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Nota Clínica

Nutritional imbalances in a Mexican vegan group: urgent need for country-specific dietary guidelines

Desequilibrios nutricionales en un grupo mexicano de veganos: necesidad de guías alimentarias para cada país

Alan Espinosa-Marrón¹, Orlando Andrés Núñez-Isaac², Angélica Moreno-Enríquez³, Irving Sosa-Crespo⁴, Jesús Alfredo Araujo-León⁵, Fernanda Molina-Segui⁶, Hugo Laviada-Molina⁶

¹Department of Nutrition and Epidemiology. Harvard T.H. Chan School of Public Health. Harvard University. Boston, MA, USA. ²Internal Medicine PGY 1. Rochester General Hospital. Rochester, NY, USA. ³Genomic and Metabolic Unit. Universidad Marista de Mérida. Mérida, Yucatán, Mexico. ⁴Facultad de Ingeniería Química. Universidad Autónoma de Yucatán. Mérida, Yucatán, Mexico. ⁵Laboratory of Chromatography. Facultad de Química. Universidad Autónoma de Yucatán. Mérida, Yucatán, Mexico.

⁶Department of Human Nutrition and Metabolism Research. Facultad de Ciencias de la Salud. Universidad Marista de Mérida. Mérida, Yucatán, Mexico

Abstract

Introduction: vegan diets exclude the consumption of animal-derived products, and health advantages have been reported when followed. However, heterogeneous eating habits, food availability, and sociocultural characteristics among regions could lead to different physiological results.

Case reports: twelve patients following a strict vegan diet for an uninterrupted period of ≥ 3 years were subjected to clinical assessment. Patients significantly exceeded the suggested intake for sugar, presented six mineral deficiencies, and exhibited three vitamins below the recommended consumption. We further identified hyperglycemia, hypertriglyceridemia, subnormal serum vitamin B₁₂ concentrations, as well as macrocytosis and microcytic anemia in several participants.

Discussion: this Mexican vegan diet is strongly influenced by endemic and cultural adaptations that could limit the benefits reported in other populations. Professional guidance is required to avoid specific deficiencies with potential repercussions. We urge country-specific vegan guidelines considering local eating habits, food availability, and sociocultural perspectives around food.

Keywords:

Vitamin B₁₂ deficiency. Veganism. Vegan diet. Nutrition status. Health status disparities.

Resumen

Introducción: la dieta vegana excluye el consumo de productos de origen animal y se ha vinculado con una disminución del riesgo de morbi-mortalidad. Sin embargo, los distintos hábitos alimentarios entre países podrían condicionar los beneficios reportados para las dietas basadas en vegetales.

Casos clínicos: doce pacientes siguiendo una estricta dieta vegana por ≥ 3 años se sometieron a una evaluación clínica. Exhibieron una ingestión de azúcar que supera el consumo sugerido, presentaron tres deficiencias vitamínicas y seis de minerales. Se identificó la presencia de hiperglucemia, hipertrigliceridemia, concentraciones séricas subnormales de vitamina B₁₂, macrocitosis y anemia microcítica en varios participantes.

Discusión: la dieta vegana de este grupo resultó fuertemente influenciada por adaptaciones culturales que podrían limitar los beneficios reportados en otras poblaciones. Se requiere orientación profesional para evitar desequilibrios nutricionales. Enfatizamos la necesidad del desarrollo de guías alimentarias y de práctica clínica que consideren los hábitos alimentarios locales, la disponibilidad de alimentos en la región y las perspectivas socioculturales en torno a la dieta vegana.

Palabras clave:

Deficiencia de vitamina B₁₂. Veganismo. Dieta vegana. Estado nutricional. Disparidades en el estado de salud.

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Correspondence:

Hugo Laviada-Molina. Department of Human Nutrition and Metabolism Research. Facultad de Ciencias de la Salud. Universidad Marista de Mérida. Periférico Norte Tablaje Catastral 13941, Sin Nombre de Col. 27. 97300 Mérida, Yucatán, Mexico
e-mail: hlaviada@marista.edu.mx

INTRODUCTION

Vegan diets exclude animal product consumption. An appropriately planned plant-based diet is nutritionally adequate and provides health benefits for preventing several metabolic diseases and cancer — reducing premature mortality (1). Evidence also suggests potential nutrient deficiencies, especially vitamin B₁₂, vitamin D, iron, iodine, calcium, zinc, and omega-3 polyunsaturated fatty acids (2).

Notably, contrasting eating habits, diverse food availability, and inequivalent sociocultural characteristics around vegan diets across countries may lead to different metabolic outcomes. The Mexican diet differs from other regions of the world, and consequently, different physiological results may be expected when following a plant-based diet due to local and cultural adaptations (3).

To our knowledge, the Mexican population following a vegan diet had not been described, and country-specific guidelines do not exist. Therefore, providing a comprehensive clinical and nutritional diagnosis in a group of patients following a vegan diet for an extended period is relevant to health providers making dietary recommendations and can be used for evidence-based dietary guidelines in Mexico.

METHODS

DESCRIPTION OF PARTICIPANTS

Twelve patients from a local vegan-vegetarian community attended the Universidad Marista de Mérida (Mexico) for medical and nutritional assessment. The group was integrated by nine females and three males following a strict vegan diet for an uninterrupted period of ≥ 3 years.

A first interview verified that patients' physical activity did not reach intensities prescribed for therapeutic purposes, discard the presence of pre-existent chronic diseases or alcoholism, and confirmed the absence of pregnancy or lactation among women. We further verified that patients were not active users of medications — particularly absorption-inhibition or modifiers of micro-nutrients or glucose metabolism drugs.

All patients provided written informed consent allowing clinical information dissemination. The present case report received approval from the Ethics Committee from the Marist University of Merida (CE_UMM002A_2017), according to the Secretary of Health of Mexico (NOM-012-SSA3-2012). Anthropometric, dietary, and biochemical parameters were evaluated as health indicators.

ANTHROPOMETRIC ASSESSMENT

Participants were evaluated after eight hours of fasting, liquid intake and exercise avoidance for twelve hours, and an empty bladder. We also provided standardized clothing (light clothing, consistently weighing 1 kg, without metal pieces). A previously

calibrated Tanita BC-418 Segmental Body Composition Analyzer[®] scale was used following the protocol proposed by Khalil and colleagues (4). For height determination, the International Society for the Advancement of Kinanthropometry methods were followed, using a SECA stadiometer (model 700). Body composition was further assessed through an octopolar multifrequency segmented bioelectric impedance analysis (BIA) (Tanita BC 418).

DIETARY EVALUATION

A Semi-Quantitative Food Frequency Questionnaire previously validated in the Mexican population (5) was used to estimate monthly eating patterns and ensure total exclusion, consciously and unconsciously, of animal-derived products. Daily nutrients intake was calculated through The Food Processor Software[®] (ESHA research) Version 10.15.41 and compared with the nutritional reference values for the Mexican population (6). Information about healthcare professional aid regarding diet planning or supplementation habits and other health-related behaviors were also registered.

BIOCHEMICAL EXAMINATION

Fifteen milliliters of total blood were collected in three SSP and EDTA tubes (BD Vacutainer[®]) for their immediate analysis. A complete blood count was obtained after performing fluorescent flow cytometry and hydrodynamic focusing. We used a 5-part Sysmex equipment[®] (model XS-1000i) previously calibrated (Sysmex calibrator[®] and Liquicheck hematology-16 trilevel, Cat: 760 Biorad[®], as third opinion quality control material). Sulfolyzer, Stromatolyser 4-DL, Cell Pack, and Stromatolyser 4-DS were used as reagents (Sysmex[®]). Cut-off points to identify abnormalities were those established by the World Health Organization for populations located below 1000 meters' sea level.

A high-performance liquid chromatography (HPLC) was performed to evaluate glycated hemoglobin (Hb_{A1c}). Biorad[®] equipment (model D10) previously calibrated (internal calibrator Biorad[®] with Lyphocheck diabetes control bi-level, Cat.740 as quality control material) was used with D-10 Hemoglobin A1C, Ref: 2200101 as reagent (Biorad[®]). A threshold of 5.7 % was considered to identify normal glycemia for persons without glucose intolerance.

The serum concentration of vitamin B₁₂ was further quantified through high-performance liquid chromatography-tandem mass spectrometry (LC-MS/MS) detector methodology according to the American Chemical Society. A level of < 200 pg/mL (148 pmol/L) was considered as threshold for vitamin deficiency.

Serum creatinine was measured through spectrophotometry. Abbott[®] equipment (model Architect c4000) previously calibrated (Clin Chem Cal Abbott[®] calibrator REF: 6K30-10, Cat.740 and Lyphocheck Assayed Chemistry Cat. C-315-5 and C-310-5 Biorad[®] as third opinion quality control material) was used with

Creatinine REF: 8L24-31 as reagent (Abbott®). Values between 0.50 and 1.40 mg/dL were considered as an optimal criterion.

For analytic purposes, the group's nutrient daily intake was compared in the Dietary Reference Intake (DRI) for the Mexican Population through a two-tailed hypothesis test using an alpha value of 0.05. The association between dietary intake and serum concentrations of vitamin B₁₂ was assessed with a Pearson's correlation coefficient. According to distribution, data is presented as means ± SD and medians (IQR). Results were generated using the Statgraphics Centurion® software version XVII and Graph Pad Prism® version 8.

RESULTS

Twelve Mexican adults (three males and nine females), consumers of a vegan diet for over three years, completed all anthropometric, dietetic, and biochemical evaluations as proxy measurements of their current health status.

Patient mean age was 29 ± 9 years and body mass index (BMI) was 22.5 ± 3.6 kg/m². The complete and segmental composition analysis derived from the bioelectrical impedance assessment is presented in figure 1. No abnormalities were identified in the body composition examination.

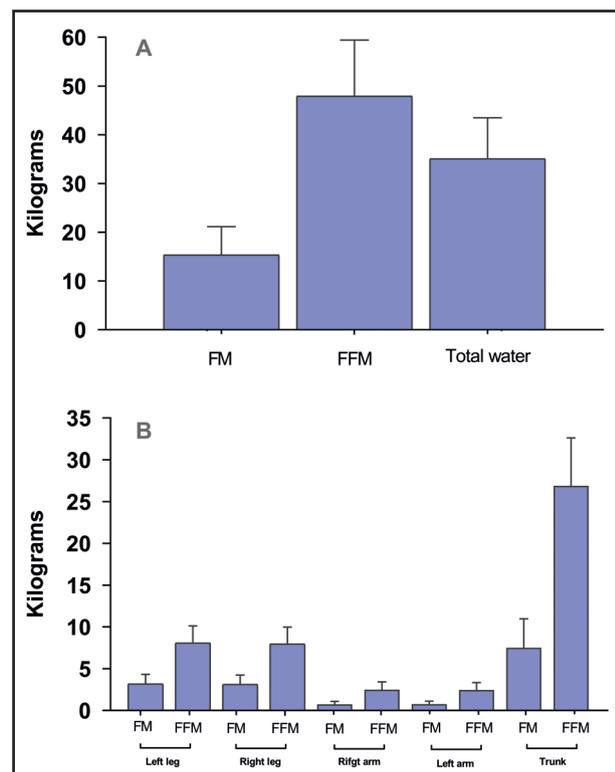


Figure 1. Bioelectrical impedance analysis among Mexican vegans (A. Complete body composition assessment. B. Segmental body composition assessment. Data are presented as means and standard deviations. FM: fat mass; FFM: fat-free mass).

Energy and nutrients daily intake are presented in table I. Patients significantly exceed the recommended intake for refined sugars, and two patients exhibited Hb_{A1c} levels above the 5.7 % recommended threshold, and other three presented hypertriglyceridemia.

Table I. Daily energy and nutrient intake (diet and supplements) in patients following a vegan diet (≥ 3 years) compared to reference values for the Mexican population¹

Dietary assessment		Vegans (n = 12)	Ideal criteria	p-value ²
Energy (kcal) ³		1,717.5 ± 641.4	1,823	0.580
Kilocalories from fat		545.4 ± 169.7	547	0.977
Kilocalories from SF		137.9 ± 59.5	< 128	0.287
Fat (g) ⁴		61.2 ± 19.0	61	0.969
Protein (g) ⁵		43.3 ± 12.6	48.6	0.172
Carbohydrates (g) ⁶		250.8 ± 104.0	251	0.992
Dietary fiber (g)		34.3 ± 9.3	30	0.138
Soluble fiber (g)		5.8 ± 2.0	-	-
Total sugars (g) ⁷		93.2 ± 32.3	< 22	< 0.001
Monosaccharides (g)		28.1 ± 11.5	-	-
Disaccharides (g)		17.8 ± 5.8	-	-
Other carbohydrates (g)		57.7 (44.2)	-	-
Retinol (IU)	Vit. A	9,190.5 ± 4,014.5	1,893.3	< 0.001
Thiamine (mg)	Vit. B ₁	1.4 ± 0.7	0.8	0.013
Riboflavin (mg)	Vit. B ₂	1.2 ± 0.5	0.84	0.030
Niacin (mg)	Vit. B ₃	12.6 ± 4.1	11	0.204
Pantothenic acid (mg)	Vit. B ₅	3.2 ± 0.83	4.0	0.007
Pyridoxine (mg)	Vit. B ₆	1.3 (0.8)	0.93	0.138
Folic acid (µg)	Vit. B ₉	767.4 ± 294.4	380	< 0.001

(Continues on next page)

Table I (Cont.). Daily energy and nutrient intake (diet and supplements) in patients following a vegan diet (≥ 3 years) compared to reference values for the Mexican population¹

Dietary assessment		Vegans (n = 12)	Ideal criteria	p-value ²
Cobalamin (mg)	Vit. B ₁₂	0.05 (0.04)	2.1	< 0.001
Biotin (μ g)		24.7 \pm 9.3	30	0.075
Ascorbic acid (mg)	Vit. C	214.9 \pm 75.2	60	< 0.001
Calciferol (μ g)	Vit. D	0.04 (0.09)	10	< 0.001
Tocopherol (mg)	Vit. E	12.8 \pm 3.9	11	0.138
Menadiol (mg)	Vit. K	258.7 \pm 163.0	78	0.003
Calcium (mg)		377 (250)	900	< 0.001
Chromium (μ g)		3.2 \pm 1.2	22	< 0.001
Copper (mg)		1.4 \pm 0.4	0.65	< 0.001
Fluoride (mg)		0.02 (0.04)	2.2	< 0.001
Iodine (μ g)		15.7 \pm 6.4	150	< 0.001
Iron (mg)		21.8 \pm 11.8	17	0.186
Magnesium (mg)		358 (205)	248	0.090
Manganese (mg)		4.3 (1.8)	1.8	< 0.001
Molybdenum (μ g)		86.9 \pm 24.4	45	< 0.001
Phosphorus (mg)		755.6 (451)	664	0.499
Potassium (mg)		3,043.8 \pm 832.3	3,400	< 0.001
Selenium (μ g)		44.2 \pm 20.8	41	0.607
Sodium (mg)		2,259.3 \pm 1,562.4	< 2,500	0.999
Zinc (mg)		7.3 (2.7)	10	0.005

¹Data presented in means \pm SD or medians (IQR) according to distribution.

²Obtained using hypothesis tests. ³Ideal caloric intakes established according to national recommendations at 30 kcal/kg. ⁴Ideal fat consumption established at 30 % of total ideal caloric intake. ⁵Ideal protein intakes considered to be 0.8 g/kg. ⁶Ideal carbohydrate consumption established at 55 % of total ideal caloric intake. ⁷Ideal sugar consumption considered to be < 5 % of total caloric intake. Vit.: vitamin.

Only two patients declared receiving professional dietetic guidance and evidence-based supplementation. According to the DRI, vegan-diet consumers presented six mineral deficiencies (calcium, chromium, fluoride, iodine, potassium, and zinc), and three of vitamins (pantothenic acid, cobalamin, and calciferol).

Hematological examination (Table II) confirmed subnormal serum vitamin B₁₂ concentrations (≤ 200 pg/mL, 148 pmol/L) in eight patients. Macrocytosis (mean corpuscular volume > 97 fL) and microcytosis (mean corpuscular volume < 97 fL) were identified in two and four vegan participants, respectively. Additionally, two vegan females were diagnosed with microcytic anemia (< 12 g/dL in women).

NUTRITIONAL DIAGNOSIS

- Disproportionate refined carbohydrates consumption, related to an unbalanced food selection and insufficient nutritional-related knowledge, evidenced by sugar intake as high as 93.2 ± 32.3 g/day, surpassing the recommended dietary intake for this macronutrient.

Table II. Biomarkers in Mexican patients following a vegan diet (≥ 3 years), compared to the ideal criteria¹

Serum biomarkers	Vegans (n = 12)	Ideal criteria
Hb (g/dL)	13.4 \pm 1.7	> 13
Hct (%)	40.0 \pm 4.1	35-42
MCV (fL)	89.3 \pm 7.3	84.0-96.0
MCH (pg)	31.0 (3.7)	27.0-33.0
MCHC (%)	34.0 (1.0)	32.0-35.0
Erythrocytes (cell/mm ³)	4,496,667 \pm 488,826	3,600,000-5,100,000
Total cholesterol (mg/dL)	154.1 \pm 36.2	< 200
LDL-cholesterol (mg/dL)	81.4 \pm 30.7	< 100
HDL-cholesterol (mg/dL)	51.9 \pm 10.9	> 45
Triglycerides (mg/dL)	102.7 \pm 46.4	< 150
Hb _{A1c} (%)	5.2 \pm 0.4	< 5.7
Vit. B ₁₂ (pg/dL)	205.5 \pm 153.4	> 200
Creatinine (mg/dL)	0.79 \pm 0.13	0.5-1.40

¹Data presented as means \pm SD or medians (IQR) according to their distribution. Vit.: vitamin. International System of Units conversions: 1 g/dL of Hb is equivalent to 0.62 mmol/L; 1 pg of MCH is equivalent to 0.062 fmol; 1 pg/mL of vitamin B₁₂ is equivalent to 0.74 pmol/L; 1 mg/dL of creatinine is equivalent to 88.4 μ mol/L.

- Inadequate oral intake of vitamin B₁₂ associated with deficient evidence-based supplementation and insufficient professional guidance, evidenced by subnormal cobalamin levels in plasma and microcytosis.
- Insufficient consumption of highly bioavailable iron food sources, associated with the exclusive incorporation of dietary non-heme iron and the lack of adequate supplementation, evidenced by microcytic anemia.

TREATMENT

We provided individualized dietary guidance according to each patients' age, sex, physiologic status, and clinical situation. First, we designed an appropriately planned vegan diet for each patient and provided comprehensive nutritional information, emphasizing balanced food group selection.

Evidence-based supplementation schemes for vitamin B₁₂ were recommended (sublingual, intramuscular, or oral dosage, together with regular consumption of fortified foods). We also prescribed iron supplementation for women of reproductive age undergoing anemia and for those declaring menorrhagia.

For the subsequent semester, monthly medical and nutritional counseling was recommended to evaluate patients' progress. However, as this pilot study was initially designed as a transversal assessment, the collection of prospective data on biochemical parameters was contemplated within our research purposes.

DISCUSSION

This clinical case report provides an overall health depiction of Mexican patients following a vegan diet.

As anticipated, dietary protein does not differ significantly from DRI. Due to regular consumption of legumes typically included in plant-based diets, vegans meet or exceed the recommended protein consumption (2). These results may explain the adequate proportion of fat-free mass identified through BIA, and we hypothesized no negative impact on body composition associated with protein consumption. Supporting our findings, Nadimi and colleagues (7) did not identify variations in fat-free mass among vegan participants. On the contrary, the large body of evidence indicates that plant-based diet consumers display a lower prevalence of overweight and obesity, and present less abdominal and body fat. Furthermore, adequate protein consumption may explain the acceptable creatinine concentrations found among these participants. However, further research is needed to expand on its possible health benefits — such as the improvement in renal function (8).

Two vegans exhibited glycemic concentrations surpassing 5.7 %, possibly attributed to excessive carbohydrate daily consumption. Other studies have also found a disproportionate intake of refined carbohydrates to replace meat, generating metabolic alterations (3).

Nevertheless, vegans also displayed adequate low-digestible carbohydrate and fiber intakes. These results may implicate positive microbiota modulations: a recent review concluded that vegans' gut profile presented a reduced abundance of pathobionts and a greater abundance of protective species (9). Possible health benefits related to fiber intake may be assumed in favor of this plant-based diet group. Further research will benefit from exploring this topic in this specific population.

Only two patients declared professional dietetic guidance and evidence-based supplementation. Our findings on vitamins deficiencies could predispose patients to a higher risk of peripheral neuropathy, glossitis, or seborrheic dermatitis related to pyridoxine deficiency; megaloblastic anemia, hyperuricemia, hyperhomocysteinemia, or subacute combined degeneration of spinal cord associated with cobalamin deficiency. Notably, macrocytosis (mean corpuscular volume > 97 fL) and microcytosis (mean corpuscular volume < 97 fL) were identified in two and four vegan participants, respectively.

Additionally, females were diagnosed with microcytic anemia (< 12 g/dL in women). We could address non-heme iron intake and menstruation's cyclic blood loss as possible etiology. These may also indicate that adult vegan females present a higher risk of developing hematologic repercussions, and closer medical-nutritional counseling in this potentially vulnerable group may be addressed. Other studies have also shown that vegetarians have a high prevalence of iron depletion — addressing the importance of premenopausal vegetarian women's iron status (10).

Participants displayed an estimated vitamin D and calcium daily intake of 0.04 mcg and 377 mg, respectively. Notably, the recommended daily Vitamin D intake is 10 micrograms for people < 70 years old. As for calcium, the recommended intake is 1200 mg for Mexican postmenopausal women and 900 mg for other adults (6).

Chronic and sustained low dietary intake of vitamin D might predispose vegans to osteoporosis and fractures at later stages of life (11). Inadequate calcium intake predisposes to hypertensive disorders.

Given the increased prevalence of veganism among the pediatric population (12), further research may be warranted to expand the role of both calcium and vitamin D in vegan children. Inadequate calcium and vitamin D intake has been associated with stunting growth (13).

Despite these seemingly adverse health outcomes, other studies suggest a lower incidence of chronic diseases in vegans. These results could partially be attributed to a favorable impact of the dietary fatty acid composition. Espinosa-Marrón and colleagues reported decreased pro-inflammatory serum fatty acids suggestive of protective vascular effect on Mexican individuals with a vegan diet (14). Additionally, regular physical activity, stress management through meditation techniques, avoidance of alcohol and tobacco, and other healthy behaviors that characterize the vegan diet in other countries are fundamental to producing positive results. However, we did not entirely identify those health-related behaviors in our participants.

DIRECTIONS FOR FUTURE RESEARCH

We strongly encourage research emphasizing plant-based diets in Mexico. This case report provides a basis on the relationship between a local Mexican vegan diet and its health implications due to insufficient professional guidance and the lack of country-specific dietary recommendations. Our results coincide partially with what has been reported in the international literature and reinforce the hypothesis that an unbalanced vegan diet implies potential nutrients deficiencies, especially vitamin B₁₂. Future research may explore homocysteine, holotranscobalamin, and methyl-malonic acid as additional biochemical screening addressing cobalamin deficiency in this vegan community.

Even in the context of a case report, we recognize that our reduced sample size with unequal male and female participants limits generalizability. Nevertheless, including twelve participants is considered appropriate for pilot studies based on the feasibility and precision around the estimates that can serve future studies (15). Furthermore, our anthropometric, dietetic, and biochemical findings, together with our holistic interpretation in this unexplored population, are relevant to the international literature and provide valuable information for health providers.

We also acknowledge that the dietary tool used to collect data was validated in Mexico but not specifically designed for a self-defined vegan population. To our knowledge, there is no such Food Frequency Questionnaire published in the Mexican literature — which emphasizes the need for developing country-specific research regarding plant-based diets.

URGENT NEED FOR COUNTRY-SPECIFIC DIETARY GUIDELINES

We present an extensive description of the nutritional content of a Mexican vegan diet that is strongly influenced by endemic and cultural adaptations. As noted, these adaptations could limit the benefits reported in other latitudes, and clinical and nutritional guidance is required to avoid specific deficiencies with potential health repercussions.

Given the diversity between countries, the well-developed European and American guidelines for vegans are not entirely suitable for other regions. Developing country-specific guidelines will help provide correct information on appropriate diet planning.

Based on our results, we suggest that Mexican guidelines should contemplate the following key points:

1. Include an extensive description of the role of evidence-based vitamin B₁₂ and D supplementation.
2. Promote constant monitoring of blood iron levels and hematological profile, recommend iron food sources, and describe supplementation schemes when needed.

3. Promote adequate food selection and combination:
 - Depict iron absorption enhancers (vitamin C) and absorption-inhibitors (i.e., calcium, phytates, oxalates).
 - Improve carbohydrates' quality and quantity selection and preventive assessments for hypertriglyceridemia and glucose intolerance.
4. Recommend locally available vegetable oils to support plant-based fat sources (i.e., avocado, chia seeds, flaxseeds), as conventional recommendations for vegetable oils that are not widely available in Mexican cuisine (olive oil, nuts, walnuts, hemp seeds, among others).

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