



Phylloquinone (Vitamin K) content of vegetables and vegetable products



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Abstract

Phylloquinone (Vitamin K) is involved in blood coagulation. It may also play a role in protecting against osteoporosis as patients with reduced bone mineral density have lower levels of circulating phylloquinone. Vegetables have been recognized as important sources of this nutrient. However, existing values are available for a relatively small number of vegetables. The objective of this research is to generate nationally representative vitamin K values in foods, which will update and expand the USDA vitamin K database, first released in 1994. This report will focus on the data for approximately 25 vegetables and vegetable products. Sample units were collected at 12 locations in the US. For fresh produce, these were composited to form four regional composites. For vegetable products, several brand-specific national composites were produced. The composites were shipped to the Vitamin K Laboratory at the Jean Mayer Human Nutrition Research Center on Aging for analysis. Phylloquinone was determined by reversed-phase HPLC with fluorescence detection. Leafy greens including cooked spinach (525 mcg/100g) and broccoli raab (241 mcg/100g) were among the best sources. Other green vegetables [e.g. broccoli (102 mcg/100g), green leaf lettuce (126 mcg/100g) and butterhead lettuce (102 mcg/100g)] were also good sources, while relatively small amounts were found in root vegetables like carrots (13 mcg/100g) and cooked potatoes (3 mcg/100g). Based on these analyses, there are more dietary sources of vitamin K in the U.S. food supply than previously thought. The values on the phylloquinone content of vegetables, and those for other foods, will be added to USDA Databases. These values will enable investigators to monitor dietary intakes of phylloquinones and for the first time to assess the impact of vitamin K intake on specific health conditions.

Introduction

•Vitamin K (Fig. 1), a fat-soluble vitamin, is essential for proper blood coagulation. Patients on oral anticoagulants are advised to consume a constant intake of phylloquinone, which is the predominate form of vitamin K in food
 •Phylloquinone is found in the highest concentrations in dark green leafy vegetables, and some plant oils (e.g. soybean). However, the food composition data are limited.

•Reported average phylloquinone intakes are low among adults in the U.S.:

	MEN	WOMEN
Adequate Intake (mcg/day):	120	90
Mean Intake (mcg/day):	80	73

•Low vitamin K intake may lead to:
 - Decreased BMD
 - Increased incidence of hip fracture

Methods

Sampling:

- Probability proportional to size
 - 4 regions (~equal population) (Figure 1)
 - 3 strata per region (diverse population sizes)
 - 1 gCMSA per strata
 - 2 counties per gCMSA (rural and urban)
 - Retail stores with sales > \$2M
 - Brand or varieties: market share or consumption data
- Reference: Pehrsson et al., 2000.

Sample preparation:

- Shipped overnight to the Food Analysis Laboratory Control Center (FALCC) at Virginia Polytechnic Institute and State University in Blacksburg, Virginia.
- Refuse (skin or peels, seeds, etc.) removed and weighed.
- If appropriate, vegetables cooked according to commonly used procedures.
- Composites prepared and homogenized
- For fresh vegetables regional composites were selected.
- For processed products, subsamples from one or two brand name national composites were selected
- Samples were shipped frozen state to the Vitamin K Laboratory at Tufts University, Boston, Massachusetts.

Analysis Method:

- Extracted vitamin K with hexane
 - Purified with solid phase extraction using silica columns
 - Quantitate using HPLC with chemical reduction and fluorescence detection
 - Correct for losses using vitamin K₁₍₂₅₎ as internal standard
- Reference: Booth et al., 1994.

Figure 2

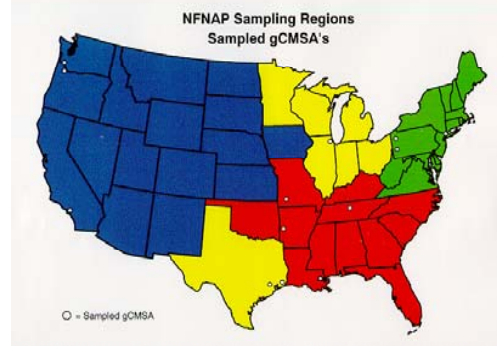


Table 1. Phylloquinone (Vitamin K)¹ content of selected vegetables and vegetable products (mcg/100 g)

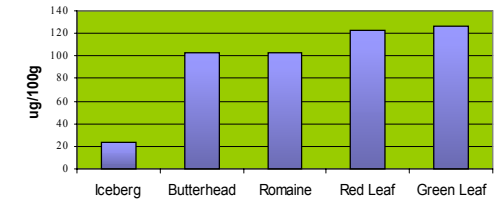
Vegetable	Mean	N	Min	Max	SD
Artichokes, boiled	14.8	1			
Artichokes, microwaved	17.6	1			
Broccoli	102	8	77	136	19.5
Broccoli, boiled	141	4	103	180	31.7
Broccoli raab	241	2	216	267	
Broccoli raab, steamed	194	6	103	294	71.9
Carrots	13.2	4	11.4	14.8	1.4
Carrots, cooked	13.7	4	10.8	18.2	3.2
Carrots, sliced or crinkle cut, frozen, unprepared	17.7	2	16.9	18.4	
Carrots, sliced or crinkle cut, frozen, boiled	13.6	1			
Carrots, frozen, whole, unprepared	15.2	2	9.8	20.6	
Carrots, frozen, whole, boiled	15.7	2	15.4	16.0	
Carrots, baby	9.4	6	4.3	14.4	4.0
Celery	29.0	8	20.6	46.8	10.5
Cucumber, with peel	16.4	4	11.5	22.2	4.5
Cucumber, without peel	2.6	2	1.7	3.5	
Lettuce, butterhead	102	8	76	159	26.5
Lettuce, romaine	103	8	70	129	19.9
Lettuce, iceberg	24.1	8	15.6	36.2	6.9
Lettuce, green leaf	126	8	111	154	14.0
Lettuce, red leaf	123	8	103	140	11.9
Onions, sweet	0.3	8	0.2	0.5	0.1
Onions, yellow	0.3	1			
Onions, yellow, sauteed	21.7	2	19.5	23.8	
Peppers, green	7.1	4	6.8	7.8	0.5
Peppers, green, sauteed	17.1	5	0.2	32.9	11.8
Peppers, red	4.9	4	3.3	6.0	1.2
Peppers, red, sauteed	16.5	4	12.5	20.9	3.5
Potatoes, russet	1.8	4	0.8	2.7	1.1
Potatoes, russet, baked	2.0	8	1.1	3.7	0.9
Potatoes, white	1.6	3	1.0	2.5	0.8
Potatoes, white, baked	2.5	7	1.3	3.9	1.1
Potatoes, red	2.9	4	1.6	3.6	0.9
Potatoes, red, baked	2.9	8	1.4	4.8	1.2
Radishes	1.3	7	0.5	3.1	1.0
Spinach, chopped, frozen, unprepared	370	3	293	441	74.5
Spinach, chopped, frozen, boiled	543	1			
Spinach, chopped, frozen, microwaved	480	1			
Spinach, whole leaf, frozen, unprepared	380	2	377	382	
Spinach, whole leaf, frozen, boiled	533	1			
Spinach, whole leaf, frozen, microwaved	544	1			
Sweet potatoes, baked	2.3	2	1.6	3.0	1.0
Tomatoes	2.7	8	2.2	3.1	0.3
Tomatoes, cooked	3.2	8	2.6	3.9	0.5
Tomato paste	9.9	3	8.5	12.1	2.0
Tomato puree	3.5	2	3.2	3.8	
Tomato sauce	2.8	2	2.5	3.1	
Tomato ketchup	2.8	2	2.5	3.0	

¹Dihydrophylloquinone was not detected in any of these samples

Discussion

Data on the phylloquinone (vitamin K) content of fresh and processed vegetables are presented in Table 1. Of the foods in Table 1, broccoli, broccoli raab, several types of lettuce and spinach all provide more than the DRI for either men or women. As seen in Figure 2, romaine lettuce, butterhead lettuce and green or red leaf lettuce provide around 100 to 126 mcg of vitamin K or about 80-100% of the DRI for men and over 100% for women.

Figure 3. Average Vitamin K Content of Lettuce



An adult man can meet his daily AI of Vitamin K (120ug) by eating:

- 3 half-cup servings of Green Leaf lettuce
- or
- 4 half-cup servings of Romaine lettuce
- or
- 19 half-cup servings of Iceberg lettuce

Other vegetables provide lesser amounts of vitamin K, with celery containing 29 mcg per 100 grams. Sauteed peppers contain higher amounts than the raw peppers, most likely due to the added fat used in cooking.

Foods such as potatoes (1.6 to 2.85 mcg/100 g) and tomato products (2.74 to 9.87 mcg/100 g) provide lesser amounts, but may end up contributing more to the diet as they are much more frequently consumed than the dark green leafy greens.

Approximately 300 other foods have been analyzed for vitamin K content. These data will be added to the USDA Nutrient Database for Standard Reference in an ongoing effort to expand the vitamin K food composition data available for dietary assessment and menu planning.

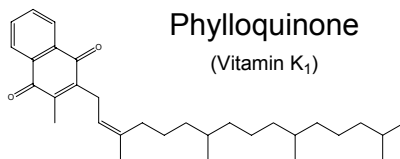
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Figure 1



2-Methyl-3-(3,7,11,15-tetramethyl-2-hexadecenyl)-1,4-naphthalenedione