Salud Pública de México
ISSN: 0036-3634
spm@insp.mx
Instituto Nacional de Salud Pública
México

Galvan-Portillo, Marcia V; Wolff, Mary S; Torres-Sánchez, Luisa E; López-Cervantes, Malaquías; López-Carrillo, Lizbeth
Assessing phytochemical intake in a group of Mexican women
Salud Pública de México, vol. 49, núm. 2, marzo-abril, 2007, pp. 126-131
Instituto Nacional de Salud Pública
Cuernavaca, México

Assessing phytochemical intake in a group of Mexican women

Marcia V Galvan-Portillo, MSc,[1] Mary S Wolff, PhD,[2] Luisa E Torres-Sánchez, Dr PH,[1]
Malaquías López-Cervantes, PhD,[3] Lizbeth López-Carrillo, Dr PH.[1]

Galván-Portillo MV, Wolff MS, Torres-Sánchez LE, López-Cervantes M, López-Carrillo L. Assessing phytochemical intake in a group of Mexican women. Salud Publica Mex 2007;49:126-131.

Abstract

Objective. Identify the content of selected phytochemicals (PHYs) in Mexican foods and evaluate the reliability of a food frequency questionnaire (FFQ) in assessing PHYs intake among Mexican women. **Material and Methods**. Values for PHYs content were obtained from four different data sets. PHYs intake was assessed in 50 women of reproductive age enrolled in a longitudinal cohort study. Values were obtained from a FFQ administered twice, one year apart in order to evaluate its reliability. Selected PHYs included flavonol (FOL), flavones (FES), flavanol (FAL), secoisolariciresinol (SE), matairesinol (MA), lariciresinol (LA), pinoresinol (PI), cynamic acid (CA) and coumestrol (CU). **Results**. Daily PHYs intake ranged from 1.3 μg ± 0.9 for MA to 116.3 ± 43.8 mg for CA. The adjusted correlation coefficients ranged from 0.17 for FAL to 0.47 for LA. Pinto beans, oranges, hot sauce, broccoli, apples and onions were the main sources of the selected PHYs daily intake. **Discussion**. The results of this study contribute to our understanding of the consumption of PHYs in the Mexican diet, and would help evaluate their potential health impact.

Key words: phytochemical intake; Mexican populations; reliability; México

Galván-Portillo MV, Wolff MS, Torres-Sánchez LE, López-Cervantes M, López-Carrillo L. Estimación de la ingesta de fitoestrógenos en un grupo de mujeres mexicanas. Salud Publica Mex 2007;49:126-131.

Resumen

Objetivo. Crear una base de datos con el contenido de nueve fitoestrógenos (FIT) presentes en alimentos mexicanos y calcular su ingestión y reproducibilidad en 50 mujeres participantes en un estudio de cohorte en México. **Material y métodos**. Los FIT seleccionados incluyeron flavonol (FOL), flavones (FES), flavanol (FAL), secoisolariciresinol (SE), matairesinol (MA), lariciresinol (LA), pinoresinol (PI), ácido cinámico (CA) y coumestrol (CU). El contenido de estos compuestos se obtuvo de cuatro diferentes fuentes de datos. La ingestión diaria se estimó a través de un cuestionario de frecuencia de consumo de alimentos, aplicado en dos oportunidades con una diferencia de un año a cada participante. La reproducibilidad en el reporte de cada FIT se estimó mediante coeficientes de correlación intraclase ajustados por residuales de energía. **Resultados**. La media de consumo de los FIT seleccionados varió de 1.3 ± 0.8 μg/d de MA hasta 116.3 ± 43.8 mg/d de CA. La reproducibilidad varió desde 0.17 para FAL hasta 0.47 para LA. Las principales fuentes de FIT fueron frijoles, naranja, salsa picante, brócoli, manzana y cebolla. **Discusión**. Este es el primer estudio que calcula la ingestión de FIT en México y podría constituir una herramienta útil para la futura evaluación de su efecto en la salud.

Palabras clave: ingesta de fitoestrógenos; población mexicana; reproducibilidad; Mexico

(1) Mexico's National Institute of Public Health. Cuernavaca, Morelos, México.
(2) Division of Environmental Health Science, Department of Community and Preventive Medicine, Mount Sinai School of Medicine. New York, NY, USA.
(3) School of Medicine. National Autonomous University of Mexico. Cuernavaca, Morelos, México.

Received on: July 14, 2006 • **Accepted on**: October 13, 2006.
Address reprint request to: Dra. Lizbeth López Carrillo. Instituto Nacional de Salud Pública. Av. Universidad 655, col. Santa María Ahuacatitlán. 62508 Cuernavaca Morelos, México.
E-mail: lizbeth@insp.mx

Phytochemicals (PHYs) are plant compounds with estrogen-like activity. Epidemiological evidence suggest that high ingestion of these compounds is associated with a decrease on the risk of breast,[1-4] prostate,[2,5,6] and gastric cancer,[7,8] as well as cardiovascular diseases,[4,9-11] osteoporosis,[2,12-14] and menopausal symptoms,[15-16] Fruits and vegetables are an important source of PHYs; however their consumption varies throughout the world.[5,12,15] In Latin American countries, the energy intake from fruits and vegetables is approximately three times higher than in North America, North-Central Europe and Asian countries.[17] This variation in phytochemical intake may explain differences in PHYs related disease patterns. The lack of comprehensive phytochemical composition food tables precludes the study of their health impact, especially in developing countries. This study aims to identify the content of selected PHYs in Mexican foods and evaluate the reliability of a food frequency questionnaire in assessing PHYs intake among women living in Mexico.

Material and Methods

Intake of selected PHYs was estimated in a sample of 50 women, aged between 17 and 37 years, participating in a longitudinal cohort study in the state of Morelos, Mexico from 2001-2002 that was approved by the IRB of the Mexico National Institute of Public Health.

Eligible participants were non-pregnant and non-lactating women, who reported no change in their diet over the past 12 months and signed an informed consent document. A more detailed description of the study design is published elsewhere.*

Women were asked about their dietary habits, on two different occasions using a standardized food frequency questionnaire (FFQ).[18,19] Trained personnel completed the in-person interviews one year apart and during the same season of the year. The frequency of the consumption of foods that are sources of PHYs (54/100 items included in the FFQ) was calculated considering a pre-determined portion size and 10 frequency categories ranging from never to six times per day.

To determine PHYs intake, we developed a database of nine selected PHYs present in the 54 foods included in the FFQ. Selected PHYs included three flavonoids (FLAV): flavonol (FOL), flavones (FES), flavanol (FAL); four Lignans (LI): secoisolariciresinol (SE), matairesinol (MA), lariciresinol (LA), pinoresinol (PI); cinnamic acid (CA) and coumestrol (COU). Mean values of FOL, FES and FAL were imputed from the 2003 USDA flavonoid data set,[20] while the 1998 Notice plus data base[21] was used as a source of CA and COU. Mean values for SE, MA, LA and PI were also obtained from published databases.[22,23] The taxonomic name, genus and species of vegetables were verified in the imputation process.[24] PHYs contents in mg/100g and μg/100g referred to wet edible portions. If values of PHYs for an individual food item were available from several references, we calculated a mean value from the pool of values. Non-vegetable sources of PHYs included milk chocolate, jam, wine and beer. Recipes of local dishes were also used to determine whether they included ingredients that were sources of PHYs.[25] The Food Intake Analysis software, along with a program written with Fox Pro v.9.0, was used to estimate the individual intake of nutrients and PHYs of interest. A detailed description of nutrient calculation is published elsewhere.[26]

Descriptive statistics were calculated to assess the characteristics of the study population. Energy adjusted (by means of energy residuals) intra-class correlation coefficients (ρ_1) were calculated to evaluate the reliability of the FFQ results. The main food sources of selected PHYs intake were identified by partial R^2 through estimated multiple linear regression models. All analyses were performed using the statistical software package STATA 7.0.

Results

General characteristics of the study population are displayed in Table I. The study sample included mostly young (mean age 23.8 years), nulliparous (85.4%) women, with normal body mass index scores (23.7 kg/m^2). Approximately half of the women had at least 12 years of education and reported having a paid job. Table II shows the imputed values (mg/100g or μg/100g in fresh edible weight) for the PHYs in the foods included in our FFQ.

Table III shows the energy-adjusted means of selected PHYs estimated in the two interviews, along with their energy adjusted intraclass correlation coefficients. The daily nutrient intake was estimated to be 2336.7 ± 476.3 kcal for energy, 76.7 ± 6.3 g for protein, 273.6 ± 26.8 g for carbohydrates and 109.5 ± 12.3 g for total fat (data not included in the table). The daily FLAV intake varied from 7.5 ± 3.8 mg for FES to 29.3 ±

* Torres-Sánchez L, Rothenberg SJ, Schnaas L, Cebrián-García M, Osorio E, Hernández M, *et al*. In utero p,p´-DDE exposure and infant neurodevelopment: perinatal cohort in México, 2006. En prensa.

Table I
Characteristics of the study population

Characteristics	*(n= 50)*
Age (years)	
Mean ± SD	23.8 ± 4.1
Median	24
Percentile 25 - 75	21 - 26
Parity (%)	
Nulliparous	85.4
Parous	14.6
Body Mass Index	
Mean ± SD	23.1 ± 3.5
Median	23.7
Percentile 25 - 75	20.7 - 25.1
Level of education (years)	
Mean ± SD	11.1 ± 3.4
Median	12
Occupation (%)	
Paid work	50
Housewife	48
Student	2

10.1 mg for FOL. LI daily intake varied from 1.3 ± 0.9 μg for MA to 205.3 ± 111.6 μg for LA. CA daily intake resulted 116.3 mg ± 43.8 while COU intake was 1.7 ± 1.1 mg. The adjusted correlation coefficients ranged from 0.17 for FAL to 0.47 for LA.

Foods that contributed 10% or more to the selected PHYs daily intake are shown in Table IV. Pinto beans were the main sources of CA, SE and COU intake, and apples accounted for 28.7% of the FLA intake variance. Hot sauce was the main contributor of FES and onion contributed to FOL intake. Broccoli was the primary source of LA and PI, and oranges explained 53.2% of the MA intake variation.

Discussion

These results provide information about the intake of selected PHYs in a group of Mexican women. Our database contains information about frequently consumed foods in the Mexican diet, which are sources of PHYs.

There are several important limitations to our study. First, our analyses were limited to nine selected PHYs, therefore we were not able to calculate total PHYs consumption. Second, we were unable to obtain data about the PHYs content of some local and frequently consumed foods included in the FFQ, including edible cactus, squash blossoms, mamey, zapote and prickly pears (local fruits). Finally, information about food preparation was not included in our questionnaire; therefore we were not able to adjust for its affect on PHYs content. Certain food preparation methods may alter the content of PHYs, although the magnitude of these effects is still unknown.[1,27]

Pinto beans provided the highest percentage of three PHYs intake (SE, COU and CA). According to very recent information several PHYs are present in different kinds of Mexican beans[28,29] however, only one type of bean was evaluated in our FFQ, further studies should include other types of beans.

The variability in the estimated intake of PHYs among countries may be explained by the fact that the many of the databases do not contain complete information on PHYs content. For example, not all database values refer to the same compounds –they may comprise as many as 4000 structurally different phytochemicals with structures varying from simple molecules (e.g. phenolic acid) to highly polymerized substances (e.g. tannins).[30]

Worldwide comparisons of PHYs should be approached with caution, as methodologies used to calculate these estimates are not standardized.

In spite of these limitations, the results of this study provide an important first step towards improving our knowledge about the consumption of PHYs in the Mexican diet that might be useful to further evaluate their health impact.

Table II
CONTENTS OF SELECTED PHYTOCHEMICALS VALUES IN 54 FOODS

Food item	*Flavone*[&]	*Flavanol*[&]	*Flavonol*[&]	*Lariciresinol*[#,≠]	*Pinoresinol*[#,≠]	*Secoisolariciresinol*[#,≠]	*Matairesinol*[#,≠]	*Cinamic acid*[‡,&]	*Coumestrol*[‡,&]
1 Margarine				7.00	0.00	32.00	0.00		
2 Red plum		6.19*	1.05§	4.00	74.00	4.00	0.00		
3 Yellow peach		2.33*		80.00	186.00	27.00	0.00		
4 Apple		9.09*	3.92§	1.00	0.00	0.00	0.00		
5 Orange				47.00	24.00	5.00	2.00	8.36	
6 Orange juice	0.35‡		0.30§					0.24	
7 Grapes		20.39*	2.37§	52.00	0.00	4.00	5.00		
8 Strawberry		4.47*	1.74§	117.00	212.00	5.00	0.00	6.63	
9 Blackberry		18.74*	1.22§						
10 Canteloupe				28.24	15.53	3.53	0.00		
11 Mango		1.72*						49.22	
12 Pear		4.25§	0.79§	155.00	34.00	4.00	0.00	34.20	
13 Papaya								29.37	
14 Pineapple								26.20	
15 Cauliflower	0.08*		0.28*					3.07	
16 Broccoli			9.79§	972.00	315.00	38.00	0.00		
17 White corn								48.80	
18 Potato			0.06*	17.00	0.00	2.00	0.00	24.18	
19 Carrot			0.07*	73.00	27.00	77.00	0.00	71.48	
20 Spinach	1.11*		4.88*					0.78	
21 Lettuce	0.44*		2.70§	3.20	1.60	8.60	0.00	7.13	
22 Cooked tomato with garlic			0.72§	38.35	13.77	2.17	0.00	4.69	
23 Raw tomato			0.72§	42.00	14.00	2.00	0.00	4.69	
24 Pinto beans						25.99		31.83	1.18
25 Avocado		0.56*							
26 Beet	0.37*		0.13*	3.00	0.00	1.00	0.00		
27 Onion			106.58§	19.00	0.00	18.00	0.00	1.33	
28 Green peas				9.30		9.30			1.50
29 Lentil soup			3.94§	15.60	3.53	4.74	0.00	0.89	
30 Broad beans		49.37*	4.60*			26.00			1.50
31 Hot sauce	5.13§		70.41§	10.10	3.72	2.75	0.00	8.84	
32 Pickled jalapenos	2.33§		36.60§	5.09	0.00	5.98	0.00	0.29	
33 Milk chocolate		13.35*							
34 Marmelade		0.90*	0.76*						
35 Freshly toasted bread slice				52.25	52.85	16.35	1.30		
36 French rolls				11.00	7.00	0.00	0.00		
37 Rice soup				2.55	0.00	5.83	0.00	2.85	
38 Pasta soup	2.37*		9.82§	3.22	0.78	2.66	0.00	0.45	
39 Ground coffee			0.10*	0.12	0.14	0.15	0.01	19984.47	
40 Instant coffee								12830.57	
41 Herbal tea		4.86‡		0.00	0.00	0.00	0.00		
42 Black tea		4.20‡	3.84‡	0.01	0.01	0.00	0.00		
43 Red wine		11.90*	1.62*	8.60	11.90	41.70	6.90		
44 White wine		1.38*	0.06*	7.30	1.70	12.20	2.70		
45 Beer			0.10*	9.00	21.70	1.00			
46 Vegetable oil				0.00	0.00	0.00	0.00	4.69	
47 Pastor tacos			3.68§	0.76	0.00	0.89	0.00	2.00	
48 Gorditas		0.07*	6.37§	10.54	2.92	4.21	0.00	2.97	
49 Memelas			6.60§	2.14	0.50	1.80	0.00	1.04	
50 Pozole			1.94§	0.49	0.00	0.86	0.00	0.47	
51 Sopes			0.07‡	0.12	0.00	0.53	0.00	0.42	
52 Quesadillas	0.03§		0.11§	0.07	0.00	17.04	0.00	21.40	0.76
53 Pambazos	0.02‡		4.18§	9.68	2.96	3.02	0.00	7.04	
54 Garlic				286.00	200.00	50.00	0.00		

* USDA flavonoid database
‡ Notis plus database
§ USDA flavonoid and notis plus databases
# Milder *et al* 2005 and Mazur *et al* 1997
& mg/100g wet edible food
≠ mg/100g wet edible food

Table III
ENERGY ADJUSTED MEANS AND CORRELATION COEFFICIENTS OF DAILY INTAKE OF SELECTED PHYTOCHEMICALS

Phytochemical	*1st FFQ**	*2nd FFQ‡*
Flavonol (mg/d)#		
Mean ± sd	31.8 ± 15.1	26.8 ± 11.3
ρ_i§	0.18	
Flavones (mg/d)#		
Mean ± sd	8.7 ± 5.2	6.3 ± 4.0
ρ_i§	0.21	
Flavanol (mg/d)#		
Mean ± sd	11.9 ± 6.5	8.1 ± 5.3
ρ_i§	0.17	
Cinnamic acid (mg/d)#		
Mean ± sd	133.1 ± 50.2	99.6 ± 50.8
ρ_i§	0.37	
Lariciresinol (μg/d)#		
Mean ± sd	236.5 ± 144.1	174.1 ± 98.
ρ_i§	0.47	
Pinoresinol (μg/d)#		
Mean ± sd	102.0 ± 62.5	73.4 ± 36.5
ρ_i§	0.39	
Secoisolariciresinol (μg/d)		
Mean ± sd	122.7 ± 63.6	122.9 ± 93.1
ρ_i§	0.37	
Matairesinol (μg/d)#		
Mean ± sd	1.5 ± 1.2	1.1 ± 1.0
ρ_i§	0.18	
Coumestrol (mg/d)		
Mean ± sd	1.7 ± 1.1	1.7 ± 1.5
ρ_i§	0.39	

* Administered in Morelos, Mexico during 2001
‡ Administered in Morelos, Mexico during 2002
§ Energy adjusted
# ttest $p<0.05$

Table IV
FOODS THAT CONTRIBUTE ≥ 10% TO THE SELECTED PHYTOCHEMICAL INTAKE OF STUDY POPULATION

Food	*Phytochemicals*	*% intake*
Pinto beans	Secoisolariciresinol	75.8
	Coumestrol	66.9
	Cinnamic acid	20.5
Broccoli	Lariciresinol	20.0
	Pinoresinol	10.3
Orange	Matairesinol	55.2
Apple	Flavanol	28.7
Hot sauce	Flavones	48.0
Onion	Flavonol	16.5

Acknowledgements

This study was supported in part by Mount Sinai School of Medicine/Queens College International Training and Research in Environmental and Occupational Health Program funded by the National Institutes of Health (D43TW00640).

References

1. Mishra S, Dickerson V, Najm W. Phytoestrogens and breast cancer prevention: What is the evidence? Am J Obstet Gynecol 2003;188(5):s66-s70.
2. Murkies A, Wilcox G, Davis S. Clinical Review 92: Phytoestrogens. J Clin Endocrinol Metab 1998;83(2):297-303.
3. Peeters P, Keinan-Boker L, van der Schouw Y, Grobbee D. Phytoestrogens and breast cancer risk. Review of the epidemiological evidence. Breast Cancer Research and Treatment 2003;77:171-183.
4. Arts I, Hollman P. Polyphenols and disease risk in epidemiologic studies. Am J Clin Nutr 2005;81(suppl):S317-S325.
5. Kurzer M, Xu X. Dietary phytoestrogens. Annu Rev Nutr 1997;17:353-381.
6. Strom S, Yamamura Y, Duphorne Ch, Spitz M, Babaian R, Pillow P, *et al.* Phytoestrogen intake and prostate cancer: a case-control study using a new database. Nutr Cancer 1999;33(1):20-25.
7. Garcia-Closas R, Gonzalez C, Agudo A, Riboli E. Intake of specific carotenoids and flavonoids and the risk of gastric cancer in Spain. Cancer Causes and Control1999;10:71-75.
8. Lagiou P, Samoli E, Lagiou A, Peterson J, Tzonou A, Dwyer J, *et al.* Flavonoids, vitamin C and adenocarcinoma of the stomach. Cancer Causes and Control 2004;15:67-72.
9. Hertog M, Kromhout D, Aravanis C, Blackburn H, Buzina R, Fidanza F, *et al.* Flavonoid intake and long-term risk of coronary heart disease and cancer in the seven countries study. Arch Intern Med 1995;155:381-386.
10. Rimm E, Katan M, Ascherio A, Stampfer M, Willett W. Relation between intake of flavonoids and risk for coronary heart disease in male health professionals. Ann Intern Med 1996;125:384-389.
11. Hirvonen T, Pirjo P, Virtanen M, Ovaskainen M, Häkkinen S, Albanes D, *et al.* Intake of Flavonols and Flavones and Risk of Coronary Heart Disease in Male Smokers. Epidemiology 2001;12:62-67.
12. Setchell K, Cassidy A. Dietary Isoflavones: Biological Effects and Relevance to Human Health. *J Nutr* 1999;129:S758-S767.
13. Setchell K, Lydeking-Olsen E. Dietary phytoestrogens and their effect on bone: evidence from in vitro and in vivo, human observational, and dietary intervention studies. Am J Clin Nutr 2003;78(suppl):S593-S609.

14. Atkinson C, Compston J, Day N, Dowsett M, Bingham S. The effects of phytoestrogen isoflavones on bone density in women: a double-blind, randomized, placebo-controlled trial. Am J Clin Nutr 2004;79(2):326-333.
15. Setchell K. Phytoestrogens: the biochemistry, physiology, and implications for human health of soy isoflavones. Am J Clin Nutr 1998;68(suppl 6):S1333-S1346.
16. Carusi D. Phytoestrogens as hormone replacement therapy: an evidence-based approach. Prim Care Update Ob/ Gyns 2000;7(6):253-259.
17. World Cancer Research Fund/American Institute for Cancer Research. Patterns of diet. In: Food, Nutrition and the prevention of cancer: a global perspective. Press, 1997:20-52.
18. Bonilla-Fernández P, López-Cervantes M, Torres-Sánchez LE, Tortolero-Luna G, López-Carrillo L. Nutritional factors and breast cancer in Mexico. Nutr Cancer 2003;45(2):148-155.
19. Galván-Portillo M, Torres-Sánchez L, López-Carrillo L. Dietary and reproductive factors associated with benign breast disease in Mexican women. Nutr Cancer 2002;43(2):133-140.
20. Nutrient data lab, Food composition lab, Beltsville Human Nutrition Research Center, ARS, U.S. Department of Agriculture. USDA Database for the Flavonoid Content of selected foods 2003;1-77. Available on: http://www.nal.usda.gov/fnic/foodcomp.
21. Institute of Food Research. Biotechnology & Biological Sciences Research Council. Colney, Norwich NR4 7UA, UK. CD-ROM Notis^{plus} a database of bioactive compounds found in food plants (1998).
22. Milder I, Arts I, van de Putte B, Venema D, Hollman P. Lignan contents of Dutch plant foods: a database including lariciresinol, pinoresinol, secoisolariciresinol and matairesinol. Br J Nutr 2005;93: 393-402.
23. Mazur W, Duke J, Wahala K, Rasku S, Adlercreutz H. Isoflavonoids and lignans in legumes: nutritional and health aspects in humans. J Nutr Biochem 1998;9:193-200.
24. USDA, ARS, National Genetic Resources Program. Germplasm Resources Information Network - (GRIN) [Online Database]. National Germplasm Resources Laboratory, Beltsville, Maryland. [Accessed on 25 augustt, 2005]. Available on: http://www.ars-grin.gov2/cgi-bin/npgs/html/index.pl (25 August 2005).
25. Muñoz Z R. Diccionario Enciclopédico de Gastronomía Mexicana. Mexico: Clio, 2000.
26. López-Carrillo L, López-Cervantes M, Ward MH, Bravo-Alvarado J, Ramirez-Espitia A. Nutrient intake and gastric cancer in Mexico. Int J Cancer 1999; 83(5):601-605.
27. Goldman I, Kader A, Heintz M. Influence of production, handling and storage on phytonutrient content of foods. Nut Rev 1999; 57(9): S46-S52.
28. Espinosa-Alonso LG, Lygin A, Widholm JM, Valverde ME, Paredes-Lopez O. Polyphenols in wild and weedy Mexican common beans (Phaseolus vulgaris L.). J Agric Food Chem 2006;54(12):4436-4444.
29. Diaz-Batalla L, Widholm JM, Fahey GC Jr, Castano-Tostado E, Paredes-Lopez O. Chemical components with health implications in wild and cultivated Mexican common bean seeds (Phaseolus vulgaris L.). J Agric Food Chem 2006;54(6):2045-2052.
30. Middleton E, Kandaswami C, Theoharides Th. The effects of plant flavonoids on mammalian cells: Implications for inflammation, heart disease, and cancer. Pharmacol Rev 2000; 52(4): 673-751.