Protein, Energy, Fat, and Mineral Composition of Diets for Low-Income Adults in Sonora, Mexico

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The major energy foods in Sonora, Mexico, are beans and corn and flour tortillas. The daily intake of beans was 329 g, corn tortillas, 253 g, and flour tortillas, 105 g. The chemical composition of the diet for low-income adults, 25 years or older, was analyzed according to AOAC (1990) methods for protein, fat, dietary fiber, phytates, Fe, Zn, Se, and Ca. The results of this study showed intakes of 92.98 g/day of fat, 104.33 g/day of protein, 49.24 g/day of dietary fiber, 2088 mg/day of phytates, 19.50 mg/day of Fe, 19.50 mg/day of Zn, 1164 mg/day of Ca, and 171.68 μg/day of Se for a diet of 2667 kcal. All of these levels exceed the U.S. RDAs and the recommendations for Mexico (NAS, 1989; INN, 1977). Comparing the analyzed values with calculated values from databases, the values for the macronutrients agreed more closely than did the values for micronutrients; however, databases that include regional foods must be used. Minerals and phytates, with the exception of Ca, are insoluble, which could indicate the presence of unavailable phytate–mineral complexes.

Keywords: *Nutrient data; Mexican diets; nutrient data bases*

INTRODUCTION

In Sonora, Mexico, as in other developing countries, cereals and legumes constitute the main ingredients in the diet. The diet of the general population of Sonora, Mexico, has been well characterized, and basically 20 different food items have been found to constitute the diet for the majority of the population as judged by frequency of consumption. Within these 20 food items, refried beans, meat, eggs, corn tortillas, milk, sugar, flour tortillas, coffee, potatoes, and tomatoes represent the major foods consumed (Valencia et al., 1992). Much is known about the types of foods, how they are prepared, the quantity consumed and by whom; however, very little is known about the chemical composition of the diet.

The majority of the population in Mexico and in the state of Sonora is considered of low income (72%) (Hernandez, 1992); however, the standard of living is higher in the state of Sonora compared to other parts of Mexico due to the strong North American influence and industrialization of the state (Camberos, 1993). The socioeconomic designation is made depending upon the income of the family, type of housing, family members that are employed, sanitary conditions, and other factors as determined in the method of Méndez (1978). As income rises, it appears that the diets improve to include a wider variety of food items and consumption of animal protein products increases as does the consumption of more fruits and vegetables. Sonora is known as the meat-eating state and is the main producer of beef cattle, swine, and poultry in Mexico. The objective of this study was to analyze the typical diet of adults of low income for energy, protein, fat, dietary fiber, total phytates, soluble and insoluble phytates, total, soluble, and insoluble iron, zinc, calcium, and selenium and compare these analyzed values with calculated values from databases.

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MATERIALS AND METHODS

Diet. The 24-h dietary recalls for adults, 25 years or older, not taking medication or vitamin or mineral supplements were reviewed. The women that were included in the sample were not pregnant or nursing. A total of 505 records were available for review. The dietary recalls registered the total grams of each food item consumed. The records had been obtained in an earlier study by this center (Valencia et al., 1992), and the individuals studied were classified into groups according to their socioeconomic level: low, medium, or high (Camberos, 1993). For each socioeconomic level, the foods consumed and the quantities were determined. The foods items that registered the highest frequency of consumption were selected to represent the typical diet. The grams of each item represented the average intake of the subjects selected for the study. Several food items appeared in an occasional food questionnaire that were not included in the composite because of infrequent consumption. The four foods that are included in the basket study that are not included in the representative composite diet of this study were white bread, pasta, oranges, and lettuce. This paper reports on the diet of the low-income group, which represents the diet of 72% of the population of Sonora (Valencia et al., 1992). The foods were purchased in local markets in Hermosillo, Sonora, Mexico, and were prepared according to traditional recipes (Camou et al., 1990). The beans were cooked in water (1:5) until tender and then blended with the liquid; salt was added to taste. The potatoes, eggs, and meat were fried in vegetable oil. The rice was prepared in the traditional manner of cooking in water and salt until dry and tender. All other items were included in the diet in the form as purchased. Once the foods were prepared, the quantity of each ingredient was measured and the total diet was blended in a Waring Commercial Blend. (Waring Products Corp. of America, New Hartford, CT). Moisture content was determined immediately; a portion was frozen and stored at −20 °C, and the remaining portion was air-dried in a laboratory oven (Blue MC-4850Q, Blue Island, IL), at 56 °C for further analysis.

Proximal Analysis. Moisture was determined according to AOAC Section 934.901 (1990) in a vacuum oven (VWR 1430, VWR Scientific Inc., Philadelphia, PA). Fat was determined according to AOAC Section 920.39 (1990) using 99.5% ethyl

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Table 1. Composite Diet (Grams per Day, Wet Weight) for Low-Income Adults 25 Years or Older in Sonora, Mexico

food	intake (g)	food	intake (g)
refried beans[a]	329 ± 157.6	soda	380 ± 98.3
corn tortilla	253 ± 161.8	meat, fried	60 ± 15.3
flour tortilla	105 ± 118.0	milk	228 ± 134.0
potatoes, fried	110 ± 44.1	coffee	435 ± 192.3
cheese, white	40 ± 2.3	sugar	24 ± 10.8
chile, serrano	10 ± 6.0	eggs, fried	70 ± 27.9
tomatoes	41 ± 23.9	vegetable oil	10 ± 0.0
onion, white	25 ± 14.0	rice, cooked	200 ± 34.6

[a] *Phaseolus vulgaris* var. Pinto.

ether (Merck of Mexico, S.A.) with a Goldfish fat extractor (Labconco Corp., Kansas City, MO). Ash was determined in a muffle furnace (Type 30400, Dubuque, IA) according to AOAC Section 923.03 (1990) and protein according to AOAC Section 960.52 (1990), using a factor of 6.25. Carbohydrates were calculated by difference. All analyses were done in triplicate.

Dietary Fiber. Dietary fiber was determined according to AOAC Section 985.29 (1990) utilizing dietary fiber kits (TDFAB-1, Sigma Chemical Co., St. Louis, MO) and Tecator filtering and incubation equipment (Fibertec system E 1023, Tecator, Sweden).

Minerals. Total minerals, iron, calcium, and zinc, were determined in the diet and in the soluble fractions by dry ashing using the method of AOAC Section 965.09 as previously reported by Wyatt and Triana (1994). The method was validated using a NBS standard, bovine 1577b (NIST, Gaithersburg, MD). A digestion procedure, which simulates digestion in the stomach, according to the method of Rao and Prabhavathi (1978) was used to determine the soluble fractions for minerals and phytates.

Phytates. Total phytates were determined according to AOAC Section 986.11 (1990) with the modifications previously reported by Wyatt and Triana (1994). The method was validated using the reference material red wheat bran (AACC, St. Paul, MN) using the values for phytates reported by Harland and Oberleas (1986) and Harland et al. (1988).

Selenium. Selenium was determined by atomic absorption using a hydride generator (AA-HG) [Varian AA-20 equipped with a hydride generator (VGA-76), Varian Technitron Pty. Ltd., Mulgrave, Victoria, Australia] using $NaHB_4$ (35% w/v) (Johnson Matthey Catalog Chemicals, Ward Hill, MA), stabilized by adding 5 mL of 10% (w/v) of NaOH (Merck of Mexico). To 2 g of the sample were added 5–10 mL of HNO_3 (70%) (Merck of Mexico) and 2–3 mL of H_2O_2 (30%) (Merck of Mexico), and digestion proceeded in a pressure-controlled microwave oven (CEM MDS 81D, CEM Corp., Matthews, NC). After digestion, the sample was heated at 80–90 °C in a water bath for 30 min to reduce the selenium to oxidation stage IV.

Energy. The energy was calculated using the physiological energy values reported by Paul and Southgate (1985) (17 kJ/g of protein, 37 kJ/g of fat, and 16 kJ/g of carbohydrates); the kilojoules were converted to kilocalories by dividing by 4.184.

Computer Program. Once the type and quantity of each food item were obtained, each item was coded and analyzed for each nutrient by two different databases, ALIM 10 000 (Juvera, 1990) and Nutritionist III (1992). The program ALIM 10 000 was developed by this center to specifically provide nutrient data on regional foods. The program includes data from *USDA Handbooks 8* and 8-1 (Watt and Merrill, 1975; Posati and Orr, 1976; Paul and Southgate, 1985) and food composition data from the Instituto Nacional de la Nutricion in Mexico (Hernandez et al., 1980–1987), plus data on regional foods analyzed in our laboratories.

RESULTS AND DISCUSSION

The food items and quantity consumed that represent the diet for low-income adults, 25 years or older in Sonora, Mexico, are given in Table 1. Refried beans, corn and flour tortillas, fried potatoes, and white rice are the basic items in the diet and the main providers of energy. The average daily intakes were 329 g of refried beans, 253 g of corn tortillas, 105 g of flour tortillas, 110 g of fried potatoes, and 200 g of cooked rice. Ballesteros et al. (1993) reported 218 g of refried beans, 184 g of corn tortillas, and 215 g flour tortillas as an average intake; however, the population for this study included people of all economic levels and all ages. In developing countries the main staples in the diet are of vegetable origin; only when purchasing power increases do consumers have resources to purchase the more expensive animal products (Contreras et al., 1981). Earlier studies conducted by this center have identified basically 20 food items that constitute the diet; the frequency of these items will vary somewhat depending on the population, but the basic diet is made up of these 20 items. Items that are regularly consumed in northern Mexico that were not included in our composite diet were oranges, white bread, pasta, and lettuce. These items were eliminated because of their lower frequency of consumption among the individuals of this study.

Table 2. Chemical Composition (Grams per 100 g) of the Diet for Low-Income Adults 25 Years or Older in Sonora, Mexico

	wet wt	dry wt
fat	4.00	15.73 ± 0.66
protein	4.50	17.65 ± 0.42
moisture	74.52	
ash	0.98	3.83 ± 0.08
carbohydrates (by diff)	16.01	62.83
dietary fiber	2.12	8.33 ± 0.14

Table 2 presents the chemical composition of the diet for low-income adults 25 years or older in Sonora, Mexico. The high moisture content is due to the addition of liquids to the diet (soda, coffee, etc). On a dry weight basis the fat and protein contents are in agreement with a diet studied by Solomons et al. (1982).

Table 3 presents the dietary intake and the comparison with the U.S. RDAs (NAS, 1989) and the recommended intakes for Mexico (INN, 1977) for men. In all cases for which recommended values are given, the Sonoran diet meets or exceeds the value with the exception of energy. Energy intakes appear to be adequate, however; what is most interesting is to analyze the contribution of calories in relation to the fat, protein, and carbohydrate content in the diet. The Select Committee on Nutrition and Human Needs (SCNHN, 1977) recommended that 30% of the calories in the diet come from fat, 12% from protein, and 58% from carbohydrates. As can be seen in Figure 1, the Sonoran diet comes close to this recommendation, probably more so than do diets from other countries. For example, in Sweden, 15% of the calories are from protein, 36% from fat, and 50% from carbohydrates (Johnsson et al., 1992). A fat consumption of 92.98 g is considered relatively high, but it is not out of line when compared to diets of other studies. With respect to the intake of fat in other parts of Mexico, Hunt et al. (1987) reported an intake of 72 ± 31 g/day in Montemorelos, Mexico, and Acosta et al. (1984) reported 110.2 g in the diet of Yucatan, Mexico. In other Latin American countries, Acosta et al. (1984) reported the following intakes: Argentina, 48.6 g; Brazil, 55.5 g; Chile, 37.2 g; Peru, 50.9 g; and Venezuela, 67.2 g. Due to the proximity of Sonora to the United States and the strong influence of this closeness in Mexico, including dietary habits, it is of interest to compare data from this study with relevant studies from the United States. The

Table 3. Comparison of Dietary Intake of Nutrients for Low-Income Adults 25 Years or Older in Sonora, Mexico, with Recommended Values (Wet Weight)

		RDA		% RDA					
		U.S.[a]	Mexico[b]	U.S.[a]	Mexico[b]	ALIM[c]	% diff	Nutr III[d]	% diff
energy (kcal/day)	2667	2900	2750	92	97	2413	−9.5	2615	−1.9
fat (g/day)	92.98					91.61	−1.5	66.03	−29.0
protein (g/day)	104.33	63	83	166	126	90.05	−13.7	98.86	−5.3
dietary fiber (g/day)	49.24					50.87	3.3	18.26	−62.9
phytates (mg/day)	2088								
Fe (mg/day)	19.50	10	10	195	195	50.90	161.0	24.50	25.6
Zn (mg/day)	19.50	15		130				13.98	−62.5
Ca (mg/day)	1164	800	500	46	233	931.43	−21.5	1065	−8.5
Se (μg/day)	171.68	70		245				70	−59.2

[a] RDA (NAS, 1989). [b] INN (1977). [c] Juvera (1990). [d] Nutritionist III (1992).

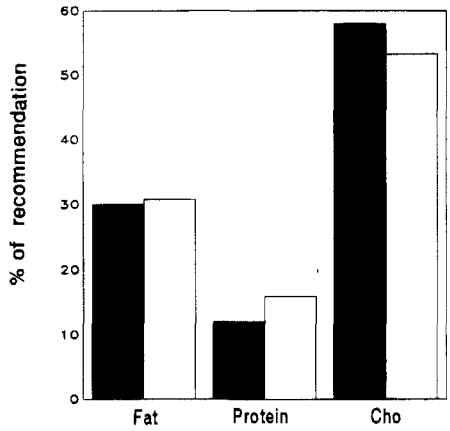

Figure 1. Percent of recommended energy from fat, protein, and carbohydrates in the low income diet for adults 25 years or older in Sonora, Mexico: (■) SCNHN (1977); (□) diet.

consumption of fat in the NHANES II study was 66.8 ± 36.8 g/day in young women (Murphy and Calloway, 1986).

Protein intake is also quite elevated in the Sonoran diet (104.33 g/day). Ballesteros et al. (1993) showed that the diet contains 45% vegetable and 55% animal protein. In terms of protein quality, the Sonoran diet was shown to have a high amino acid score and apparent digestibility for adults. In other parts of Mexico, Acosta et al. (1984) reported a much higher intake of 159.7 g/day in Yucatan, Mexico, and Anderson et al. (1991) reported a minimum of 51 g/day in Valle del Mezquital, Mexico. In the United States, Murphy and Calloway (1986) reported a lower intake of 63.5 ± 33.6 g in women and Worthington-Roberts et al. (1988) reported an intake for mixed diets of chicken or chicken and fish of 76.12, 72.2, and 64.4 g for lactovegetarians.

There is concern about fat intake with regard to both heart disease and cancer. No information is available to date about the chemical composition of the fat in the Sonoran diet; however, animal fats are used in cooking and in food preparation such as in tamales and tortillas, and the consumption of red meats and processed meats is substantial. Eggs, milk, and cheese are also present in the diet. Studies have shown that as total fat increases, the risk of colon cancer increases. Positive trends were seen by Willett et al. (1990) for total fat and for intake greater than 82 g/day. With regard to cancer, fiber plays a large role and higher fiber intakes are shown to be beneficial. Willett et al. (1990) showed an inverse relationship between total dietary fiber and the risk of colon cancer. However, it is generally considered that high fiber and low fat and especially fat low in saturated fats are more effective. An intake of 49.24 g of fiber was found in the Sonoran diet, and this value coincides with the value reported by Ballesteros et al. (1993) of 52.79 g. The high intake of fiber in Mexico is probably due to the high intake of beans and tortillas.

Bourges (1990) reported that the rural Mexican diet contributes at least 32 g of dietary fiber per day without taking into consideration the fruits and vegetables. In countries where the diet is high in foods of plant origin, high fiber and phytate contents are observed. In New Guinea, Africa, where the diet is of vegetable origin, the intake is 37 g in 10 year old children and the intake for adults probably would be close to the value reported in this study (Gibson et al., 1991). Murphy and Calloway in 1986 reported lower values for women in the United States, with an intake of 13.2 ± 0.3 g/day. In Pennsylvania, women of 19−21 years showed an intake of 12.6 ± 2.79 g/day (Leuenberg et al., 1989).

The daily intake of phytates was 2088 mg/day (Table 3). The diet contained 357 ± 1 mg/100 g of dry weight of total phytates and 66.66% were insoluble. It has long been recognized that phytates interact with proteins and minerals, which leads to decreased protein and mineral solubility which in turn affects their utilization (Nolan et al., 1987). With regard to the effects phytates may have on minerals, it appears that the reactions are complex and affected by pH, temperature, and concentration of cationic minerals, and some competition or preference exists for binding sites with certain minerals as well (Champagne et al., 1985; Graf, 1983; Lee et al., 1988). Ferguson et al. (1989) showed that the diets of African children had 1857 and 2167 mg of phytates, indicating a high percent of the children were at risk for zinc deficiency. Ellis et al. (1982) quantified the phytate content in three hospital diets and reported an intake of 378 mg in a composite of regular daily diets. A later study showed the diets of omnivors and vegetarian men to include 734 and 1500 mg, respectively, and that of Asiatic vegetarians to include 1150 mg. The US HANES II study reported a phytate intake of 395 ± 14 mg and a phytate/Zn ratio of 5.76 (Murphy and Calloway, 1986).

Analyzing phytates with different molar ratios can give some indication of the interference with minerals. We found a phytate/Zn ratio of 10.5, and according to Oberleas and Harland (1981) a value greater than 15 indicates problems with Zn absorption. The Ca/phytate ratio was 8.7, with a value greater than 6 indicating problems (Wise, 1983); for [Ca][phytate]/[Zn] it was 0.49, where a value greater than 0.5 indicates problems (Ellis et al., 1987). No agreement exists as to which calculation is best to use, but taking into consideration that the concentrations of both Ca and Zn are in the last ratio, and the value for this study is approaching the

Table 4. Total Minerals (Milligrams per 100 g of Dry Weight), Soluble and Insoluble, in Diets of Low-Income Adults 25 Years or Older in Sonora, Mexico

	total	soluble	insoluble	% soluble
Fe	3.33 ± 0.57	<LD*	3.25 ± 0.16	
Zn	3.33 ± 0.57	2.05 ± 0.28	1.28 ± 0.10	61.6
Ca	197 ± 2	172 ± 2	18 ± 1	87.3
Se	0.10 ± 0.00			

limit of 0.5, one might speculate that Zn availability is affected in this type of diet.

Nahapetian and Young (1980) showed that high calcium intakes inhibit the utilization of phytates, altering absorption and affecting mineral utilization. Thus, the high Ca level of Mexican diets may be altering phytate metabolism as well as utilization of other minerals. In a rural Mexican diet, which had properties similar to those of the diet of this study, Rosado et al. (1992) showed that Zn, Fe, and Ca levels are high in the diet but bioavailabilities are low. Zn had an apparent absorption of 4.6%, Fe, 16.7%, and Ca a negative balance. Zn is known to associate strongly with phytates (Folich and Asp, 1985), and Platt and Clydesdale (1987) showed Fe was bound to the insoluble fraction and that Ca affected the solubility of Fe and phytic acid.

Table 4 shows the total minerals, soluble and insoluble, fraction in the diet of low-income adults. For Fe, 3.33 ± 0.57 mg/100 g of dry weight was found, and practically all of the Fe exists in the insoluble fraction. Zn levels of 3.33 ± 0.57 mg/100 g of dry weight were found and 61.56% was in the soluble fraction. Ca at 197 mg/100 g of dry weight and a higher solubility, 87.3%, were found. Se values of 0.01 mg/100 g of dry weight were found. As can be seen in Table 3, the intake of these minerals exceeds recommendations (NAS, 1989; INN, 1977). In all cases, with the exception of Fe, the RDAs for men are higher than for women in the same age group. Even when judged on the basis of the Fe RDA for adult women, which is 15 mg/day, the diet evaluated in this study provided sufficient Fe. The availability of these minerals in this diet remains to be studied. Acosta et al. (1984) reported an average Fe absorption of 10.1% for Mexican diets, which in this case would provide 1.9 mg of Fe. However, some reports recommend 5% for diets high in fiber and low in enhancing factors. The high solubility of Ca found in this diet is of interest in view of data presented in the literature. Rosado et al. (1992) presented data that showed very low availability of Ca in rural Mexican diets and attributed this to the fact that the Ca in tortillas probably exists in poorly absorbable form. They also raise some questions about the incidence of Ca-related diseases such as osteoporosis and eclampsia in populations that depend on corn tortillas as a basic staple in their diets. Without a doubt, phytates also play a very important role in this. Graf (1983) showed that certain Ca–phytate complexes, Ca^{2+}–phytate, Ca_1–phytate, and Ca_2–phytate, are soluble, whereas all other complexes were precipitated.

Also presented in Table 3 is a comparison of the analyzed values with those calculated from two different databases, the ALIM 10 000 (Juvera, 1990), which contains data on regional foods, and the Nutritionist III (1992), which is based primarily on *USDA Handbook 8* data. By looking at the percent difference figures, it is readily seen that analyzed values for macronutrients compare favorably with calculated values, but when it comes to micronutrients a greater error exists. No doubt the Fe values reported for various foods included in the ALIM 10 000 database need to be reanalyzed with current, more accurate methods as the database is reporting unrealistically high values. The use of databases such as Nutritionist III that do not contain data on regional foods and attempts to select similar foods within the database simply do not provide reliable data.

CONCLUSIONS

The diet for low-income adults 25 years or older in Sonora, Mexico, meets or exceeds recommended values (NAS, 1989; INN, 1977) for the nutrients analyzed in this study, that is for protein, energy, Fe, Zn, Ca, and Se. From a quality aspect, the diet is varied and includes food from all basic food groups; however, the consumption of cereals and legumes is high. It has long been recognized that the intake of fruits and vegetables is low in Sonoran diets and, therefore, it is likely that the intake of certain vitamins is low. Also because of the relatively high fiber and phytate intake, there are probably some interferences with mineral absorption. Furthermore, it was found that the majority of the minerals with the exception of Ca are insoluble. Even though the intake of dietary fiber is high, higher than found in more typical mixed diets, the percent of calories from carbohydrates (53%) does not meet the recommended intake of 58%, probably reflecting that this is indeed an unrealistic goal. Fat calories do not appear to be in excess, even though the majority of the prepared food is fried. Protein calories are high, but it must be kept in mind that these come from a high intake of vegetable protein, primarily beans. Bioavailability studies need to be conducted to determine the precise absorption of minerals in this type of diet as well as analyze the diet for other important nutrients such as vitamins. Because of the interactions of nutrients that can occur in a mixed diet, it is important to analyze nutrients in mixed diets instead of isolated food items. It would be of interest to determine if the long-term consumption of a high-phytate diet such as exists in the typical Mexican population results in any intestinal adaptive effects on mineral utilization.

LITERATURE CITED

Acosta, A.; Amar, M.; Cornbuth-Szarfarc, S. C.; Dillman, E.; Fosil, M.; Gongora Biach, R.; Grebe, G.; Hertrampf, E.; Kremenchuzkky, S.; Layrisse, M.; Martínez-Torres, C.; Morón, C.; Pizarro, F.; Reyna Farje, C.; Stekel, A.; Villavicencio, D.; Zuñiga, H. Iron absorption from typical Latin American diets. *Am. J. Clin. Nutr.* **1984**, *39*, 953–962.

Anderson, R. K.; Serano, G.; Clavo, J.; Payne, G. C. Estudio del estado de nutrición y los hábitos alimentarios de communidades otmíes en el Valle del Mezquital de México (Studies of the nutritional state and food habits in communities in the Mezquital Valley of Mexico). *Cuad. Nutr.* **1991**, *14* (5), 8–16.

AOAC. *Official Methods of Analysis of The Association of Official Analytical Chemists*, 15th ed.; Kenneth Helrich, Ed.; AOAC: Washington, DC, 1990.

Ballesteros, M. N.; Valencia, M. E.; Brown, P. S. Effect of diet composition on protein requirements of children and adults in northern Mexico. *Am. J. Clin. Nutr. Met.* **1993**, *37*, 90–100.

Bourges, H. La fibra al desnudo (Fiber revealed). *Cuad. Nutr.* **1990**, *12* (5), 33–37.

Camberos, C. M. La pobreza regional de Sonora. Los límites de la modernización (Poverty in Sonora. The limits of modernization). *Rev. Estud. Soc.* **1993**.

Camou, E. H.; Hinojosa, A.; Larios, de G. M.; Platt, A.; Aja, H.; Murillo, J.; Manzo, F. *Cocina Sonorense*, 1st ed.; Instituto Sonorense de Cultura, Editorial Yescas: Sonora, Mexico, 1990.

Champagne, E. T.; Rao, R. M.; Liuzza, K. A.; Robinson, J. W.; Gale, R. J.; Miller, F. The interactions of minerals, proteins, and phytic acid in rice bran. *Cereal Chem.* **1985**, *62*, 218–22.

Contreras, G.; Elías, L. G.; Bressani, R. Effect of vitamin and mineral supplementation on protein utilization from corn-bean mixtures. *Arch. Latinoam. Nutr.* **1981**, *31* (4), 808–826.

Ellis, R.; Kesley, J. L.; Reynolds, R. D.; Morris, E. R.; Moser, P. B.; Frazier, C. W. Phytate: zinc and phytate x calcium: zinc millimolar ratios in self-selected diets of Americans, Asian Indians and Mepalese. *J. Am. Diet. Assoc.* **1987**, *87* (8), 1043–1047.

Ellis, R.; Reynolds, R. D.; Kesley, J. L.; Morris, E. Phytate: zinc molar ratio, mineral and fiber content of three hospital diets. *J. Am. Diet. Assoc.* **1982**, *81*, 26–29.

Ferguson, E. L.; Gibson, R. S.; Thompson, L. V.; Ounpuu, S. Dietary calcium pytate, and zinc intakes and the calcium, phytate, and zinc molar ratios of a selected group of East African Children. *Am. J. Clin. Nutr.* **1989**, *50*, 1450–1456.

Frolich, W.; Asp, N. G. Minerals and phytate in the analysis of dietary fiber from cereals. III. *Cereal Chem.* **1985**, *62* (4), 238–242.

Gibson, R. S.; Heywood, A.; Yaman, C.; Sohlstrom, A.; Thompson, L. U.; Heywood, P. Growth in children from the Wosera Subdistrict, Papau New Guinea, in relation to energy and protein intakes and zinc status. *Am. J. Clin. Nutr.* **1991**, *53*, 782–789.

Graf, E. Calcium binding to phytic acid. *J. Agric. Food Chem.* **1983**, *31*, 851–855.

Harland, B. F.; Oberleas, D. Anion-exchange method for determination of phytate in foods: collaborative study. *J. Assoc. Off. Anal. Chem.* **1986**, *69* (4), 667–670.

Harland, B. F.; Oke, O. L.; Felix-Phipps, R. Preliminary studies on the phytate content of Nigerian foods. *J. Food Compos. Anal.* **1988**, *1*, 202–205.

Hernández, Laos E. La pobreza en México (Poverty in Mexico). *Comercio Exterior* **1992**, *42* (4), 402–411.

Hernández, M.; Chávez, A.; Bourges, H. *Valor nutritivo de los alimentos. Tablas de uso práctico*, 8th ed.; Instituto Nacional de la Nutrición: Mexico; 1980–1987.

Hunt, I. F.; Murphy, N. J.; Martner-Hewer, P. M.; Faraji, B.; Swendseid, M. E. Reynolds, R. D.; Sanchez, A.; Mejía, A. Zinc, vitamin B-6 and other nutrients in pregnant women attending prenatal clinics in Mexico. *Am. J. Clin. Nutr.* **1987**, *46*, 563–569.

INN (Instituto Nacional de la Nutrición). *Encuestas Nutricionales en México (Nutritional Studies in Mexico)*; Publication 1033; Mexico, 1977.

Johnsson, G.; Holmen, A.; Persson, L.; Hogstedt, B.; Wassen, C.; Ottava, L.; Gustafsson, J. The effect of a shift from a mixed diet to a lacto-vegetarian diet on human urinary and fecal mutagenic activity. *Carcinogenesis* **1992**, *13*, (2), 153–157.

Juvera, F.; Valencia, M. E.; Ortega, M. I. *Tablas de composición de alimentos en el Noroeste de México. (I) Base de datos y (II) Programa CIAD*; XII Congreso de Nutrición de Centroamérica y Panamá: Guatemala, 1990.

Lee, D.; Schroeder, J.; Gordon, D. T. Enchancement of Cu bioavailability in the rat by phytic acid. *J. Nutr.* **1988**, *118*, 712–717.

Leuenberg, P. K.; Buchanan, J. R.; Myees, C. A.; Lloyd, T.; Demers, L. M. Determination of peak trabecular bone density: interplay of dietary fiber, carbohydrates and androgens. *Am. J. Clin.* **1989**, *50*, 955–61.

Méndez, A. Métodos para medir la situación socioeconómica de las familiar rurales centroamericanas y su aplicación a programas de salud (Methods to determine the socioeconomic situation of rural central american families and their application to health programs). *Arch. Latinoam. Nutr.* **1978**, *20*, 281–291.

Murphy, S. P.; Calloway, P. H. Nutrient intake of women in NHANES II emphasizing minerals fiber and phytate. *J. Am. Diet. Am.* **1986**, *86*, (10), 1366–1372.

Nahapetian, A.; Young, V. R. Metabolism of ^{14}C-phytate in rats: effect of low and high dietary calcium intake. *J. Nutr.* **1980**, *110*, 1458–1472.

NAS. *Recommended Dietary Allowances*, 10th ed.; National Academy of Science: Washington, DC, 1989.

Nolan, K. B.; Duffin, P. A.; McWeeny, D. J. Phytate and mineral bioavailability. In vitro Mg^{2+}, Ca^{2+}, Fe^{2+}, and Zn^{2+} (also Cd^{2+}) solubilities in the presence of phytate. *J. Sci. Food Agric.* **1987**, *40*, 79–85.

Nutritionist III. *N² Computing*; Silverton, OR, 1992.

Paul, A. A.; Southgate, D. A. T. *McCance and Widdowson's. The Composition of Foods*, 4th ed.; Elsevier: North, London, 1985.

Platt, S. R.; Clydesdale, F. M. Interactions of iron, alone and in combination with calcium, zinc, and copper, with a phytate-rich, fiber-rich fraction of wheat bran under gastrointestinal pH conditions. *Cereal Chem.* **1987**, *64*, 102–105.

Posati, L.; Orr, M. L. Composition of foods. Dairy and egg products. Raw-processed-prepared. *Agriculture Handbook 8-1*; U.S. Department of Agriculture, Agriculture Research Service: Washington, DC, 1976.

Rao, N. R.; Prabhavathi, T. An in vitro method for predicting the bioavailability of iron from foods. *Am. J. Clin. Nutr.* **1978**, *31*, 169–175.

Rosado, J. L.; Lopez, P.; Morales, M.; Munoz, E.; Allen, L. H. Bioavailability of energy, nitrogen, fat, zinc, iron and calcium from rural and urban Mexican diets. *Br. J. Nutr.* **1992**, *68*, 45–58.

SCNHN (Select Committee on Nutrition and Human Needs, U.S. Senate). *Dietary Goals for the United States*, 2nd ed.; U.S. Government Printing Office: Washington, DC, 1977.

Solomons, N. W.; Janghorboni, M.; Ting, B.; Steinke, F. H.; Christensen, M.; Bijlani, R.; Istafan, N.; Young, V. R. Bioavailability of Zn from a diet based on isolated soy protein: application in young men of the stable isotope tracer ^{70}Zn. *J. Nutr.* **1982**, *112*, 1809–1821.

Valencia, M. E.; Hoyos L. C.; Ballesteros, M. N.; Ortega, M. I.; Palacios, M. R.; Grijalva, M. I.; Atondo, J. L. *Canasta Estatal de Consumo de Alimentos y Aporte de Nutrimentos*, Reporte Técnico en Proceso. División de Nutrición, CIAD: Hermosillo, Mexico, 1992.

Watt, B. K.; Merrill, A. L. Composition of foods, raw, processed. *Agricultural Handbook* 8; U.S. Department of Agriculture: Washington, DC, 1975.

Willett, W. C.; Stampfer, M. J.; Colditz, G. A.; Rosner, B. A.; Speizer. Relation of meat, fat, and fiber intake to the risk of colon cancer in a prospective study among women. *New Engl. J. Med.* **1990**, *323* (24), 1664–1672.

Wise, A. Influence of calcium on trace metal-phytate interaction. In *Phytic Acid: Chemistry and Applications*; Pilatus Press: Minneapolis, 1983; pp 151–160.

Worthington-Roberts, B.; Breskin, M.; Monsen, E. Iron status of premenopausal women in a university community and its relationship to habitual dietary sources of protein. *Am. J. Clin. Nutr.* **1988**, *47*, 275–9.

Wyatt, C. J.; Triana, M. A. Soluble and insoluble Zn, Fe, Ca and phytates in foods commonly consumed in Northern Mexico. *J. Agric. Food Chem.* **1994**, *42* (10), 2204–2209.

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