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Isoflavonoid Content of Hong Kong Soy Foods

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Progress in understanding the effects of dietary soy isoflavones on chronic disease prevention in the Hong Kong Chinese population has been hampered by the lack of a comprehensive soy isoflavone database. In this study, we determined the concentrations and distribution of isoflavones in 47 foods included in a soy food frequency questionnaire by reverse-phase HPLC. Results indicated that most soy products contained isoflavones ranging from 1 mg of aglucon equivalents/100 g of wet weight (bean strip noodle and egg bean curd) to 80 mg of aglucon equivalents/100 g of wet weight (oyster sauce soybean and sweet bean curd sheet). Among our food groups, mean isoflavone concentrations were lowest in the soy milk group (9.99 mg of aglucon equivalents/100 g of wet weight) and highest in the bean curd skin group (40 mg of aglucon equivalents/100 g of wet weight). The conjugation patterns of isoflavones varied within and between food groups as influenced by the types of soybeans and the processing or cooking techniques used. The isoflavone concentrations reported herein will be useful for ascertaining the relationship between exposure to dietary soy isoflavones and health effects in the Chinese population.

KEYWORDS: Soy products; isoflavones; genistein; daidzein; glycitein; HPLC

INTRODUCTION

During the past few decades, epidemiological studies have shown that Asian countries, particularly Japan and China, have a lower incidence of hormone-related cancers (breast and prostate), coronary heart disease, and osteoporosis, and fewer menopausal symptoms, than countries in North America and Europe (*1*). It has been suggested that diets high in isoflavones contained in soy may in part be responsible for some of these observed differences. Isoflavones, a subclass of flavonoids, possess a myriad of biological properties that may be beneficial to human health. Attractive biological properties include anti-estrogenic, anti-mutagenic, and anti-proliferative activities (*2*).

Depending on the type of matrix to be analyzed, analytical methods, including high-performance liquid chromatography with ultraviolet detection (HPLC-UV), gas chromatography with mass spectrometric detection (GC−MS), and liquid chromatography with mass spectrometric detection (LC−MS), have been applied to quantify the isoflavone concentrations in foods. A database of values for the isoflavone content of foods was released in 1999 by the U.S. Department of Agriculture (USDA) in collaboration with Iowa State University (*3*). Since the original construction of the isoflavone database, many additional citations have appeared, and the USDA isoflavone database has been updated with stricter evaluation of data quality (*4*). Nonetheless, a review of these published data indicates that the range of isoflavone concentration present in a particular food could vary widely (*4*). For example, cooked soybeans may contain 23−128 mg/100 g of total isoflavones, while the amount contained in soy milk may range from 1.0 to 31 mg/100 g.

A 47-item food frequency questionnaire (FFQ) was designed to estimate the usual dietary intake of soy foods and isoflavones in the Hong Kong Chinese population. The design of this study has been previously reported (*5*, *6*). Because the isoflavone content and composition in different soy products vary depending on the type of soybeans, geographic area of cultivation, and methods of processing (*7*), we also conducted chemical analyses of isoflavones in local soy products included in the FFQ. This paper reports the concentrations of three types of isoflavones (daidzein, genistein, and glycitein) in four chemical forms (aglycons, β-glucosides, malonyl-β-glucosides, and acetyl-β-glucosides) of the 47 food items included in the soy FFQ being validated for use among Chinese women.

MATERIALS AND METHODS

Purchase of Soybeans and Soy Products. At the baseline interview for the validation study of the soy FFQ, participants (n = 145) were asked to provide information about the varieties, the usual place of purchase,

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and the common brand names for the individual soy products they had consumed at least once a month during the preceding 12-month period. Food purchase was then performed for these soy foods. For products without brand names, a maximum of 12 samples were collected for each food item from a range of retail outlets located in different geographical areas across the three regions of Hong Kong. For a soy product with retail brand names, samples representing the different brands were purchased. Samples with different expiration dates of the same brand were also included so the total number of samples may exceed the number of brands. The soy food samples were collected between March 27 and 31, 2003, processed, and then shipped to Iowa State University for isoflavone extraction and analysis.

Food Storage and Preparation. Freshly purchased products were first placed in Ziploc freezer bags. Perishable or semiperishable chilled soy products were kept in ice-filled buckets during transport and transferred to a 2−8 °C refrigerator before food preparation and processing. Shelf stable foods were stored at room temperature in a cool dry place before processing.

Each food sample was individually processed. The equipment used to prepare the samples was thoroughly washed with domestic detergent and rinsed in clear water between each sample processing. Soy products that required cooking were rinsed for 15−20 s to remove dirt or dust and allowed to drain on absorbent paper towels for 2 min before being weighed to the nearest 0.1 g. Samples that required cooking were boiled for 2−4 min, except as noted. The samples were then drained of excess surface moisture on absorbent paper towels and cooled to room temperature before being reweighed.

Preparation of Composite Samples. Cooked samples were individually homogenized at maximum speed with a Tefal chopper (Model Rondo 1000) from 20 s to 2 min depending on the moisture content of the sample. A single composite sample was then made for each soy product by combining a defined amount of individual sample homogenates. Since ~10 g of dry weight of the composite homogenates was required to perform all the necessary analyses at the appropriate detection limits, 50−100 g of wet weight of individual homogenates was collected to form the composite sample. This homogenization procedure was also used to obtain composite samples for ready-to-eat and -drink products and miso pastes.

Packaging and Shipment of Composite Samples. The composite homogenates of each soy product were rehomogenized for 2 min before the requested amount (soy food, 144−288 g; soy drinks/soups, 480 mL) was placed into prelabeled, leak proof polypropylene containers with tightly closed lids and then wrapped with Parafilm. To cover for any possible loss of or damage to the samples during shipment, additional composite homogenates for each soy product were collected and stored as backup samples. Containers storing the shipment samples were individually cushioned with absorbent paper towels and sealed with Ziploc freezer bags to prevent breakage during shipment. The packaged containers were then stored below −70 °C (Sanyo ultralow temperature freezer, model MDF-U71V) for 48 h before being shipped to Iowa State University for isoflavone analysis. To keep the composite homogenates frozen during shipment, the packaged containers were placed in a Styrofoam box packed with dry ice on the day of shipment and delivered by international air courier via the fastest route possible. Dry ice was replenished in transit in Los Angeles, CA; on arrival at the laboratory, the samples were cold to the touch.

Isoflavone Extraction and HPLC Analysis. The moisture content in composite homogenates was determined by vacuum oven drying (*8*). The concentrations of 12 isoflavonoids (daidzein, genistein, and glycitein and their β-glucosides, malonyl-β-glucosides, and acetyl-β-glucosides) were determined by reversed phase high-performance liquid chromatography (HPLC) (*9*). Two grams in duplicate of freeze-dried composite homogenates were suspended in a solution prepared with 10 mL of acetonitrile and 7 mL of distilled water and stirred at room temperature for 2 h based on a modification of the method of ref (*10*). The extracts were filtered through Whatman no. 42 filter paper, and the solvent was evaporated on a rotary evaporator at ≤30 °C. The filtrate was then redissolved in 10 mL of 80% HPLC grade methanol and passed through a 0.45 μm PTFE filter (Alltech Associates, Deerfield, IL) before 20 μL was injected into the HPLC system. Chromatography was performed using a YMC-pack ODS-AM-303 column (5 μm, 25 cm × 4.6 mm) equilibrated with solvent A (0.1% glacial acetic acid in H_2O) and eluted with a linear gradient from 15 to 35% solvent B (0.1% glacial acetic acid in acetonitrile) at a flow rate of 1.0 mL/min over a period of 50 min. Elution was monitored with a Beckman 168 photodiode array detector (Millipore Corp., Marlborough, MA) between 200 and 350 nm. UV spectra were recorded and area responses integrated with Beckman System Gold. The analytical quality control measures used in ref (*9*) were included in this study.

The concentrations of individual isoflavones were reported as micrograms per gram of dry matter. To express the amount of total isoflavones as milligrams of aglucon equivalents, the concentrations of the isoflavone β-glucosides, daidzin, genistin, and glycitin, the malonylglucosides, and acetylglucosides were first converted to aglucon equivalents. Samples with the derived aglucon equivalent concentrations of the isoflavone glucosides were then combined with isoflavone aglucons daidzein, genistein, and glycitein to form total isoflavones. Concentrations of total isoflavones in foods as consumed were calculated using the formula dry matter (100% minus moisture) × total isoflavones in food on a dry weight basis and expressed as milligrams of aglucon equivalents per 100 g of wet weight. All samples were analyzed in duplicate, and the average concentrations of the two measures were used for data presentation. The intra- and interassay coefficients of variation for total daidzein and genistein in soybean flour stored at −29 °C were less than 5% (*9*). Because data on the conjugation patterns of bean curd puff, triangular in shape (item 45), and preserved hot bean curd with sesame oil (item 46) were found to be potentially problematic, backup samples (only item 46) were sent to Iowa State University for reanalysis in 2004. However, there was insufficient sample of food item 45 for reanalysis. Data values of food item 46 were replaced with the reanalyzed values, and food item 45 was excluded from the soy database.

Statistical Analysis. Descriptive statistics were computed using the Statistical Analysis System for Windows (version 6.12, SAS Institute, Cary, NC). The mean, standard deviation, and interquartile range-to-median ratio of total isoflavones for 47 soy products expressed either on a dry weight or wet weight basis were calculated.

RESULTS

The food items analyzed for this study are grouped into four broad categories: soybean, bean curd skin, soybean milk, and tofu. The concentrations of total isoflavones in each type of soy product are presented in **Table 1**. All soy products, except baked beans in tomato sauce (item 5), contained total isoflavones ranging from 1 mg of aglucon equivalents/100 g of wet weight in soy noodles (item 6) and egg bean curd (item 31) to 80 mg of aglucon equivalents/100 g of wet weight in oyster sauce bean (item 4) and sweet bean curd sheet (item 17). Further, total isoflavone concentrations at the 25th and 75th percentiles of all foods are 8 and 30 mg of wet weight, respectively, with an interquartile range-to-median ratio of 1.38. When the moisture content in foods was taken into account, homemade soy milk (item 22) had the largest amount of total isoflavones (1851 μg of aglucon equivalents/g of dry weight), whereas soy noodles (item 6) contained only trace amounts (32 μg of aglucon equivalents/g of dry weight). Oyster sauce bean (item 4), having the highest concentrations on a wet weight basis, had a low moisture content. Bean curds purchased from wet markets (items 33−38) had higher wet weight isoflavone concentrations than brand-name bean curd in aseptic packed containers (items 39−41). Further, the denser the texture of the bean curd, the more isoflavones it contains. With the exception of natto (item 7) and smelly tofu (item 49), fermented soy products, including miso paste, instant miso soup, ready-to-drink miso soup purchased from Japanese restaurants (items 8−10), and fermented bean curd (items 46−48), had levels of total isoflavones (milligrams of aglucon equivalents per 100 g of wet weight) 2−5 times lower than those of many nonfermented soy products. Deep-fried bean curd (items 42−44) also had wet weight concentrations of total

Table 1. Isoflavone Content of Soy Products (mg of aglucon equivalents/100 g of wet weight) Commonly Consumed in Hong Kong[a]

			glucosides			malonylglucoside			acetylglucoside			aglycon			%[b]				μg of aglucon equivalents/g of dry weight				mg of aglucon equivalents/100 g of wet weight
item		%M	D	G	GL	D	G	GL	D	G	GL	Dein	Gein	Glein	GU	MA	AC	AG	total Dein	total Gein	total Glein	total Iso	total Iso
												Soybean											
1	soybean[c] (*n* = 12)	63.0	241	355	47	308	379	34	24	41	0	20	26	0	47	44	4	5	337	469	48	854	32
2	green soybean (*n* = 12)	70.9	38	67	59	190	248	98	0	23	0	27	22	19	22	60	3	15	146	205	109	460	13
3	soybean sprout (*n* = 12)	92.8	172	319	0	699	745	54	0	20	0	22	12	0	27	69	1	3	481	612	29	1121	8
4	oyster sauce soybean (*n* = 2)	10.3	420	589	97	66	79	18	41	61	23	17	24	9	77	9	8	6	330	467	94	891	80
5	baked beans in tomato sauce (*n* = 10)	74.0	0	0	0	0	0	0	0	0	0	0	0	0	—	—	—	—	0	0	0	0	0
6	bean strip noodle (*n* = 5)	73.0	0	10	0	0	0	0	0	18	0	8	7	0	20	0	32	48	8	24	0	32	1
												Fermented Soybean											
7	natto (*n* = 7)	58.8	841	1001	195	27	35	0	21	56	0	46	96	17	84	2	3	11	585	772	141	1498	62
8	miso paste (*n* = 9)	46.6	114	229	20	12	25	0	18	41	0	91	140	27	42	4	6	48	178	320	40	537	29
9	instant miso soup (*n* = 10)	49.9	133	232	23	11	22	0	18	41	17	110	155	32	40	3	7	50	207	335	56	597	30
10	commercially prepared miso soup (*n* = 12)	95.1	103	200	22	19	33	7	13	32	0	68	103	20	45	7	6	43	148	264	38	449	2
												Bean Curd Skin											
11	layered tofu sheet (*n* = 12)	73.4	13	46	11	0	23	0	0	19	0	31	60	12	26	7	7	60	39	112	19	170	5
12	fresh bean curd sheet (*n* = 12)	65.9	254	431	58	56	90	17	16	32	18	244	383	51	37	7	3	54	436	718	107	1262	43
13	bean curd skin (*n* = 12)	77.1	778	1315	160	44	58	14	15	32	14	70	90	18	84	4	2	11	576	960	135	1672	38
14	bean curd sheet (*n* = 11)	68.8	692	1001	131	113	139	24	21	39	0	99	112	21	73	9	2	15	591	832	117	1540	48
15	tofu stick (*n* = 12)	68.9	645	920	166	101	114	25	19	35	13	71	84	21	76	9	3	12	526	738	148	1412	44
16	deep-fried tofu stick (*n* = 11)	62.1	193	308	51	65	84	20	15	43	0	49	62	14	58	15	6	21	209	323	57	588	22
17	sweet bean curd sheet (*n* = 12)	47.9	944	975	191	64	54	17	17	28	12	62	54	17	85	5	2	9	681	708	155	1543	80
18	vegetarian ham (*n* = 5)	62.0	315	647	43	20	34	0	24	57	10	59	54	11	75	3	6	15	275	509	45	828	31
19	vegetarian chicken (*n* = 10)	68.6	144	393	35	0	15	0	9	21	0	40	62	11	72	2	3	23	132	328	34	494	16
20	vegetarian roll (shaped like twisted leg) (*n* = 5)	55.5	816	1254	148	25	36	0	17	33	12	115	130	23	80	2	2	16	636	951	124	1711	76
21	vegetarian duck (*n* = 4)	58.3	667	1091	131	0	43	0	17	33	12	99	94	23	81	2	2	15	516	817	114	1446	60
												Soybean Milk											
22	homemade soybean milk (*n* = 12)	95.8	407	420	119	1107	907	142	0	27	0	59	66	14	32	60	1	8	868	817	166	1851	8
23	commercially prepared, regular soybean milk (without brand name) (*n* = 12)	88.0	246	314	55	156	171	29	10	20	0	34	41	11	57	27	3	13	269	338	62	669	8
24	commercially prepared, regular soybean milk (with brand name) (*n* = 12)	89.0	248	351	65	46	64	15	17	25	0	22	23	10	74	12	4	10	206	290	59	555	6
25	calcium-enriched soybean milk, Calcipus (*n* = 12)	91.1	298	457	75	15	24	6	15	28	5	43	50	15	77	3	4	16	240	364	69	673	6
26	high-calcium soybean milk (*n* = 12)	88.9	165	223	41	119	138	22	11	21	0	56	60	17	47	26	3	24	223	284	55	562	6
27	high-calcium low-sugar soybean milk (*n* = 12)	89.6	226	238	63	347	314	55	37	22	0	17	17	8	42	48	4	5	351	341	78	771	8
28	low-sugar soybean milk (*n* = 12)	89.6	263	334	66	380	405	60	0	24	0	38	41	10	43	46	1	9	391	475	85	951	10
29	low-fat soybean milk, So Natural Light (*n* = 2)	89.4	462	660	81	33	54	0	14	28	12	13	13	9	87	5	4	4	319	470	67	856	9
30	soy milk powder (*n* = 11)	49.0	128	202	43	211	250	41	17	31	0	18	18	9	41	46	5	8	212	293	58	562	29
												Tofu											
31	egg bean curd (*n* = 13)	89.7	19	26	11	20	23	14	0	0	0	0	0	0	55	45	0	0	22	28	15	65	1
32	bean curd pudding (*n* = 12)	85.4	127	167	37	114	138	23	0	19	0	24	26	9	49	34	3	14	159	213	46	418	6
33	wrapped tofu (*n* = 12)	83.7	271	429	79	362	448	77	0	31	0	35	46	14	46	43	2	9	384	565	106	1055	17
34	soft tofu (*n* = 12)	83.3	368	558	101	324	394	63	0	31	0	43	58	17	54	34	2	10	432	630	115	1176	20
35	firm tofu (without brand name) (*n* = 12)	75.4	247	385	71	270	342	52	16	27	0	30	38	12	49	39	3	9	325	473	85	883	22
36	dried tofu (*n* = 12)	75.4	218	383	62	268	377	52	0	27	0	44	59	13	46	40	2	13	313	510	80	904	22
37	chauchow dried tofu (*n* = 12)	74.3	312	600	70	202	285	35	0	39	0	65	87	15	57	25	2	16	358	633	78	1070	27
38	five-spiced dried tofu (*n* = 12)	63.7	240	393	69	166	239	0	0	29	0	38	49	13	57	27	2	13	268	436	57	761	28
39	bean curd for steaming (*n* = 8)	88.1	485	516	115	477	415	77	0	29	0	22	24	10	55	39	1	4	560	580	124	1264	15

Table 1. Continued

			glucosides			malonylglucoside			acetylglucoside			aglycon			%[b]				μg of aglucon equivalents/g of dry weight				mg of aglucon equivalents/100 g of wet weight
item		%M	D	G	GL	D	G	GL	D	G	GL	Dein	Gein	Glein	GU	MA	AC	AG	total Dein	total Gein	total Glein	total Iso	total Iso
40	firm tofu (with brand name) (*n* = 5)	87.8	351	379	93	649	580	122	0	24	0	24	26	10	40	54	1	5	566	579	135	1280	16
41	bean curd for frying/deep frying (*n* = 6)	87.0	420	449	102	504	440	82	0	27	0	21	22	9	50	44	1	4	532	547	118	1198	16
	Deep-Fried Tofu																						
42	deep-fried bean curd (*n* = 13)	66.1	22	60	12	26	56	12	19	38	0	35	75	12	22	19	12	47	73	163	26	262	9
43	bean curd puff, square in shape (*n* = 13)	69.5	38	93	15	38	68	14	23	44	16	18	32	8	35	24	18	23	73	151	35	259	8
44	bean curd puff, rectangular in shape (*n* = 12)	62.6	23	61	13	34	69	13	14	31	0	31	62	12	24	24	10	42	70	154	27	251	9
45	bean curd puff, triangular in shape	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Fermented Tofu																						
46	preserved hot bean curd with sesame oil (*n* = 12)	72.3	0	0	0	0	0	0	0	0	15	89	153	56	0	0	3	97	89	153	65	306	8
47	preserved bean curd with sesame oil (*n* = 10)	73.6	0	0	0	0	0	0	0	0	15	104	134	52	0	0	3	97	104	134	61	299	8
48	preserved red bean curd (*n* = 13)	61.4	0	0	0	0	0	0	0	0	14	121	195	42	0	0	2	98	121	195	50	366	14
49	deep-fried preserved chou tofu (smelly tofu) (*n* = 6)	62.9	145	315	36	80	142	18	0	31	0	124	166	35	40	16	2	42	253	454	67	774	29

[a] Each composite sample is analyzed in duplicate. Abbreviations: %M, moisture; D, daidzin; G, genistein; GL, glycitin; Dein, daidzein; Gein, genistein; Glein, glycitein; GU, glucosides; MA, malonylglucosides; AC, acetylglucoside; AG, aglycon; D, Total Dein, glucosides of daidzin and daidzein; Total Gein, glucosides of geinstein and genstein; Total Glein, glucosides of glycitin and glycitein; Total Iso, Total Dein + Total Gein + Total Glein. [b] Percentage does not total 100 because of rounding. [c] Soybeans were soaked in water for 12 h at room temperature and then boiled for 30 min.

isoflavones similar to those found in fermented bean curd. Of the four broad categories, soy milk had the lowest mean total isoflavone content of 9.99 mg of aglucon equivalents/100 g of wet weight (standard deviation, 7.14 mg), whereas bean curd skin (items 11−17) had the highest mean total isoflavone content (mean ± standard deviation, 40.07 ± 23.46 mg of aglucon equivalents/100 g).

The chemical compositions of isoflavones in soy products are variable within and between food groups, and several distinct conjugation patterns are observed. Except in soy noodles (item 6) and deep-fried bean curd (items 42−44), few acetylglucosides are found in soy products. Natto (item 7) contained predominantly glucosides, whereas in miso soup (items 8−10), 40% or more of the isoflavones are in the forms of glucosides and aglucons. The isoflavone conjugation patterns in soybean, green soybean, and soybean sprouts (items 1−3, respectively) were similar to those found in soy milk (items 22−30) and unprocessed tofu (items 31−41). Malonylglucosides and glucosides are the predominant forms of isoflavones, but the proportion of aglucons in these products can vary from 0% in egg bean curd (item 31) to 24% in high-calcium soy milk (item 26). With the exception of layered tofu sheets and fresh bean curd skin (items 11 and 12, respectively), all food items in the bean curd skin category contained 58−85% glucosides. Smelly tofu (item 49) exhibited a conjugation pattern very similar to that of miso soup, and aglucons were present almost exclusively in fermented bean curd (items 46−48) of the tofu category.

DISCUSSION

This study provides information about the concentrations and distribution of isoflavones in 47 locally available soy products in Hong Kong. Our results confirm earlier findings that soy is a rich source of isoflavones typically containing more genistein than daidzein, though the genistein:daidzein ratio varies among different soy products (*4*, *9*, *11*, *12*).

The analytical data generated from food chemical analyses reveal considerable variability in the concentration of isoflavones in soy products. The observed variation could be attributed in part to differences in moisture content among the foods investigated. A substantial increase in the concentrations of total isoflavones is noted, and the interquartile range-to-median ratio is reduced to 0.95 (from 1.38, a 31% reduction), after correcting for moisture content in foods.

Depending on the type and intensity of processing techniques used during production, the amount and form of isoflavones found in the final soy products can vary widely. Our analysis shows fermented bean curds (items 46−48) have wet weight concentrations of total isoflavones one-third lower than those of nonfermented unprocessed tofu (item 35). Further, concentrations were substantially reduced following deep frying of soy products (compared with the nonfried item). With non-soy-derived materials as the dominant ingredients, both egg bean curd (item 31) and soy noodles (item 6) were also found to contain very low concentrations of isoflavones. These results are congruent with previous research which also found that fermentation and enzymatic hydrolysis (*12*), commercial food processing (*13*), and dilution with non-soy ingredients (*12*, *13*) may reduce the amount of isoflavone in foods.

Consistent with previous research (*13*), soy products prepared with thermal processing (e.g., unprocessed tofu) have greater concentrations of β-glucosides than malonylglucosides, whereas products undergoing deep frying (e.g., bean curd puffs) have more acetylglucosides. Malonylglucosides are the principal form of isoflavones found in raw and unprocessed soybeans (*14*). They are susceptible to heat and readily converted to β-glucosides and acetylglucosides via hydrolysis in hot water and decarboxylation by frying in oil, respectively (*13*).

The relative proportions of isoflavone aglucons were also found to vary among fermented soy products. Our analysis shows the percentages of aglucons in fermented bean curd (items 46−49), miso soup (items 8−10), and natto (item 7) were 97, 47, and 11%, respectively. These findings resemble very closely those reported by Franke et al. (*13*) and are consistent with other data suggesting the conversion of malonylglucosides to aglucons depends on many factors, especially the inoculum used in the hydrolysis of the sugar moiety (*12*).

The USDA−Iowa State University database provides published isoflavone values for foods whose analytical qualities have been evaluated using the methods developed by Holden et al. (*15*, *16*). In general, values for most Hong Kong foods lie within the broad range of source data used to compile the USDA−Iowa State University database (*3*). A comparison of our results with theirs further revealed the mean concentrations of total isoflavones in different kinds of soy milk (items 24−29) are similar to those reported in the USDA database (*4*). The USDA database showed canned soybeans contain 43.90−79.60 mg/100 g of total isoflavones (*4*). However, we found that beans baked in tomato sauce (item 5) contain no isoflavones. This finding is unexpected, and a re-examination of the food labels has revealed an inaccurate translation of the English word "beans" to "soybeans" in Chinese.

Differences in food sampling methodology and HPLC analytical methods make comparison of data across studies difficult. Moreover, product information, including amounts and types of food-grade soybean and processing techniques, are not known. Like all studies that aim to compile food databases, our study is not without limitations. Depending on type, climate, crop year, and location of growth, soybeans are inherently heterogeneous in concentrations of isoflavones (*7*). To attenuate the effects of these factors on isoflavone concentrations present in individual soybeans and soy products, composite samples in different seasons throughout the study period could be collected and combined for chemical analysis. This was not done in this study; for reasons of feasibility, all food samples were collected over a 3 week period. However, to the best of our knowledge, this is the first study to determine the concentrations and conjugation patterns of isoflavones in soy foods that are likely to be significant contributors to the usual dietary soy isoflavone intake in the Hong Kong Chinese population, in particular, middle-aged and older women. This database will be useful for ascertaining the health effects of isoflavone exposure among Chinese. Only one study has reported differences in absorption between isoflavone glucosides and aglucons (*17*), while all other reports in the literature show no differences in bioavailability based on glucoside form (*18*, *19*). This database will further permit the evaluation of the influence of soy matrix and its chemical composition on isoflavone bioavailability and metabolism.

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