NUTS AND SEEDS AS SOURCES OF ALPHA AND GAMMA TOCOPHEROLS

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ABSTRACT

Some nuts and seeds are among the highest natural sources of vitamin E in the US food supply. In its chief function as an antioxidant, vitamin E prevents free radical reactions, which is important in protecting cells from oxidative damage. Vitamin E has been associated with reduced risk of certain cancers such as colon, bladder, and prostate. Recent studies have focused on effects of gamma-tocopherol as well as alpha-tocopherol. Of the four tocopherols (alpha, beta, gamma, and delta), alpha-tocopherol is the only one used to estimate the current Recommended Dietary Allowances (RDA) for vitamin E. The other tocopherols are absorbed and may have other functions, but are not converted to alpha-tocopherol in the body. The RDA for vitamin E is 15 mg/day of alpha-tocopherol for adults. According to NHANES 2001-2002, more than 90% of adults do not meet the Estimated Average Requirement of 12 mg/day. Nuts and seeds are often cited as good sources of vitamin E. USDA has recently updated tocopherol values in several nuts and seeds in the USDA National Nutrient Database for Standard Reference (SR). Findings indicate 1 oz. portions of almonds, hazelnuts, and sunflower seeds provide greater than 20% of the RDA for vitamin E; and brazilnuts and pine nuts provide between 10 and 20% of the RDA. One-ounce portions of cashews, macadamias, pecans, pistachios, black and English walnuts, flaxseed, and sesame seeds all provide between 1 and 4% of the RDA. The highest nut and seed sources of gamma-tocopherol are black walnuts (28 mg/100g), pecans (24 mg/100g), pistachios (22 mg/100g), and English walnuts and flaxseed (20 mg/100g). These tocopherol values are derived from data from USDA studies, the food industry, and the scientific literature. Keeping SR up-to-date allows researchers to more accurately estimate nutrient intake, thus enabling them to more effectively study the relationships between diet and disease.

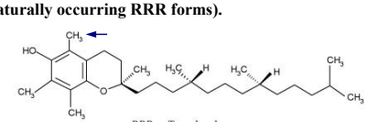
INTRODUCTION

Alpha- and gamma-tocopherols are both powerful antioxidants, but may play different roles in human health. The chemical structures differ only slightly. Alpha-tocopherol has a methyl group in the C-5 position, as shown in Figure 1. Alpha-tocopherol is found in higher concentrations in the body, but gamma-tocopherol is the most abundant tocopherol in the US diet. Alpha-tocopherol is the only tocopherol used to estimate the current Recommended Dietary Allowance (RDA) for vitamin E (IOM, 2000). Recent studies indicate gamma-tocopherol may help protect against colon and prostate cancers (Jiang 2001), while alpha-tocopherol may significantly reduce the risk of developing bladder cancer (Hernandez 2004).

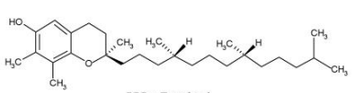
Considering the interest in dietary vitamin E (alpha-tocopherol) and gamma-tocopherol, and the fact that nuts and seeds are often cited as good sources of naturally-occurring vitamin E, we examined the levels reported for nuts and seeds in the USDA National Nutrient Database for Standard Reference (SR) and to identify which ones have the highest levels to contribute to the diet of the US population.

SR is the major source of food composition data in the United States. It provides the foundation for most food composition databases in the public and private sectors. As information is updated, the Nutrient Data Laboratory releases new versions of the database. SR, Release 19 (SR19) will be available on the Internet in summer 2006 at www.ars.usda.gov/nutrientdata. While the four tocopherols (alpha, beta, gamma, and delta) were added to SR beginning with Release 16, the vast majority of the available data is for alpha-tocopherol.

Figure 1. Chemical structures of alpha- and gamma-tocopherol (naturally occurring RRR forms).



RRR-α-Tocopherol



RRR-γ-Tocopherol

METHODS

The tocopherol data presented were obtained from various sources, as shown in Table 1. All of the data in Table 1 will be in SR19 except for almond butter, poppy seeds, sesame seeds, and sunflower seed butter. Data for these four food items will be included in SR20 (to be released in 2007). Sampling methods for each of the studies listed in Table 1 are described below.

Sampling

•International Tree Nut Council (INC) study – USDA, in collaboration with the nut industry, obtained samples of almonds, hazelnuts, macadamias, pecans, pistachios, and English walnuts from processing plants. These samples were representative of the predominant varieties and growing locations for each nut.
•Almond Board study – The Almond Board of California obtained 8 different types and brands of almond butter for analysis.
•National Food and Nutrient Analysis Program (NFNAP) – Samples of brazilnuts, cashews, pine nuts, flaxseed, poppy seeds, and sesame seeds were collected from 12 retail outlets throughout different regions of the United States using NFNAP's probability-based, nationwide sampling plan (Perry, 2001).
•Other USDA studies – Contracts from 1987 through 1997 in which the samples were primarily obtained from local retail stores and sent to a university lab for analysis.
•Hammons study -- Hammons Products Company obtained 12 bags of black walnuts which were composited into a single sample for analysis.
•National Sunflower Association (NSA) study – Representative samples from processing plants were sent to a commercial lab for analysis.

All nuts and seeds reported here were analyzed by commercial, university, or government labs using high performance liquid chromatography (HPLC) methodology. The number of datapoints (samples) analyzed are provided in Table 1.

Table 1. Alpha- and gamma-tocopherol values[1] for nuts and seeds in SR.

Nuts	Alpha-tocopherol mg/100g		Gamma-tocopherol mg/100g		Number Datapoints	Source(s) of Data
Almonds	25.87	± 1.35	0.89	± 0.08	4	USDA/INC study
Almond butter	24.21	± 1.08	1.01	± 0.07	8	Almond Board study
Brazilnuts	5.73	± 1.54	7.87	± 2.15	6	NFNAP and other USDA study
Cashews, oil-roasted	0.92	± 0.24	5.40	± 0.37	4 [2]	NFNAP and other USDA study
Hazelnuts	15.03	± 0.39	0.00		4	USDA/INC study
Macadamias, dry roasted	0.57	± 0.11	0.00		4 [2]	USDA/INC study
Pecans	1.40	± 0.08	24.44	± 1.50	9	USDA/INC study
Pine nuts	9.33	± 0.29	11.15	± 0.20	4	NFNAP
Pistachios, dry roasted	1.93	± 0.10	22.45	± 0.28	4	USDA/INC study
Walnuts, black	1.80		28.48		1	Hammons study
Walnuts, English	0.70	± 0.32	20.83	± 2.61	13	USDA/INC and other USDA study
Seeds (kernels)						
Flaxseed	0.31	± 0.01	19.95	± 5.07	6	NFNAP and Daun et al.
Pumpkin seeds	0.00		19.07		1	Fukuba and Murota
Poppy seeds	2.24		8.82		1	NFNAP
Sesame seed, decorticated	1.21		28.09		2 [2]	NFNAP and Cooney et al.
Sunflower seeds, dried	34.50		0.00		2	Holliday and Phillips
Sunflower seeds, dry roasted	26.10	± 4.83	0.00		4	NSA and other USDA study
Sunflower seeds, oil-roasted	36.33	± 2.24	0.46	± 0.09	3	NSA study

[1]Values represent mean ± S.E.M.
[2]Number of datapoints for gamma-tocopherol = 1

RESULTS AND DISCUSSION

The SR data show a wide range of alpha- and gamma-tocopherol levels in nuts and seeds (Table 1). The highest sources of alpha-tocopherol in nuts and seeds are sunflower seeds, almonds/almond butter, hazelnuts, and pine nuts. The highest sources of gamma-tocopherol are black walnuts, sesame seeds, pecans, pistachios, English walnuts, flaxseed, and pumpkin seeds. A 1-ounce portion of sunflower seeds provides about 2/3 of the adult RDA for vitamin E, while a 1-ounce portion of almonds provides nearly ½ of the recommended intake for adults (Table 2).

The percent of individuals whose diets are considered inadequate is high (Table 3). The mean intake of alpha-tocopherol from the 2001-2002 NHANES was 8.2 mg for men and 6.3 mg for women – well below the adult Estimated Average Requirement (EAR) of 12 mg/day (Table 3). In a recent USDA study, Gao et al. (2006) used linear programming to create a model diet which maximized the alpha-tocopherol level. This resulted in alpha-tocopherol intakes ranging from 15 to 20 mg per day for men and women, indicating US adults do have the potential to meet the RDA for vitamin E through diet alone. When the model diet did not include nuts and seeds, the modeled alpha-tocopherol intake was only 13 mg.

Consuming some types of nuts and seeds can help boost the dietary intake of both alpha- and gamma-tocopherol, which would help meet the EAR and may have the added benefit of reducing the risk of certain cancers, although current recommended intakes are not based on the proposed cancer relationships.

Table 2. Percent adult RDA of vitamin E (15mg alpha-tocopherol) provided by 1 oz. portions of nuts and seeds

Nuts (amount per 1 oz)	Amount, mg per 1 oz α-tocopherol	% RDA
Almonds (23)	7.35	49
Almond butter (2 Tbsp)	6.88	46
Brazilnuts (6)	1.63	11
Cashews, oil-roasted (18)	0.26	2
Hazelnuts (21)	4.27	28
Macadamias, dry roasted (11)	0.16	1
Pecans (19)	0.40	3
Pine nuts (167)	2.65	18
Pistachios, dry roasted (49)	0.55	4
Walnuts, black (1/4 cup)	0.51	3
Walnuts, English (7)	0.20	1
Seeds (3-4 Tbsp kernels)		
Flaxseed	0.09	1
Sesame seed, decorticated	0.48	3
Sunflower seeds, dried	9.80	65
Sunflower seeds, oil-roasted	10.32	69
Sunflower seed butter	4.76	32

Table 3. NHANES 2001-2002 mean vitamin E (alpha-tocopherol) intakes for adults

Adults 19+	Mean intake, mg	% less than EAR[1]
Men	8.2	89
Women	6.3	97

[1] Estimated Average Requirement; 12 mg for adults

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