Assessment of Sources and Dietary Intake of Isoflavones in the U.S. Diet

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Abstract 729.4

Soy products are a major source of dietary isoflavones, with weak estrogenic, and other biological properties that may contribute to the reduction of the risk of some chronic diseases, such as certain cancers, i.e. prostate and melanoma. This presentation will examine sources of isoflavones in the diet for the U.S. population. Data for isoflavones taken from the USDA Database for the Isoflavone Content of Selected Foods, Release 2.0 were combined with food consumption data from NHANES. Using the information in the Food and Nutrient Database for Dietary Studies (FNDDS) and the corresponding consumption data, weighted grams consumed for each food item were calculated. By multiplying total isoflavone content by the grams consumed of the respective food items, the dietary intake of total isoflavones contributed by individual food items was determined. Soymilk was the leading source of total isoflavones, followed by tofu, chicken and meatless vegetarian products. Many people do not consume soy foods directly, but soy-based ingredients are commonly used in food manufacturing. Non-soy products, such as frankfurters and various baked products which may contain soy-based ingredients, such as soy flour or soy isolates, provide isoflavones to the diet. Knowing the quantities of isoflavones consumed and their relative contributions to dietary intake will assist in a range of studies relating to various diseases.

Introduction

Isoflavones, a subclass of flavonoids, may contribute to the reduction of the risk of some chronic diseases. Taku *et al* in 2007[5] showed that soy isoflavones alone and along with soy proteins lower serum total and LDL cholesterol in humans. Although evidence for the beneficial role of isoflavones in breast cancer has become conflicted, results of clinical trials for prostate cancer are encouraging [3] and non-hormonal properties of isoflavones, including cell cycle arrest and cell apoptosis, may reduce the risk of some cancers[4]. Since soybeans are also a good source of protein, inclusion of soy foods in the diet may be beneficial and is frequently recommended. With the approval of a health claim for soy proteins by the U.S. Food and Drug Administration (FDA) in 1999, the number of new soy products has increased. Release 2.0 of the isoflavone database by the USDA Nutrient Data Laboratory[7] was issued in 2008 and contained data for 557 food items. Soy products are now used as ingredients in a variety of foods and their use often results in an increase in the isoflavone content of those foods. The objective of this study is to identify and quantify food sources of isoflavones in order to ascertain estimates of dietary intake.

Methods

To develop a list of key contributors of isoflavones to the diet, the Key Foods approach was used[1,2]. The following sources were used:

- Isoflavone data from the 2008 USDA Database for the Isoflavone Content of Selected Foods, Release 2.0[7]
- The link file from Release 3 of the Food and Nutrient Database for Dietary Surveys[8] (2006)
- Weighted two-day food consumption data for the U.S. population from the What We Eat in America--National Health and Nutrition Examination Survey (NHANES) 2005-2006 Data Files[9]

Of the 557 foods in the isoflavone database, 290 are used in the dataset to create the nutrient profiles for FNDDS 3.0. Values were imputed for the missing food items by the following procedures:

- Assumed zero –used for most animal products, fruits and vegetables, where analytical values for a few items in the respective group were zero
- Based on a similar food – used for soy products, products containing soy ingredients, and other food items where analytical values were available for imputing.

These data files were processed as follows:

- Multiply the weighted amount (in g) of each food reported as consumed (WWEIA--NHANES) by the percentage contribution of each ingredient in the food; do this for all foods
- Sum the amount consumed for each ingredient in all foods to give the total amount consumed of that ingredient or food to get the total amount consumed per day
- Multiply the amount of each ingredient or food by the isoflavone content in the food to give its percent isoflavone contribution to the total intake
- Group like foods (i.e. all types of soy milk, or meatless products) and assign a unique code
- Sum grams consumed and percent of total grams consumed for each group
- Sort and rank total intake for each isoflavone by food group

Results

Average per capita intake of total isoflavones for the U.S. population was estimated to be 0.68 mg/day. Diadzein and genistein are the major isoflavones found in foods, with lesser amounts of glycitein. The rank order of foods contributing individual isoflavones (Tables 1-3) were similar.

Soymilk, the largest contributor, comprised 22%, 22%, 24%, and 18% of the intake for total isoflavones, daidzein, genistein, and glycitein, respectively. Another group which is a major contributor is meatless products. It includes “veggie” burgers (the largest contributor in this group), bacon bits, meatless sausages, frankfurters, chicken, etc. These products provided 12% of the total isoflavone intake, 13% of the daidzein intake, 12% of the genistein intake, and 20% of the glycitein intake. Foods such as chicken and coffee, which contain small amounts of isoflavones but are widely consumed, were major contributors. Chicken provided 12% of total isoflavone intake, while coffee provided 5%.

Table 1. Percent of total isoflavones intake contributed by foods

Group Code	Group Description	Average Content (mg/100 g)	Percent of total grams consumed
16-SM	Soymilk (all types and flavors)	7.80	22.26
16-TF	Tofu	24.07	12.32
05-CH	Chicken	0.53	12.30
16-ML	Meatless products (includes veggie burgers and other imitation vegetarian products)	24.20	12.05
16-SB	Soybeans	65.11	5.20
14-CF	Coffee	0.03	5.13
18-DN	Doughnuts	1.37	5.12
07-HD	Frankfurters (various meats)	0.60	4.40
21-CF	Chicken, fried (includes chicken nuggets and fingers)	0.55	2.79
18-BW	Bread and rolls, white	0.10	2.29
05-TY	Turkey	0.52	2.15
03-IS	Infant formulas, soy-based	11.79	1.67
07-SA	Sausage (various meats)	0.20	1.17
16-SS	Soy sauce	1.19	1.07
16-MS	Miso	41.45	1.05
25-FB	Formulated bar, POWER BAR, chocolate	5.07	0.98
01-EG	Eggs	0.05	0.66
16-PB	Peanut butter	0.30	0.65
11-SP	Sweet potato	0.30	0.64
03-IM	Infant formulas, milk-based	0.84	0.52

Table 2. Percent of diadzein intake contributed by foods

Group Code	Group Description	Average Content (mg/100 g)	Percent of total grams consumed
16-SM	Soymilk (all types and flavors)	3.40	21.51
16-ML	Meatless products (includes veggie burgers and other imitation vegetarian products)	11.60	12.64
16-TF	Tofu	9.62	11.16
05-CH	Chicken	0.19	9.91
14-CF	Coffee	0.03	9.13
18-DN	Doughnuts	0.68	5.56
16-SB	Soybeans	30.76	5.45
07-HD	Frankfurters (various meats)	0.30	5.04
21-CF	Chicken, fried (includes chicken nuggets and fingers)	0.21	3.32
18-BW	Bread and rolls, white	0.06	2.04
05-TY	Turkey	0.18	1.60
16-SS	Soy sauce	0.79	1.57
03-IS	Infant formulas, soy-based	3.87	1.15
07-SA	Sausage (various meats)	0.07	0.93
16-MS	Miso	16.43	0.92
16-PB	Peanut butter	0.19	0.89
01-EG	Eggs	0.03	0.89
18-BG	Bagels	0.19	0.88
25-FB	Formulated bar, POWER BAR, chocolate	1.80	0.85
11-SP	Sweet potato	0.14	0.77





Table 3. Percent of genistein intake contributed by foods

Group Code	Group Description	Average Content (mg/100 g)	Percent of total grams consumed
16-SM	Soymilk (all types and flavors)	4.15	24.51
16-TF	Tofu	12.91	13.56
16-ML	Meatless products (includes veggie burgers and other imitation vegetarian products)	11.34	11.69
05-Ch	Chicken	0.24	11.56
16-SB	Soybeans	31.26	5.17
18-DN	Doughnuts	0.61	4.73
07-HD	Frankfurters (various meats)	0.25	3.83
05-CF	Chicken, fried (includes chicken nuggets and fingers)	0.26	3.81
14-CF	Coffee	0.01	3.03
18-BW	Bread and rolls, white	0.05	2.86
05-TY	Turkey	0.24	2.02
03-IS	Infant formulas, soy-based	5.92	1.76
07-SA	Sausage (various meats)	0.11	1.38
25-FB	Formulated bar, POWER BAR, chocolate	3.27	1.30
16-MS	Miso	23.24	1.22
16-SS	Soy sauce	0.39	0.72
11-SP	Sweet potato	0.13	0.58
01-EG	Eggs	0.02	0.54
03-IM	Infant formulas, milk-based	0.41	0.54
16-PB	Peanut butter	0.10	0.46

Table 4. Total Isoflavone Content of Selected Foods

NDB No.	Food Description	Common Measure	Weight of Common Measure (g)	Content per common measure (mg)
16117	Soy flour, defatted	1 cup	105	158
43212	Bacon bits, meatless	1 tbsp	7	8
16122	Soy protein isolate	1 oz	28	26
16112	Miso	1 cup	275	114
16127	Tofu, soft	1/2 cup	124	28
08393	Cereals, ready-to-eat, KASHI GOLEAN by Kellogg's	1 cup	52	9
16107	Sausage, meatless	1 link	25	4
16147	Veggie burgers	1 patty	70	4
11453	Soybeans, sprouted, steamed	1 cup	94	12
16139	Soymilk, original and vanilla, with added calcium, vitamins A and D	1 cup	243	19

Table 5. Per capita consumption (mg/day) of isoflavones in the U.S. diet for all ages

Total isoflavones	0.68
Daidzein	0.31
Genistein	0.33
Glycitein	0.03

Conclusion

Soy products, such as soymilk, meatless vegetarian products, and tofu are the major contributors of isoflavones to the diet. Other food items, where soy products are used as ingredients (such as doughnuts, frankfurters, infant formulas, bread and rolls) may also contribute significant amounts of isoflavones to the diet. Table 4 provides the Isoflavone content of selected foods, based on common measures.

Traditionally soybeans and soy products were thought to be the primary dietary sources of isoflavones in the diet. However, with the wide use of soy-based ingredients such as soy flour and soy protein isolates in a variety of food items, other food products can also contribute isoflavones to the diet. Soy products are consumed in relatively low amounts by the general U.S. population, resulting in a total isoflavone intake of 0.68mg/day. This value is similar to the median intake of 0.66 mg/day of four isoflavones obtained in the E3N-EPIC cohort of 41-71 year old women in France[6].

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