Intake of Dietary Phytoestrogens by Dutch Women[1]

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ABSTRACT Higher consumption of phytoestrogens might be protective against certain chronic diseases. Accurate quantification of habitual phytoestrogen intake is important for assessing associations between phytoestrogens and risk for certain diseases. The aim of this study was to estimate dietary intake of phytoestrogens in Dutch middle-aged and elderly women and to describe their main sources. Women were recruited between 1993 and 1997 and aged 50–69 y at enrollment (Prospect-EPIC; $n = 17{,}357$). A detailed food frequency questionnaire referring to the preceding year was filled in at recruitment. A literature search was conducted to obtain data regarding content of the isoflavones daidzein, genistein, formononetin, biochanin A, the coumestan coumesterol and the lignans matairesinol and secoisolariciresinol in relevant food items. Concentrations of each phytoestrogen in each food item were subsequently grouped by seven categories; group scores were multiplied by daily intakes of food items and then summed across food items to produce for each participant a total daily intake score for each phytoestrogen. Approximately 75% of participants were postmenopausal at recruitment. The mean age was 57 y. Geometric means of daily intake of daidzein, genistein, formononetin, biochanin A, coumesterol, matairesinol and secoisolariciresinol were 0.15, 0.16, 0.08, 0.001, <0.001, 0.07 and 0.93 mg, respectively. The main sources for isoflavones were peas and beans, nuts, grain products, coffee, tea and soy products. The main sources for coumestans were peas, beans and other vegetables. The main sources of lignans were grain products, fruit and alcoholic beverages (red and white wines). We conclude that intake levels of phytoestrogen in our study population are low; however, they are comparable with intake levels previously reported for other Western cohorts. In this population, phytoestrogen intake consisted largely of lignans. J. Nutr. 132: 1319–1328, 2002.

KEY WORDS: • *phytoestrogens* • *isoflavones* • *coumestans* • *lignans* • *food frequency questionnaire*

Phytoestrogens, natural plant substances, are subdivided into three main classes: isoflavones, lignans and coumestans (1). Isoflavones are predominantly found in soybeans and other legumes (1–5). Two of the major isoflavones are genistein and daidzein. They are both present in plants and may also be metabolized from other isoflavonoid plant precursors, biochanin A and formononetin, respectively (1–5). Gut bacterial flora may further metabolize daidzein into equol or O-demethylangolensin (O-Dma),[3] and genistein into p-ethyl phenol. Daidzein, genistein, equol and O-Dma are the major phytoestrogens detected in blood and urine of humans and animals (1–5).

Lignans form the building blocks for lignin, which is a main component of the plant cell wall. They are found mostly in oil seeds (i.e., flaxseed), whole grains, legumes, vegetables, berries and other fruits (1–5). Enterolacton and enterodiol, the main mammalian lignans, are formed from the plant lignans matairesinol and secoisolariciresinol, respectively, and possibly from other yet unknown plant precursors, by gut micro-flora. The chemical structure of the mammalian lignans differs somewhat from that of their plant precursors (1–6). Coumestans occur predominantly during germination, for example, in bean sprouts; the main compound in this subgroup is coumesterol (1).

Bioavailability of phytoestrogens varies among individuals and depends on many factors, such as habitual diet (7–10), duration of soy consumption (10–12), gender (11), different individual metabolism patterns that might be determined by genetic factors (13), and different bacterial flora (14,15).

Structurally, coumestans and isoflavones resemble endogenous steroid estrogen and are able to bind to the estrogen receptor (ER), preferably ERβ, although their binding affinity depends on their plasma concentration and is several-fold lower than that of endogenous estradiol. Both phytoestrogen subclasses have demonstrated ER-mediated estrogenic properties (transcriptional activity). They were also suggested to act as anti-estrogens by competing with the more potent endogenous estrogen on the ER; however, it seems that their anti-estrogenic potential is not ER-mediated (16). Lignans hardly show binding affinity to ER (16). Besides their hormonally mediated influences, phytoestrogens were shown to have anti-oxidative, antiproliferative and anti-angiogenic activities,

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[3] Abbreviations used: BMI, body mass index; CI, confidence interval; EPIC, European Prospective Investigation into Cancer and Nutrition; ER, estrogen receptor; FFQ, food frequency questionnaire; O-Dma, *O*-demethylangolensin.

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which were not hormonally-dependant, in many in vitro and animal studies (1–5,17,18).

Epidemiological studies suggest that consumption of a phytoestrogen-rich diet, as seen in traditional Asian societies, is associated with a lower risk of the so-called Western diseases (1–4,17,19–21), i.e., coronary heart disease (22–25), osteoporosis (26–32), menopausal symptoms (33,34) and certain cancers (35,36), such as prostate (37,38), breast (39–47), and possibly colorectal cancer (48,49).

Accurate quantification of habitual phytoestrogen intake is difficult. Soy intake may serve as a good approximation for isoflavones intake in Asian populations that consume soy traditionally (50). However, Western populations consume soy quite infrequently, while lignan sources such as whole oil seeds, grains, fruit, vegetables and nuts are more popular (3,51–54). Estimation of isoflavones intake is mostly based on dietary questionnaires, diaries or interviews (37,39–43,48) in which soy food consumption serves as a proxy for isoflavones. Urinary levels of isoflavones may also be used (7,9,10,44–47,53,54). It was shown that the accuracy of the different assessment methods for isoflavones intake is comparable (55). For lignans, assessment of intake was mostly done by biomarkers levels, either in blood (6,8) or in urine (7,9,47,53,54). For both subgroups of phytoestrogens, a single serum measurement may reflect, although not perfectly, an individual's long-term intake, but mostly it is true for lignans (56).

Recently, a method of estimating daily phytoestrogen intake, based on daily intake of certain food items for which values of phytoestrogen content are available (through publications in the literature based on direct measurements in laboratories) was developed (52,57,58) and used (51,52, 59,60). We used a similar measurement tool to estimate the daily intake of phytoestrogens in the Dutch women participating in the Prospect/European Prospective Investigation into Cancer and Nutrition (EPIC) cohort. In addition, the main sources of phytoestrogen consumption in this population were assessed.

SUBJECTS AND METHODS

Subjects. Our study population consisted of the Dutch participants of the EPIC cohort, conducted in Utrecht, The Netherlands (prospect-EPIC) (unpublished data). The cohort includes 17,357 women aged 49–70 y, residing in Utrecht and vicinity, who were recruited between 1993 and 1997 through a regional program for breast cancer screening (34.5% response). All signed an informed consent. At recruitment, each participant filled in a general questionnaire concerning life style factors, gynaecological and obstetric history and past and current morbidity, as well as a food frequency questionnaire (FFQ) aimed at describing the habitual diet during the year preceding enrolment. In addition, pulse rate, blood pressure and some anthropometric measurements were taken, and a blood sample was taken and stored at −196°C.

For this study, eligible participants were all prospect-EPIC participants with a complete FFQ, whose daily energy intake was equal to or higher than 2100 kJ and lower than 25.3 MJ (n = 17,140). The study was approved by the Institutional Review Board of the University Medical Center Utrecht.

Food sources of phytoestrogens. To locate published laboratory analysis data for the phytoestrogen contents of food items, we conducted a search of the medical (Medline) and agricultural (Agricola) scientific literature. Phytoestrogens, daidzein, genistein, formononetin, biochanin A, coumestrol, matairesinol and secoisolariciresinol were used as search terms. We also searched the literature with the terms plant estrogens, isoflavones, coumestans, lignans, enterolactone and enterodiol (52). In addition, experts in the field of phytoestrogens, as well as several Dutch food manufacturers, were contacted (Appendix A).

Prospect-EPIC FFQ. The self-administered FFQ contained questions about the average consumption frequency during the past year for 227 food items. These food items were selected through the database of the Dutch National Food Consumption Survey 1987–1988 (61), and, subsequently, a list of products that accounted for at least 90% of the population mean intake of the food groups and nutrients of interest was created. A few other food items were added to the list because of specific hypotheses (e.g., garlic) or as a result of expected changes in food patterns (e.g., low fat products). The questionnaire contained color photographs of two to four different-sized portions of 21 food items, and the given answers enabled participants to indicate whether they ate as much as any of the portions shown, less than the smallest, or more than the largest. Subjects could indicate their consumption frequency of each food item on a daily/weekly/monthly/yearly scale or as never consumed. For several food items, additional questions regarding consumption frequency of sub-items were asked. Questionnaires also included some blank-spaced questions, in which names of brands used (e.g., margarine) could be filled in. One of the questions in the FFQ referred to intake of tofu, tempeh and vegetarian burgers, and it also included a blank space for filling out other similar foods taken (such as miso and soy milk). In total, the information obtained by the FFQ enabled the estimation of the habitual daily consumption of 178 food items (in g/d). The FFQ was validated before the study (62,63).

Scoring phytoestrogen intake. We decided to group the literature values for phytoestrogen content in foods in seven categories instead of using the exact values to avoid implying a degree of accuracy for which the currently available data are too limited and too preliminary. The method used in our study was described elsewhere in detail (52) and was slightly modified. Briefly, using the data obtained through our literature review, we calculated and assigned for each of the FFQ relevant items, concentrations of the isoflavones daidzein, genistein, formononetin, biochanin A, the coumestan coumestrol and the lignans matairesinol and secoisolariciresinol. We applied the following guidelines: all values found in the literature were converted to mg/100 g food; values expressed on a dry weight basis were converted to wet weight basis by using moisture content provided by the author or by assuming commonly expected moisture content for that particular food (64), or by using adjustments for the method of preparation (65); if wet and dry weights were reported from different original sources in the literature, we chose the reported wet weight value; in the case that wet weight values equaled zero in the literature while dry weight values did not, we used the dry weight values and converted them back into wet weight values; when different values were reported from the same or different original sources in the literature, the highest value reported was chosen; when a specific phytoestrogen concentration was reported as trace or traceable, 0.00001 mg/100 g was assigned, based on the sensitivity of the gas chromatography-mass spectrometry method used by Mazur et al. (66); if no information about phytoestrogen content of a certain food item was available, we assigned a proxy value based on a similar food item, i.e., from the same botanical group, if available. If not available, we assigned the value zero; if the questionnaire listed similar food items on the same question, a mean of phytoestrogen content was computed, weighted according to the frequencies of Dutch consumption of these items (61). However, if data for one or more food items were unavailable, data for a similar food item (e.g., same botanical group) were used as a proxy. If no data, accurate or proxy, could be obtained for a certain food item, its contribution to the total phytoestrogen content was considered to zero; when there was no information available on the lignan precursors matairesinol and secoisolaraisinol, we estimated these values by using data on the biologically active products enterolactone and enterodiol, if available (67). This was done by comparing data for food items with a known content of both lignan precursors (matairesinol and secoisolariciresinol) and active substances (enterolactone and enterodiol) and subsequently estimating the general difference between the precursors and the active substances in orders of magnitude, then applying these results to those food items that lacked information regarding lignan precursor content but did have information regarding active substances values; estimation of phytoestrogen content in breakfast cereals was done using the manufacturers' declarations (following a mailed request) about their grains and fiber content.

Subsequently, we grouped the phytoestrogen concentration of each relevant food item into one of seven categories (**Table 1**), and, finally, we multiplied the phytoestrogen score of each food item by its consumption quantity per day for each participant. This final phytoestrogen score was summed across foods to obtain a total intake score for each phytoestrogen per each participant, per day (52).

Data analysis. General characteristics of the study population are presented. Mean intake (arithmetic and geometric) and standard deviations of phytoestrogens (in scores of intake) and certain nutrients and food groups were calculated, including medians of intake and interquartile range. For some food groups, we present the Dutch recommended daily allowances (68). The main sources of isoflavones, coumestans and lignans in the diet of our study population are also described.

All analyses were done by using SPSS for Windows, Version 9.0 (69), and the SAS Statistical Package, Version V8 (SAS, Cary, NC).

RESULTS

Phytoestrogens concentration (mg/100 g of selected food item) in the FFQ are listed in Appendix A.

Almost all participants were born in The Netherlands. Mean age at recruitment was ~57 y, and most of the study participants were postmenopausal at study entry (defined as cessation of menstruation for at least 12 mo; **Table 2**).

Means of daily intake of certain food groups and nutrients, including the Dutch recommended daily allowances are presented in **Table 3**. Approximately 16% of the mean daily energy intake derived from protein, 36% from fat and 44% from carbohydrates (Table 3).

The arithmetic means of daily intakes were 0.37 ± 1.24 mg for daidzein, 0.42 ± 1.33 mg for genistein, 0.09 ± 0.05 mg for formononetin, 0.001 ± 0.001 mg for biochanin A, 0.0002 ± 0.0002 mg for coumesterol, 0.08 ± 0.05 mg for matairesinol and 1.03 ± 0.004 mg for secoisolariciresinol. Although distribution of coumesterol and the lignans followed the normal curve, isoflavone intake values were positively skewed. Therefore, phytoestrogens intake values were logarithmically transformed to produce an approximately normal distribution curve. Estimates for means for the log-transformed intakes were later exponentiated to obtain the geometric means and respective 95% confidence intervals (CI; **Table 4**). The median intake score and interquartile range for the phytoestrogens studied are also presented, and geometric means of isoflavones corresponded closely to its medians.

The main sources of daily intake of all phytoestrogens were studied by food groups and are presented in **Table 5**. Over 80% of the daily intake of all isoflavones was derived from vegetables, breakfast cereals, grain products, coffee/tea, traditional soy foods and nuts. Peas and beans served as the main source of almost all isoflavones. Nuts were an important source of biochanin A. Use of traditional soy foods was not common in this population; they were responsible for only 6.5% of the total daily intake of daidzein and genistein.

Vegetables accounted for most of the daily intake of coumesterol, most of it derived from peas and beans, and ~30% was derived from other (non-potatoes and non-leafy) vegetables.

Grain products, vegetables, fruit, coffee/tea and alcoholic beverages accounted for over 85% of the total daily intake of the lignans matairesinol and secoisolariciresinol. Grain products were the richest source of both lignans followed by coffee and tea (Table 5).

TABLE 1

Grouping of phytoestrogen concentrations into score categories

Phytoestrogen, mg/100 g	Phytoestrogen score, mg/100 g
0	0
0.00001–0.00099, trace	0.0005
0.001–0.0099	0.005
0.01–0.099	0.05
0.1–0.99	0.5
1–9.99	5
10 and over	50

TABLE 2

Characteristics of the study population

Married/living together, %	77
Born in The Netherlands, %	95
Academic education, %	16
Past/current smoker, %	56
Age, *y*	57.1 ± 6.0
Height, *cm*	164.3 ± 6.1
Weight, *kg*	70.2 ± 11.5
BMI,[1] *kg/m*[2]	26.0 ± 4.1
Waist to hip ratio	0.8 ± 0.1
Age at menarche, *y*	13.4 ± 1.6
Ever pregnant, %	88
Age at first delivery, *y*	25.1 ± 4.0
Median number of children, *n*	2
Ever use of oral contraceptives, %	64
Menopause	
Total, %	75
Natural, %	37
Age at menopause, *y*	47.4 ± 5.8
Age at natural menopause, *y*	49.6 ± 4.2
Ever use of HRT, %	26

[1] Values are means ± SD or %, *n* = 17,140.
[2] BMI, body mass index; HRT, hormonal replacement therapy.

DISCUSSION

There is increasing interest in soy because of its perceived beneficial effects on health and its possible role in chronic disease prevention. Our study was designed to assess the habitual daily intake of phytoestrogens in middle-aged and elderly Dutch women. Intake was generally low, and most phytoestrogens were consumed in the form of lignans. These findings agree with previously published data of phytoestrogen intake in Western populations (51,52).

In our study population, total isoflavone consumption was estimated to be ~0.9 mg/d (according to arithmetic means). These results are comparable with previously published findings: total isoflavone intake among Californian women (whites, Latino-Americans and Afro-Americans) was estimated to be ~2.9 mg/d (51) and among postmenopausal American women in the Framingham study, ~0.8 mg/d (52). A comparison of the results of the three currently available descriptive studies of phytoestrogen dietary intake in Western populations is presented in **Table 6**. In contrast, daily intakes in Oriental diets are 10- to 40-fold higher: daily intake of isoflavones in Chinese women in Shanghai was estimated to be ~40 mg (70). Median daily intakes of daidzein and genistein among Japanese men were estimated to be ~9.5–12.1 mg and 14.9–19.6 mg, respec-

TABLE 3

Intakes of selected food groups and nutrients by Dutch women

Food group	Mean ± SD	Median (interquartile range)	Recommended daily allowance[1]
Potatoes, *g/d*	85.08 ± 56.03	73.05 (45.71–111.96)	150–250
Bread, *g/d*	124.00 ± 46.69	120.99 (93.00–151.84)	150–180
Wheat products, *g/d*	35.94 ± 35.26	25.71 (12.00–47.94)	NA[2]
Fruit, *g/d*	232.38 ± 139.15	231.58 (125.31–306.86)	200
Vegetables, *g/d*	143.68 ± 53.38	136.65 (106.92–174.05)	150–200
Soy products, *g/d*	10.62 ± 12.28	0.00 (0.00–0.00)	NA
Nuts and snacks, *g/d*	12.65 ± 13.85	7.99 (3.33–16.61)	NA
Soup, *g/d*	69.06 ± 72.14	35.71 (16.67–71.43)	NA
Total beverages, *mL/d*	1553.52 ± 516.37	1489.08 (1194.79–1837.68)	≥1,500
Nutrients			
Total energy, *kJ/d*	7525.79 ± 1826.02	7383.22 (6293.32–8564.83)	7800–8200
Total protein, *g/d*	71.68 ± 17.99	70.47 (59.74–82.13)	52
Plant protein, *g/d*	24.39 ± 6.71	23.74 (19.89–28.14)	NA
Total fat, *g/d*	71.51 ± 23.03	68.85 (55.49–84.40)	30–35% of total energy
Total carbohydrates, *g/d*	199.82 ± 53.46	195.18 (163.17–231.48)	55% of total energy
Total fiber, *g/d*	22.59 ± 5.58	22.32 (18.87–25.98)	NA
Total water, *mL/d*	2521.17 ± 620.29	2453.38 (2100.02–2878.91)	≥1500

[1] Refer to (69).
[2] Not available.

tively (71) and Korean subjects were estimated to consume 14.9 mg/d of isoflavones (72).

Not only are intakes of isoflavones among Western subjects substantially lower compared to oriental subjects, types and sources of phytoestrogens consumed differ as well. The phytoestrogen intake in our study was constituted largely of lignans (~70% of total phytoestrogen intake according to geometric means), mainly derived from grain products and coffee and tea. These foods usually contain relatively low to moderate amounts of phytoestrogen per gram of food but are consumed frequently. The main sources of isoflavone intake in this study were peas and beans, coffee and tea, nuts, grain products and, to a lesser extent, soy foods. A similar pattern was seen among American women (51,52), although traditional soy foods had a slightly higher impact on isoflavone intake among the Californian women (51). However, among Japanese, Chinese and Korean subjects, traditional soy foods, such as tofu in variant forms, constitute the main, and sometimes only, sources of isoflavones (70–74).

To appreciate these findings, some aspects of our data should be considered. We used a standardized semiquantitative FFQ as our tool of measurement, designed to assess habitual dietary intake of nutrients and food groups during the preceding year. The advantage of using a FFQ when assessing phytoestrogen intake is that it enables the assessment of direct dietary intake. Biomarkers, such as plasma or urinary excretions, usually represent only a short period of phytoestrogen intake, up to 48 h (4,12), and are influenced by the bioavailability of phytoestrogens consumed (gut microflora, use of antibiotics, gender, etc.). However, since the instrument was not specifically designed for assessing phytoestrogen intake, it did not include information concerning certain food items that might have contributed to the total phytoestrogen intake in our population. Therefore, our results probably underestimate the true intake of phytoestrogens. Moreover, unsuspected and hidden sources of soy could not be accounted for and may also lead to an underestimation of phytoestrogen intake in our population. Soy protein has been long utilized in food production systems, i.e., whole soybeans processed into snack foods, beverages and fermented foods; soy flour and grits blended into corn, wheat or sorghum and used in cereal mixtures or baked goods; soy proteins used in processed meat products or added to soup stock cubes and doughnuts (75–77). In addition, lack of data concerning presence and content of lignans in foods could lead to additional inaccuracies when assessing phytoestrogen intake in Western populations, which tend to consume more lignans than Oriental populations.

TABLE 4

Intakes of phytoestrogen by Dutch women

Phytoestrogen	Mean intake score (95% CI)[1] (geometric mean)	Median intake score (interquartile range)
	mg/d	
Daidzein	0.151 (0.021; 1.220)	0.134 (0.094–0.191)
Genistein	0.161 (0.025; 0.899)	0.141 (0.091–0.224)
Formononetin	0.077 (0.026; 0.234)	0.079 (0.055–0.117)
Biochanin A	0.001 (0.0003; 0.004)	0.001 (0.0008–0.0017)
Coumesterol	0.0002 (0.00005; 0.00006)	0.0002 (0.0001–0.0003)
Matairesinol	0.065 (0.016; 0.262)	0.073 (0.043–0.106)
Secoisolariciresinol	0.926 (0.577; 1.494)	0.988 (0.676–1.285)

[1] CI, confidence interval.

TABLE 5

Intakes of phytoestrogen by food groups by Dutch women

Food group	Daidzein	Genistein	Formononetin	Biochanin A	Coumesterol	Matairesinol	Secoisolariciresinol
				% daily intake			
Vegetables	31.8[1]	31.0[1]	49.8[1]	35.2	97.2[1]	6.4	8.2
Peas/beans	28.6	25.7	49.8	35.2	62.2	<0.1	0.3
Potatoes	2.1	4.1	—	—	—	4.8	5.6
Leafy vegetables[2]	0.6	0.4				1.1	1.9
Other	0.5	0.8	<0.1	—	35.0	0.5	0.4
Fruit	4.3	2.1	—	—	—	3.6	1.0
Berries	0.1	0.8				2.8	4.1
Non-berries	4.2	1.3				0.8	9.9
Fruit/vegetable juice	1.5	<0.1	—	—	—	0.3	1.6
Fruit juices	1.0	<0.1				0.2	1.5
Vegetable juices	0.5	<0.1				0.1	0.1
Coffee/tea	16.3	4.8	24.3	—	—	12.2	22.8
Coffee	14.5	4.8	24.3			—	15.8
Tea	1.8	—	—			12.2	7.0
Traditional soy foods	6.5	6.5	—	—	—	—	—
Breakfast cereals	17.2	14.4	0.1	0.1	0.2	7.0	0.1
Grain products	15.5	11.9	6.2	0.1	2.3	62.9[1]	40.8[1]
Bread	15.4	11.8	6.2	0.1	2.3	54.2	40.7
Cakes/cookies	0.1	0.1	—	—	—	5.5	<0.1
Pasta/rice	—	—	—	—	—	3.2	0.1
Nuts (mostly peanuts)	3.8	16.2	2.1	45.0[1]	—	0.1	4.8
Alcohol	<0.1	<0.1	<0.1	—	—	6.4	1.3
Other	3.1	13.1	17.5	19.6	0.3	1.1	6.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Main sources (by foodgroups) for isoflavones, coumestans and lignans intake.
[2] Leafy vegetables = cabbage/lettuce/chicory/endive/spinach.

In conclusion, phytoestrogen intake is rather low among Dutch middle-aged and elderly women. Foods other than the traditional soy-based foods are the major source of phytoestrogen intake among this population, as in other Western populations (51,52). The relative contribution of the various foods to total intake of phytoestrogens may vary by population demographics (habitual dietary patterns), brands of certain foods consumed and studied (i.e., soy additives) and the food frequency instruments used. Future research on the associations between phytoestrogen intake and certain endpoints should examine a large variety of foods in addition to the traditional soy-based foods and will benefit from using a measurement tool aimed primarily at assessing phytoestrogen intake, such as recently presented by Horn-Ross et al. (58).

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TABLE 6

Intakes of phytoestrogen in Western populations—a comparison of the available data

	Horn-Ross et al. 2000 (52)	De Kleijn et al.[1] 2001 (53) The Framingham study	Present study[1] The Prospect-EPIC study
Population	American white, Latina and Afro-American women	American white women	Dutch white women
n	447	964	17,140
Age, *y*	50–79	35–81	50–69
		mg/d	
Daidzein	1.48	0.29	0.37
Genistein	1.28	0.34	0.42
Formononetin	0.08	0.12	0.09
Biochanin A	0.03	0.01	0.001
Total Isoflavones	2.87	0.76	0.88
Coumesterol	0.21	0.01	<0.001
Total coumestans	0.21	0.01	<0.001
Matairesinol	0.04	0.02	0.08
Secoisolariciresinol	0.14	0.62	1.03
Total lignans	0.18	0.64	1.11

[1] Results presented as scores of phytoestrogen intake.

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APPENDIX A

Concentration of phytoestrogens in selected foods items (EPIC-FFQ)—the basis for scoring[1,2]

	Isoflavones				Coumestans	Lignans precursors		Lignans	
	Daidzein	Genistein	Formonon.	Biochanin A	Coumesterl	Mat.	Secoiso.	Enterolac.	Enterodiol
	mg of phytoestrogens/100 g product								
Breakfast cereals and other grains									
Muesli	1.33768058	1.373014	0.000852	0.0000003	0.0000003	0.21899621	0.02116253	0.029130	0.032965
Cornflakes						0	0.000521331	0.010348	0.001612
Grains: sorghum and buckwheat								0.199	0.056
White rice	0	0				0.00001	0.001536		
Brown rice								0.169	0.128
Wheat pasta	0.0000083	0.0000083				0.00645408			
Whole wheat pasta								0.34113	0.06557
Bread and baked goods									
White bread	0.0000058	0.0000058				0.00451008			
Whole grain bread	0.01	0.01	0.0024			0.0707	0.483006		
Brown bread	0.002014	0.002809	0.000636						
White currant & raisin bread	0.0000058	0.0000058				0.00857133	0.016587		
Rye bread	0.00001	0.00001	0.00001					0.064	0.023
Rolls, croissants	0.0000058	0.0000058				0.00451008			
Crisp bread	0.01	0.01	0.002842	0.00001	0.00001				
Biscuits, toasts, crackers	0.0000058	0.0000058				0.00451008			
Breakfast rye cake	0	0				0.022608			
Apple cake	0.00125196	0.0000073				0.00139968	0.0000055	0.0187	0.00055
Fruit cake	0.000480884	0.0018533				0.00101088	0.000372	0.03030	0.0492
Cookie filled with almonds	0.00110308	0.0000034				0.00264674	0.0294164		
Fruit									
Apples	0.00227292	0.00001				0	0.00001	0.034	0.001
Pears	0.0000486	0.0008748						0.112	0.069
Oranges	0	0				0	0.01129	0.027	0.012
Mandarins	0.0003	0.0029				0	0.01129	0.027	0.012
Grapefruit						0	0.0199782		
Citrous fruit, mixed	0	0				0	0.01286735	0.00891	0.00396
Banana	0	0				0	0.00298	0.055	0.014
Strawberries	0.0005	0.0046				0.00971564	0.1866	0.041	0.038
Grapes									
Peaches (proxy: plum)	0.0005	0.0010				0	0.00074	0.047	0.098
Cherries (proxy: plum)	0	0				0	0.00074	0.047	0.098
Kiwi						0.00137295	0.1971285		
Melon	0.0015	0.0004				0	0.01227935	0.021	0.016
Watermelon						0.000187	0.00425		
Vegetables									
Potatoes, fries	0.0010	0.0027				0.0015462	0.02577	0.033	0.050
Garlic	0.00065279	0.0009364				0.0162	0.1713	0.081	0.326
Regular lettuce								0.0425	0.055
Cucumber	0	0.0003				0.00001	0.001004	0.018	0.011
Tomato	0.0033	0				0.00032175	0.0025542	0.011	0.010
Carrots	0.00019968	0.00021216				0.000356928	0.02396	0.284	0.062
Cabbage	0.00001	0.0029				0.00001	0.00624	0.03	0.034
Red cabbage	0.000495	0.0029	0.001089			0.00001	0.013959	0.030	0.034
Cauliflower	0.0004225	0.0007605				0.00001	0.0081965	0.068	0.077
Broccoli	0.000468	0.000624			0.000624	0.001794	0.032292	0.161	0.065
Brussels sprouts								0.057	0.018
Green pepper	0	0				0.000553	0.009243	0.162	0.033
Red pepper						0	0.0040685		
Chicory	0.0005	0				0.000825	0.009625		
Mushrooms	0.0016564	0.009594				0.0083	0	0.043	0.013
Green regular beans	0	0	0.01455	0.00001	0				
Green string beans								0.04	0.056
Red beet	0	0						0.109	0.026
Spinach (proxy: beet)								0.109	0.026
Endive (proxy: chicory)	0.0005	0				0.000825	0.009625		
Onion	0	0				0.000832	0.008632	0.011	0.101
Leek								0.024	0.174

APPENDIX A *(Continued)*

Concentration of phytoestrogens in selected foods items (EPIC-FFQ)—the basis for scoring[1,2]

	Isoflavones				Coumestans	Lignans precursors		Lignans	
	Daidzein	Genistein	Formonon.	Biochanin A	Coumesterl	Mat.	Secoiso.	Enterolac.	Enterodiol
	mg of phytoestrogens/100 g product								
Legumes									
Green peas	0.0490383	0.0460719				0.00001	0.013		
Marrowfat peas (proxy: peas)	0.0490383	0.0460719				0.00001	0.013		
Brown & white beans	0.00511368	0.24827022	0.2706	0.00424465	0				
Lentils	0.0093496	0.017081	0.01	0.0063829	0.0061132	0.00001	0.006293		
Dried green peas	7.3	0.00001	0.0043512	0.02664	0.00001				
Broad beans	0.0286518	0.0011	0.035139	0.00001	0				
Soy foods									
Vegetarian schnitzel		1							
Tempeh	27.3	39.8							
Tofu	25.34	42.15							
Nuts									
Almonds	0.003792	0				0.00001	0.101436		
Cashew						0.0039052	0.2509		
Hazelnuts	0.0055	0.0185				0.003956	0.117691		
Walnuts	0.004893	0.00001				0.004893	0.1595		
Mixed nuts	0.009823	0.064625	0.0025	0.0025	0	0.0019703	0.20075675	0.02625	0.014
Peanuts	0.03	0.24	0.01	0.01	0	0.00001	0.333	0.105	0.056
Fruit and vegetables juices									
Apple juice	0.00227292	0.00001				0	0.00001	0.034	0.001
Orange juice	0	0				0	0.01129	0.027	0.012
Grapefruit juice						0	0.0199782		
Currant juice	0	0				0.00429875	0.0250368		
Raspberry juice	0.0000036	0.0000036				0	0.010008		
Mixed fruit drinks	0.000279861	0.000067585				0	0.00178888	0.009744	0.0079275
Tomato juice	0.00495	0				0.00048255	0.0038313	0.0165	0.015
Beetroot juice	0	0				0.00001	0.0220108		
Carrot juice	0.000198602	0.000211039				0.000355115	0.0238402	0.28258	0.06169
Hot drinks									
Coffee	0.00102168	0.00044892	0.00120747				0.01108368		
Black tea	0.0001947					0.0012095	0.0077644		
Alcoholic drinks									
Beer	0.0000646	0.0001821	0.0004024	0.0001376	0				
White wine	0	0	0	0	0	0.0022	0.0174		
Red wine	0	0	0	0	0	0.0098	0.1280		
Port (proxy: red wine)	0	0	0	0	0	0.0098	0.1280		
Whiskey	0	0	0	0	0				
Red currant gin	0	0					0.00598386		
Spreads, sweet spreads and sauces									
Jam	0.000123333	0.00069066				0.00119825	0.0231965	0.01665	0.02886
Syrup	0.000422763	0.00000186				0.0000014	0.0025623	0.006324	0.000186
Peanut butter	0.0285	0.228	0.0095	0.0095	0	0.00001	0.31635	0.09975	0.0532
Peanut sauce	0.0954	0.1452	0.0038	0.0038	0	0.00009552	0.12910352	0.04111	0.03239
Spaghetti sauce	0.0023764	0.0000004	0	0	0	0.00065918	0.00304750	0.00946	0.02134
Apple mousse	0.00204562	0.000009				0	0.000009	0.0306	0.0009
Mixed dishes									
Soup + vegetables	0.000016185	0.000403598	0.00000026	0.00000026	0	0.000031671	0.001137301	0.011102	0.012220
Soup + legumes	0.001022736	0.049654	0.05412	0.000848912	0	0.0000416	0.0004316	0.00175	0.01375
Pizza	0.001289756	0.00038626				0.002395047	0.000945054	0.00579	0.00422
Spring roll	0.0000057	0.00004103	0.0000013	0	0	0.00334508	0.0008736	0.00612	0.01868

1 A reference list is available as supplemental data in the online posting of this paper at www.nutrition.org.
2 ↑, from page 28.

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