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Abstract

Historically, many snack foods had been formulated with hydrogenated vegetable oils, the primary contributor of *trans* fatty acids (TFA) in the US diet. Health concerns about TFA and saturated fat intake and increased risk for chronic health disorders have prompted some manufacturers to reformulate their products. In response to these changes and the new food labeling mandate for declaration of TFA, data are being updated and expanded in the USDA National Nutrient Database for Standard Reference (SR). The SR, a repository of information for over 7,000 foods and over 100 nutrients, is the foundation for most nutrient databases and supports nutrition monitoring research and policy development. The USDA National Food and Nutrient Analysis Program (NFNAP) is generating new analytical data for fatty acids and other nutrients through a rigorous, nationally-representative sampling approach. Under NFNAP, fatty acids are determined by gas chromatographic quantification of fatty acid methyl esters. The resulting data, along with analytical industry fatty acid data, were compiled for select high consumption snacks. Total fat and fatty acid data were compared to values obtained prior to reformulation for cheese puffs, tortilla chips, corn chips, and other snacks; significant decreases in *trans* fat were observed for most of these snack foods.

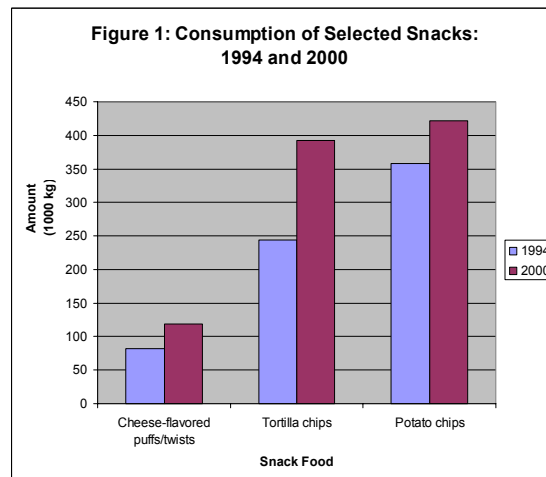
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Introduction

The principal source of *trans* fatty acids (TFA) in the diet of the US population is industrially hydrogenated vegetable oils, introduced in the early 1900s. Hydrogenation increases thermal and oxidative stability which results in a desired firmness and plasticity to certain processed foods. The first table of TFA content of foods was disseminated on the Nutrient Data Lab (NDL) Web site (www.nal.usda.gov/fnic/foodcomp) in 1995. TFA content of numerous foods have been analyzed since 1998 under the USDA National Food and Nutrient Analysis Program (NFNAP).

Biochemical differences between *trans* and *cis* isomers have led to safety concerns regarding TFA intake. The Institute of Medicine¹ cited a positive linear trend between TFA intake and total and LDL cholesterol. In July 2003, the FDA issued a final rule requiring that by January 1, 2006, *trans* fat grams must be listed directly below saturated fat on the food label². Under labeling regulations, TFA content is expressed as g/serving (28 g), to the nearest 0.5 g increment below 5 g. If a serving contains less than 0.5g, the declared content is "0"².

Consumption of snack foods, a source of hydrogenated oils and shortenings, has increased steadily in the US. Figure 1³ shows the increase in consumption of select categories of popular snacks analyzed under NFNAP. When manufacturers reformulated some of their products to minimize TFA content, e.g., Frito-Lay Doritos[®], Tostitos[®] and Cheetos^{®4}, NDL targeted these products for analysis.



Methods

Through a Specific Cooperative Agreement between the University of Maryland at College Park and the USDA, complete fatty acid analyses including *trans*-isomers, are being made on selected foods identified as traditional key contributors to TFA intake.

Sampling

A nationally representative sampling frame for retail foods, including snacks, was developed for the 48 conterminous states⁵. The country was divided into 4 regions of similar population size (65-68 million). Within each region, 3 generalized Consolidated Metropolitan Statistical Areas (gCMSAs, based on 1990 Census CMSAs) were randomly selected to provide coverage for large, medium, and smaller populations. Within each gCMSA, 2 counties were selected based on urbanicity (i.e., urban, suburban, and rural demographics). Within each county, 1 retail location was randomly selected from a pool of supermarkets with sales volumes exceeding \$2 million/yr. According to this design, products were picked up in 12 locations across the US. These foods have been sampled according to a probability-proportional to market share design (i.e., brand names) within each snack food type; to date, approximately 8 snack foods have been sampled for nutrient analysis.

Methods

Fatty Acid Analysis

- Fatty acid methyl esters (FAME) were prepared without prior extraction⁶
- Crude FAME were purified using a mini column of silicic acid to remove polar and pigmented substances

- FAME were separated on a 30 m x 0.25 mm capillary column coated with SP2380 using an HP5890 II chromatographic system equipped with an auto-analyzer; individual peaks were identified based on retention times of authentic FAME and quantified with response factors (from analysis of commercial standard mixtures)

- The proportion of *trans*- and *cis*- 18:1 was calculated with correction factors determined by separation of *cis* and *trans* fatty acids using silver nitrate thin layer chromatography and a 100m CP-Sil 88 capillary column⁷

- Samples containing fatty acids shorter than 14 carbons were also quantified as butyl esters essentially as described previously⁸ using a 25m Supelco "EQUITY™-1" capillary column; butyl ester values were converted to FAME and normalized to the FAME chromatogram

- FAME were converted to g fatty acid/100 g food using factors (based on relative molecular weights) developed by Sheppard⁹

fatty acid, g/100 g food = %ME/100 * total lipid, g/100 g food * MW acid/MW ME
where ME = methyl ester; MW = molecular.

Results and Discussion

Preliminary results for a representative sampling and analysis of several snacks foods under the NFNAP project are shown in Table 1. USDA analytical data are available for Cheetos Crunchy[®] Twists - before and after reformulation; *trans* fat dramatically decreased from 10.8g/100g to 0.53 g/100g. The principal *trans* fatty acid before reformulation was 18:1t, at 8.94 g/100 g; the remainder of the *trans* fat came from 18:2 isomers. All of the *trans* fat after reformulation was from 18:1t. The manufacturer calculated a *trans* total of 0.32 g/100 g. *Trans* fats in reformulated Cheetos Puffs[®] dropped from 10.8g/100g to 0.84 g/100g. For other products, analytical fatty acid data are available for only the old or new formulation; the manufacturer-calculated TFA content for reformulated snack items ranges from 0.07 - 0.14 g/100g. Although Nacho and Cooler Ranch Doritos[®] were reformulated from partially hydrogenated oils to vegetable oil (corn, soybean or sunflower) as the primary oils, they still contain very small amounts of partially hydrogenated oils and *trans* fat from cheese flavoring. TFA content decreased from approximately 4 g/100g to less than 1g/100g (Table 1). USDA potato chip data (1989-90) ranged widely in TFA (0.15-10.64 g/100g), depending on the oils used. For reformulated potato chips produced by one manufacturer, the calculated TFA value is 0.12 g/100g. Total fat (g/100g) did not change for the products examined.

Table 1. Total Fat and *Trans* Fat Content of Select Snack Foods

Product	Total <i>trans</i> g/100 g		Total <i>trans</i> g/28g	Total fat g/100g ²
	Before reformulation	After reformulation	After reformulation	Before/After reformulation
Doritos Cooler Ranch [®]	~4 ¹	0.35 ²	0.01 ⁴	25
Doritos Nacho [®]	~4 ¹	0.14 ²	0.00 ⁴	25
Cheetos Crunchy [®]	10.8 ²	0.53 ²	0.02 ²	35
Cheetos Puffs [®]	10.8 ²	0.84 ²	0.03 ²	35
Potato Chips, multi-brand	0.15 – 10.64 ^{2,3}	0.12 ⁴	0.04 ⁴	35

¹Calculated from formulation. ²USDA NFNAP/analytical data. ³TFA depends on oil used. ⁴Data based on one manufacturer

Conclusion

From 1993 to 2002, total snack sales volume increased from 5.5 to 6.5 billion pounds. If *trans* fat is reduced or eliminated in most of the savory snacks, one could expect a substantial drop in the *trans* level of the US diet. Data show that the *trans* fat levels in several popular snacks have decreased. The review of the data for other brands and types of snacks is underway. Data for *trans* fat in USDA food composition databases is being or has been revised; NDL will continue to monitor the TFA content of foods in anticipation of manufacturer reformulations in the near future.

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