g, SFA –0.3 g, PUFA –3.5 g, and TFA –0.04 g among adults aged 20+ years (Table 4).

These changes in dietary fatty acid intake can be used to predict their impact on blood cholesterol, and along with other markers (e.g. blood pressure), to estimate potential changes in CVD risk.

Table 4. Differences in intakes (modelling scenario intakes *minus* baseline intakes) of Fatty acids (g/day) and Energy (kcal/day) among adults aged 20+ years (n = 4309) in NHANES 2011 – 2012

Fatty acid names according to SR26	Scientific name	Mean	Mean Err	Median	Median Err	P10	P10 Err	P90	P90 Err
16:00	16:0, palmitic acid	-0.36	-0.01	-0.41	-0.01	-0.19	0.00	-0.43	0.01
16:1 undifferentiated	16:1n-7, palmitoleic acid	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17:00	17:0, margaric acid	0.05	0.00	0.05	0.00	0.02	0.00	0.08	0.00
17:01		0.11	0.00	0.10	0.00	0.04	0.00	0.20	0.00
18:00	18:0, stearic acid	-0.04	0.00	-0.05	0.00	-0.02	0.00	-0.09	0.00
18:1 undifferentiated		4.44	0.04	4.31	0.00	1.89	0.05	7.33	0.12
18:2 undifferentiated		-3.04	-0.02	-3.00	-0.06	-1.48	-0.03	-4.42	-0.09
18:3 undifferentiated		-0.37	0.00	-0.39	0.00	-0.22	0.00	-0.51	-0.01
20:00	20:0, arachidic acid	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.00
20:01		0.01	0.00	0.01	0.00	0.01	0.00	0.02	0.00
22:00	behenic acid	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00
24:00		0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00
Fatty acids, total monounsaturated		4.31	0.03	4.03	0.03	1.87	0.02	7.13	0.13
Fatty acids, total polyunsaturated		-3.53	-0.02	-3.42	-0.02	-1.85	-0.04	-5.28	-0.20
Fatty acids, total saturated		-0.33	-0.01	-0.37	0.02	-0.15	0.01	-0.48	0.03
Fatty acids, total trans		-0.04	0.00	-0.04	0.00	-0.02	0.00	-0.06	0.00
Total lipid (fat)		0.00	-0.01	0.00	0.01	0.00	0.02	0.04	0.08
Energy (kcal)		0.00	0.51	0.03	-0.09	0.17	0.06	0.13	0.69

References

[1] SR26:
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[1] Creme Global
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