

Functional food consumption preference in Culiacán, Mexico

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Abstract

Objective. To determine functional food consumption preferences in Culiacán, Mexico. **Materials and methods.** A survey was designed, validated, and implemented to gather information on functional food consumption. Associations between health conditions and functional food consumption were evaluated. Using the Borda count methodology, the preference order of different functional foods was identified, seeking statistical differences between preferences. **Results.** A validated questionnaire was obtained for the survey application. Association was found between having a diagnosed illness, undergoing medical treatment, and sex with awareness of functional foods; however, no association was observed between having a diagnosed illness and potential functional food consumption. The top three preferred foods were beverages, bars, and yogurt, with taste being the most important characteristic for functional food consumption. **Conclusions.** There is low consumption of functional foods, which may be associated with various factors. In designing and developing functional foods, it is important to consider

Resumen

Objetivo. Determinar las preferencias de consumo de alimentos funcionales en Culiacán, México. **Material y métodos.** Se diseñó, validó y aplicó una encuesta para recopilar información sobre el consumo de alimentos funcionales. Se evaluaron asociaciones entre condiciones de salud y consumo de alimentos funcionales. Siguiendo la metodología de conteo de Borda se identificó el orden de preferencia de diferentes tipos de alimentos funcionales, buscando también diferencias estadísticas entre las preferencias. **Resultados.** Se obtuvo un cuestionario validado para la aplicación en la encuesta. Se encontraron asociaciones entre tener una enfermedad diagnosticada, estar bajo un tratamiento médico y el sexo, con el conocimiento sobre el término "alimentos funcionales"; en contraste, no se observó una asociación en tener una enfermedad diagnosticada y el posible consumo de alimentos funcionales. Los tres alimentos preferidos fueron las bebidas, las barras y el yogur, siendo el sabor la característica más importante para el consumo de los alimentos funcionales. **Conclusiones.** Existe un bajo consumo de alimentos

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preferences such as beverages, bars, and yogurts, emphasizing consumer taste acceptance.

Keywords: functional food; consumption; food preferences; survey

funcionales, lo cual se puede asociar a diversos factores. Dentro del diseño y elaboración de alimentos funcionales es importante considerar las preferencias como bebidas, barras y yogur, dando especial énfasis a la aceptación del sabor por parte de los consumidores.

Palabras clave: alimentos funcionales; consumo; preferencias de alimentos; encuesta

Food choices influence consumers' health, as certain food items may reduce the risk of acquiring non-communicable chronic conditions.¹ Currently, consumers seek their diet to provide more benefits to their health than just basic nutritional value. This is due to understanding the importance of the relationship between their diet and health status.² The increased understanding among consumers regarding the link between food and health has resulted in a higher demand for functional foods (FF), given their association with health benefits.^{3,4} FF are described as natural or processed foods that, beyond their nutritional composition, confer additional health benefits, contributing to the prevention and mitigation of the risk of developing chronic and viral diseases and their associated symptoms.⁵⁻⁷ Examples include probiotics, prebiotics, beverages, cereals, bakery products, spreads, meat and eggs.⁸ While the main market of FF is the USA, Japan, and Europe, the influence of consumer characteristics, such as cultural aspects, in the acceptance of FF emphasizes the need for specific research.⁹⁻¹¹ In this regard, consumer involvement in developing new foods is crucial to ensure success in the market.^{2,12} While there are various studies related to the consumption of FF,^{1,3,11} most have been conducted in developed countries; therefore, their findings may not be extrapolatable to emerging and developing economies.¹³ This is why additional research is needed to gain insights into preferences for consuming FF in different markets, such as in Mexico. This study aims to determine the consumption preferences of FF within the Mexican population.

Materials and methods

Design, evaluation, and validation of the questionnaire

Questionnaire design

The survey components were methodically developed after a thorough review of relevant scientific literature to

create items adept at capturing indispensable information for the research. Subsequently, the questionnaire was digitalized using the SurveyMonkey platform (San Mateo, CA, USA) for subsequent analysis and implementation.

Content validity coefficient

The methodology of Hernández-Nieto¹⁴ was followed, involving experts in the field of FF. The Content Validity Coefficient (CVC) was calculated for each item, considering relevance, clarity, terminology, and format/writing, using a 5-point Likert scale. The mean score for each item was used to determine the CVC for each element. The error assigned to each item (Pe_i) was calculated to reduce potential judge bias. Finally, the CVC was calculated as $CVC = CVC_1 - Pe_i$.¹⁴

Clarity and comprehension evaluation

A group of 132 participants evaluated clarity using a numerical scale ranging from 0 to 10 (0= very difficult to understand; 10= very easy to understand), and comprehension on a 3-point ordinal scale (1: incomprehensible; 2 difficult to understand; and 3 understandable). The extent of agreement among participants was assessed using Kendall's W concordance coefficient, which ranged from 0 (indicating no agreement) to 1 (representing total agreement). A Kendall's W value ≥ 0.70 was assessed to indicate adequate participant agreement.¹⁵

Questionnaire consistency

Potential consumers assessed the questionnaire's consistency by responding to it twice, with a time interval of at least one week between the initial and subsequent applications. Questionnaire repeatability was evaluated utilizing Cohen's kappa coefficient.¹⁶

Pilot test

Finally, a face-to-face survey was undertaken with a representative population sample to assess linguistic

fluency, identify errors, and quantify the time required for survey completion. The criteria for inclusion comprised the following: 1) Individuals residing in Culiacán, Sinaloa, Mexico, who consented to participate in the study; 2) 18 years of age or older. Incomplete questionnaires were excluded from the analysis.

Application of the survey

The sample size of the study was calculated employing the following equation:

$$n = \frac{(N * Z^2 * p(1-p))}{E^2 * ((N-1) + Z^2 * p * (1-p))}$$

Where “n” is the sample size, “N” is the population size, “Z” is the critical value of the desired confidence level, “p” is the expected proportion of the population, and “E” is the margin of error. Given the adoption of a face-to-face methodology, the study took place in Culiacán, Sinaloa, Mexico, in October 2023. Inclusion criteria included subjects aged ≥ 18 and individuals residing in Culiacán, Sinaloa, Mexico, while exclusion criteria encompassed subjects below 18 and those not living in Culiacán, Sinaloa, Mexico.

Preference for types of FF

The Borda Count^{17,18} (CB) was employed to determine the preference and ranking order among various types of FF. Points were assigned according to the order specified by participants,¹⁹ to discern significant differences in preferences for FF types, generating numerical variables for the identification of significant differences.

Statistical analysis

The survey results were reported using descriptive statistics. Categorical variables were presented as proportions with confidence intervals. Associations between categorical variables were assessed using Fisher’s exact test. For numerical variables, normality was evaluated using the Kolmogorov-Smirnov test. Based on the normality of the data, variables that passed the test were reported as means with confidence intervals, while those that did not were presented as medians with interquartile ranges. Differences between groups were analyzed using one-way Anova, and the Tukey post hoc test was applied for pairwise comparisons. Kendall’s W and Cohen’s Kappa (used to measure the agreement), and the Kolmogorov-Smirnov normality test of numerical variables were determined

using PASW Statistics version 25.0 (SPSS Inc., Chicago, IL, USA). Minitab 19 software (State College, PA) was utilized for the remaining statistical analyses. A significance level of $p < 0.05$ was considered to identify statistically significant differences.

Human subjects’ considerations

The confidentiality and anonymity of the respondents were ensured. Respondents were provided with verbal informed consent, where they were given an overview of the type of data collected and its use. They were told to stop responding at any time or choose not to answer any questions if they wished. This research was approved by the Ethics Committee of the *Facultad de Ciencias de la Nutrición y Gastronomía* of *Universidad Autónoma de Sinaloa* (CE-UACNyG-2023-FEB-001).

Results

Design, evaluation, and validation of the questionnaire

Questionnaire

The questionnaire was structured into three sections. The first section, “Demographic data,” was completed by all participants. The second section was specifically designated for people with diagnosed illness (PWDI), further subdivided as follows: PWDI who consume FF and who would consume FF. The third section comprised people without a diagnosed illness (PWODI), further categorized into two groups: PWODI, who would consume FF, and PWODI, who would not consume FF. The number of items requiring responses varied depending on the specific section.

Content validity

Three experts in the field of FF participated, providing ratings for relevance (mean \pm standard deviation = 4.95 ± 0.15), clarity (4.98 ± 0.06), terminology (4.98 ± 0.08), and format and writing (mean = 5). The Content Validity Coefficient (CVC) was calculated as 0.95, indicating excellent validity and agreement.¹⁴ These results imply that no item requires reformulation, and subsequent evaluations can proceed.

Clarity and comprehension

In this phase, a total of 132 individuals participated, providing assessments for the clarity of the questionnaire, resulting in a mean score of 9.78 ± 0.78 , accompanied by

a Kendall's W coefficient of 0.817. This reflects a strong level of agreement among evaluators regarding the clarity of the questionnaire. Regarding the comprehension of the questionnaire, participants assigned a mean rating of 2.78 ± 0.15 , and a Kendall's W coefficient of 0.93 was observed, indicating an extremely strong level of agreement among the evaluators. These compelling results substantiate the decision not to introduce modifications to the questionnaire or any of its items.

Questionnaire consistency

For consistency assessment, the questionnaire was completed by 44 individuals who responded on two separate occasions, with an interval exceeding one week. A Cohen's kappa coefficient of 0.977 was calculated, indicating an almost perfect level of agreement among participants, approaching an optimal level of consistency.

Pilot test

The survey was administered to a limited cohort of participants ($n=204$). Respondents did not express any ambiguity or uncertainties regarding the formulated questions or provided answers. Similarly, the interviewer did not identify any concerns related to consistency or errors in the logical structure and sequence of the survey. The duration of survey completion varied, ranging from 3 to 5 min.

Survey

The sample calculation yielded a sample size of 1 066 individuals; nevertheless, our survey encompassed 1 078 participants, which achieved a well-balanced distribution in terms of respondents' sex (48% male and 52% female), with a median age of 29 years. A predominant proportion (78%) held a bachelor's degree. A substantial 45% of the sampled individuals acknowledged a medical diagnosis of a pathological condition, wherein overweight/obesity emerged as the prevailing morbidity. Notably, only 21% of those identified as PWDI were undergoing active medical intervention, as delineated in table I. Concerning familiarity with the term FF, 76% of PWDI who were acquainted with the term exhibited precise understanding, unlike PWODI, where only 57% demonstrated knowledge of FF (table I).

Regarding Functional Foods consumption and potential preferences (table II), it was observed that beverages and yogurt emerged as the most preferred choices. The preponderance of PWDI engaging in FF consumption did so without explicit recommendations, and the primary impediments to FF consumption

Table I
SOCIODEMOGRAPHIC DATA, PREVALENCES AND KNOWLEDGE ABOUT FF (N=1 078).
CULIACÁN, SINALOA, OCTOBER 2023

Variable	Description	(n)	95%CI
Sex	Male	48 (521)	45,51
	Female	52 (557)	48,54
Age (years)	18-26	31 (333)	28,33
	27-59	67 (719)	63,69
	>60	2 (26)	1,3
Education	Elementary school	1 (9)	0,3,1,5
	Middle school	4 (43)	2,5
	Preparatory school	15 (160)	12,17
	Bachelor's degree	78 (839)	75,80
	Postgraduate	3 (27)	1,3,6
Medically diagnosed illness	Yes	45 (489)	42,48
	No	55 (589)	51,57
People with diagnosed illnesses (n= 489)			
People under medical treatment	Yes	21 (102)	17,24
	No	79 (387)	13,19
Prevalence of diseases	Overweight/Obesity	28 (138)	24,32
	Hypertension	15 (73)	11,18
	Diabetes	14 (68)	10,17
	High cholesterol levels	7 (32)	4,9
	Atherosclerosis	0,6	0,1,1,7
	Other	53 (258)	48,57
Knowledge about FF			
PWDI (n= 489)	Have heard about FF	20 (100)	16,24
	Have not heard about FF	80 (389)	75,83
PWODI (n= 589)	Have heard about FF	15 (86)	11,17
	Have not heard about FF	85 (503)	85,88
Sources of information about FF			
PWDI who have heard about FF (n= 100)	School	34 (34)	24,44
	Social media	32 (32)	23,42
	Book	20 (20)	12,29
	News	7 (7)	2,13
	Radio	1 (1)	0,03,5
	Influencer	5 (5)	1,11
	Scientific articles	14 (14)	7,22
	Friends/family	26 (26)	17,35
	Doctor/Nutritionist	8 (8)	3,15
	Other	21 (21)	13,30

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PWODI who have heard about FF (n= 86)	School	33 (28)	22,43
	Social media	13 (11)	6,21
	Book	11 (9)	4,18
	News	3 (3)	0,79
	Radio	0 (0)	-
	Influencer	1 (1)	0,02,6
	Scientific articles	22 (19)	13,32
	Friends/family	2 (2)	0,2,8
	Doctor/Nutritionist	0 (0)	-
Other	6 (5)	1,13	

Do you know what FF are?

PWODI who have heard about FF (n= 100)	Know what FF are	76 (76)	66,83
	Don't know what FF are	24 (24)	16,33
PWODI who have heard about FF (n= 86)	Know what FF are	57 (49)	45,67
	Don't know what FF are	43 (37)	32,54

FF: functional food; PWID: people with diagnosed illness; PWODI: people without a diagnosed illness

included a lack of knowledge about these products and a preference to sample them before regular incorporation. Regarding the selection and ranking of the three preferred foods by the surveyed individuals, beverages, yogurt, and bars were the most predominant choices, respectively, in contrast with drink powder, bread, and candies/sweets, which were predominantly selected for elimination (table III). Concerning the importance of FF attributes for sustaining consumption, characteristics such as taste, aroma, appearance of the FF, scientific evidence of efficacy, and nutritional composition were identified as important or very important for most individuals. However, in the stratification through CB, it is emphasized that the prevailing factor was taste, as illustrated in table IV. Economically, a significantly higher percentage (30.6%) of PWDI who incorporate functional foods (FF) would be willing to expend more than 50.00 Mexican pesos per week. In contrast, 39.4% of PWDI and 46.3% of PWODI contemplating FF consumption would demonstrate a readiness to pay a lower amount, ranging from 21.00 to 30.00 Mexican pesos per week.

Relationship between diagnosed medical conditions and functional food consumption

The presence of a diagnosed medical condition showed statistically significant associations both with prior

knowledge of FF ($p= 0.012$) and with knowing about FF ($p= 0.007$). Additionally, an association was observed between knowledge of functional foods and their subsequent consumption ($p < 0.0001$). Two additional variables linked to FF consumption by PWDI were being under medical treatment for the disease ($p= 0.0138$) and the sex variable ($p= 0.0005$). Concerning the potential consumption among both PWDI and PWODI, the presence of a diagnosed medical condition did not exhibit any statistically significant association with the likely consumption of FF ($p= 0.503$).

Preference for the type of FF

Using the CB method, beverages, bars, and yogurt emerged as the top three preferred foods (table III). When selecting these three foods and employing the methodology proposed by Noble and colleagues,¹⁹ no statistically significant differences ($p= 0.082$) were observed between beverages and yogurt as the primary choice for PWDI who consume FF. Similarly, no significant differences ($p= 0.581$) emerged between beverages and bars in selecting PWDI willing to consume FF. In contrast, upon examining PWODI who would consume FF, statistically significant differences ($p= 0.0001$) were found between beverages and bars as the top choice (figure 1).

Discussion

The modest percentage of individuals possessing knowledge about FF, comprising only 11.59% of the total sample, starkly contrasts Rojas-Rivas and colleagues' findings.²⁰ Their study asserts that Mexicans have a comprehensive understanding of FF. Notably, their investigation incorporates the free Word Association technique,²⁰ while in the current study, conversely, knowledge assessment was conducted by administering two specific questions: 1) have you heard about FF? and 2) Do you know what FF are? In the latter, the definition that participants had and the definitions described in the literature^{6,7,21} were evaluated. However, similar findings were obtained in Turkey, where only 13.51% of respondents demonstrated familiarity with the term FF.²² Nevertheless, compared to research carried out in Italy and Greece, where 46 and 68%, respectively, were not familiar with the term,^{9,23} the percentage observed in the current study is considerably reduced.

The statistically significant association between having a diagnosed disease and knowledge of the term FF can be attributed to the relationship between FF and health benefits.^{1,9,23} The association between health conditions and the knowledge of FF may be

Table II
CONSUMPTION OF FF (N=1 078). CULIACÁN, SINALOA, OCTOBER 2023

Group of people	Do you consume FF?	% (n)	95%CI	Why do you consume them?	% (n)	95%CI	Foods consumed	% (n)	95%CI							
PVDI (n= 489)	Yes	44 (216)	39,48				Yogurt	65 (140)	58,71							
							Beverage	56 (120)	49,62							
							Bar	34 (73)	27,40							
							Bread	27 (58)	21,33							
							Cookies	26 (56)	20,32							
							Drink powder	10 (21)	6,14							
							Sweets/candy	9 (20)	5,14							
							Other	3 (6)	0,2,4							
							No	56 (273)	51,60					I didn't know about them	83 (226)	77,87
														I need to try them first	28 (76)	22,33
They are not easy to find	7 (20)	4,11														
I don't think I need them	7 (18)	3,10														
They are expensive	2 (6)	0,8,4														
I prefer using pharmacy medications	0 (0)	-														
I don't trust functional foods	1 (2)	0,08,2														
I don't trust the companies that produce them	0 (0)	-														
Another reason	1 (2)	0,08,2														
Group of people	Would you consume FF?	(n)	95%CI	Why wouldn't you consume them?	(n)	95%CI	Foods I would consume	(n)	95%CI							
PVDI who don't consume FF (n= 273)	Yes	81 (221)	75,85				Yogurt	26 (57)	20,32							
							Beverage	42(94)	36,49							
							Bar	19 (42)	14,25							
							Bread	11 (25)	7,16							
							Cookies	14 (31)	10,19							
							Drink powder	5 (12)	3,9							
							Sweets/candy	7 (16)	4,11							
							Other	1 (2)	0,1,3							
							No	19 (52)	14,24					I didn't know about them	96 (50)	96,99
														I need to try them first	4 (2)	0,4,13
They are not easy to find	0 (0)	-														
I don't think I need them	0 (0)	-														
They are expensive	0 (0)	-														
I prefer using pharmacy medications	0 (0)	-														
I don't trust functional foods	0 (0)	-														
I don't trust the companies that produce them	0 (0)	-														
Another reason	0 (0)	-														

(continues...)

(continuation)

				Yogurt	70 (343)	66,74
				Beverage	88 (429)	84,91
				Bar	64 (310)	59,68
				Bread	26 (126)	21,30
	Yes	83 (488)	79,85	Cookies	39 (190)	34,43
				Drink powder	9 (44)	6,12
				Sweets/candy	15 (71)	11,18
				Other	1 (7)	0,5,2
PWODI (n= 589)				I didn't know about them	15 (16)	9,24
				I need to try them first	47 (48)	37,57
				They are not easy to find	5 (6)	2,12
				I don't think I need them	15 (15)	8,23
	No	17 (101)	14,20	They are expensive	8 (8)	3,15
				I prefer using pharmacy medications	6 (6)	2,12
				I don't trust functional foods	2 (2)	0,2,6
				I don't trust the companies that produce them	0 (0)	-
				Another reason	2 (2)	0,2,6

FF: functional food; PWID: people with diagnosed illness; PWODI: people without a diagnosed illness.

Table III
PREFERENCE FOR TYPES OF FOODS BETWEEN CONSUMERS AND POTENTIAL CONSUMERS OF FF. CULIACÁN SINALOA, OCTOBER 2023

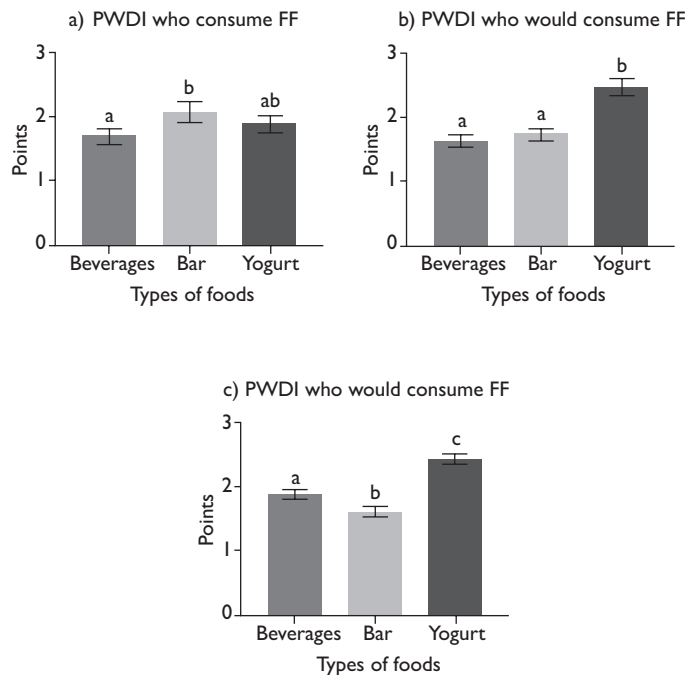
	Choice order	Types of FF (Frequency %)	95%CI	Order of ranking (CB)
PWDI who consume FF (n= 216)	1°	Beverages (41)	34,48	Beverages
	2°	Yogurt (22)/beverage (22)	16,28	Bar
	3°	Yogurt (19)	13,25	Yogurt
PWDI who would consume FF (n= 221)	1°	Beverage (48)	41,54	Beverages
	2°	Bar (37)	30,44	Bar
	3°	Yogurt (46)	40,53	Yogurt
PWODI who would consume FF(n= 488)	1°	Beverage (38)	34,43	Beverages
	2°	Bar (28)	24,32	Bar
	3°	Yogur (42)	38,47	Yogurt
	Elimination order	Frequency (%)	95CI	Order of ranking (CB)
PWDI who consume FF (n= 216)	1°	Drink powder (40)	33,47	Drink powder
	2°	Sweets/candy (26)	20,32	Sweets/candy
	3°	Sweets/candy (25)	19,31	Bread
PWDI who would consume FF (n= 221)	1°	Drink powder (53)	46,60	Drink powder
	2°	Bread (33)	26,39	Sweets/candy
	3°	Sweets/candy (35)	28,41	Bread
PWODI who would consume FF (n= 488)	1°	Drink powder (43)	38,47	Drink powder
	2°	Bread (32)	28,36	Sweets/candy
	3°	Sweets/candy (30)	26,34	Bread

FF: functional food; PWID: people with diagnosed illness; PWODI: people without a diagnosed illness; CB: Borda count.

Table IV
IMPORTANCE OF ATTRIBUTES IN ACQUIRING FF BETWEEN CONSUMERS AND POTENTIAL CONSUMERS.
CULIACÁN, SINALOA, OCTOBER 2023

	PWDI who consume FF (n= 216)			PWDI who would consume FF (n= 221)			PWODI who would consume FF (n= 488)		
	Frequency (%)	95%CI	Order of ranking (CB)	Frequency (%)	95%CI	Order of ranking (CB)	Frequency (%)	95%CI	Order of ranking (CB)
Taste	Very important (76)	69,81	1°	Very important (69)	62,75	1°	Very important (65)	60,69	1°
Smell	Very important (60)	53,66	2°	Important (53)	46,59	4°	Important (62)	57,66	4°
Appearance of the packaging	Not very important (38)	31,45	6°	Indifferent (38)	31,45	6°	Indifferent (45)	40,50	6°
Appearance of the FF	Very important (62)	55,69	4°	Important (48)	41,55	5°	Important (46)	41,50	5°
Scientific evidence of efficacy	Very important (62)	55,69	3°	Very important (58)	51,64	2°	Very important (57)	52,61	2°
Nutritional composition	Very important (55)	48,62	5°	Very important (59)	52,65	3°	Very important (51)	46,55	3°

FF: functional food; PWID: people with diagnosed illness; PWODI: people without a diagnosed illness; CB: Borda count.



Note: Difference between the top 3 preferred foods by people group. Different letters indicate statistically significant differences ($p < 0.05$). The results are presented as means with 95%CI.

PWDI: people with diagnosed illness; PWODI: people without a diagnosed illness; FF: functional food.

FIGURE 1. DIFFERENCES AMONG THE TOP THREE PREFERRED FOODS: A) DIFFERENCES BETWEEN THE THREE PRODUCTS MOST PREFERRED BY PWDI WHO CONSUME FF; B) DIFFERENCES BETWEEN THE THREE PRODUCTS MOST PREFERRED BY PWDI WHO WOULD CONSUME FF; C) DIFFERENCES BETWEEN THE THREE PRODUCTS MOST PREFERRED BY PWO+DI WHO COULD CONSUME FF

due to individuals actively seeking information and understanding, driven by recognizing FF as a valuable component in promoting health and mitigating the effects of their diagnosed medical conditions. School as the main source of information is not among the main means described in the literature,^{2,23} which can be attributed to a large percentage (78%) of the surveyed population having a bachelor's degree and 3% having postgraduate studies. The main sources of information agree on social networks, family and friends and healthcare professionals.²³⁻²⁵ It is noteworthy that the influence of healthcare professionals, such as doctors and dietitians, plays a pivotal role in fostering the consumption of FF.²⁵

While the presence of diseases, health status, and health awareness has been consistently linked to a robust motivation for the purchase and consumption of FF in previous studies,^{2,9,13} our current investigation reveals that only 44% of PWDI are presently engaged in FF consumption. This relatively low percentage can be elucidated by the associations between FF consumption and medical treatment for diseases, with only 21% of PWDI currently undergoing medical treatment. Additionally, the association with sex and FF consumption is noteworthy, given the higher representation of surveyed women (52%). Conversely, 83% of respondents who do not consume FF attribute their choice to unfamiliarity with the concept, reinforcing the association between knowledge of FF and its consumption. This underscores the pivotal role of awareness in driving FF consumption.^{3,25} Non-consumption prevalence aligns closely with findings in Greece,²³ where 58.1% do not consume FF. It is crucial to note that our percentage pertains specifically to the PWDI population, potentially resulting in an even higher proportion of non-consumers compared to countries like Italy and Norway, where FF consumption rates are comparatively elevated.^{9,26}

The lack of a significant association between having a diagnosed disease and the possible consumption of FF is similar to the results of Natarajan and colleagues,²⁷ who mention that having or not having health problems does not influence the intention to buy or consume functional beverages.²⁷ However, various studies showed that suffering from a nutritional or metabolic disease is the main variable associated with FF consumption.^{2,9,28} Since it is advisable to study FF as individual products in different food categories rather than as a homogeneous group,² it is important to identify the preference for types of FF in the population.

The absence of a notable correlation between having a diagnosed medical condition and the potential consumption of FF aligns with findings from Natarajan and colleagues,²⁷ who argue that the presence or absence

of health issues does not significantly impact the inclination to purchase or consume functional beverages.²⁷ Nonetheless, other studies underscore that the presence of nutritional or metabolic disorders is a primary variable linked to the consumption of FF.^{2,9,28}

The prevailing choice among PWDI who partake in FF consumption is yogurt, encompassing 65% of this subgroup. This aligns with the findings by Deborah and colleagues,⁹ wherein respondents predominantly consumed yogurt enriched with probiotics. This inclination may be due to the acceptance of health claims, particularly when associated with products projecting a wholesome image, as exemplified by yogurt.¹³ Concurrently, yogurt is the most favored snack among Mexicans.²⁹ Yogurt, in addition to containing components like probiotics that benefit health, has a composition that facilitates the inclusion of bioactive compounds and phytochemicals.^{30,31} Despite yogurt holding the top spot in terms of consumption among PWDI-consuming FF, surprisingly, most individuals prioritize beverages as their primary choice when selecting in order of preference, a trend substantiated by the CB. However, employing the methodology described by Noble and colleagues¹⁹ yielded inconclusive results, as no statistically significant differences were discerned between the preferences for yogurt and beverages. The selection of beverages as the primary food in the preference order, observed in most of the population and confirmed by the CB, was consistently replicated across the other two demographic groups. The preference for beverages as one of the most favored product types can be attributed to consumer convenience and satisfaction, along with the ease of distribution and storage. This choice is considered a suitable medium for incorporating bioactive compounds and nutrients, which allows functional beverages to provide benefits beyond basic hydration, rendering them an appealing category within the realm of FF.^{27,32,33} Bars were found among the three preferred types of food (table III). The variety of bars can provide health benefits, and additionally, their manufacturing process facilitates the incorporation of several ingredients that add functionality to bars.^{34,35}

The acceptance of FF depends mainly on the base product used as a carrier of the functional element. This is why products that form the basis of the daily diet can be consumed frequently, as with beverage consumption in Mexico. It is reported that the consumption of sugary beverages is similar to the consumption of plain water.^{36,37} The consideration of taste as the first in order of importance is supported in the literature, where it is mentioned that liking the taste is an important attribute for developing a positive attitude towards functional foods. This is why FF,

with health benefits and an acceptable taste is needed to ensure the success of FF.^{1-3,38} Our study population, which consists of consumers and potential consumers, ranked taste as the first place, compared to the results of Büyükkaragöz and colleagues,²⁸ where the population that could overlook taste if the food has functionality is probably FF consumers.²⁸

Regarding the price of FF, consumers show a willingness to pay a higher price for FF, especially if they suffer from a medical condition.³⁹ This is demonstrated in our study, where most (30.6%) PWDI consuming FF would pay more than 50.00 Mexican pesos. However, Marina and colleagues,⁴⁰ grouped a set of respondents as “lovers of functional food,” showing they would buy more functional foods if they had a lower price.⁴⁰ While the cost could be an important factor in choosing FF, it is less significant than taste.³⁶ The study revealed associations related to the consumption of FF, including the connection between having a diagnosed disease and awareness of the term FF. This knowledge is intricately linked to consumption; thus, there is a demand for effective dissemination of information about FF. As no significant associations were identified between the presence or absence of a diagnosed disease and potential consumption, it is relevant to consider the preferences of both groups of individuals in the development of FF. The favored types of foods included beverages, yogurt, and bars. These results support the development and formulation of FF that align correspond with consumer preferences, as FF should remain an integral part of consumers’ diets.⁴¹ Considering that FF are more of represent a concept rather than a specific type of food, their development this concept involves enhancing conventional foods by adding bioactive compounds with specific functionality to existing benefits conventional foods.^{8,21} It is recommended that, in the design of FF designing, it special attention be given tois especially important to prioritize factors such as the type of product type, taste sensory characteristics and the clear communication of scientific evidence.

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References

1. Jung SE, Shin YH, Severt K, Crowe-White KM. Determinants of a consumer's intention to consume antioxidant-infused sugar-free chewing gum: measuring taste, attitude, and health consciousness. *J Food Prod Mark.* 2020;26(1):38-54. <https://doi.org/10.1080/10454446.2020.1717712>
2. Karelakis C, Zevgitis P, Galanopoulos K, Mattas K. Consumer trends and attitudes to functional foods. *J Int Food Agribus Mark.* 2020;32(3):266-94. <https://doi.org/10.1080/08974438.2019.1599760>
3. Cerjak M, Tomić M. Buying motives and trust of young consumers for functional fermented dairy products: evidence from Croatian students. *J Int Food Agribus Mark.* 2015;27(3):177-87. <https://doi.org/10.1080/08974438.2014.918919>
4. Domínguez-Díaz L, Fernández-Ruiz V, Cámara M. An international regulatory review of food health-related claims in functional food products labeling. *J Funct Foods.* 2020;68:103896. <https://doi.org/10.1016/j.jff.2020.103896>
5. Granato D, Barba FJ, Bursać Kovačević D, Lorenzo JM, Cruz AG, Putnik P. Functional foods: product development, technological trends, efficacy testing, and safety. *Annu Rev Food Sci Technol.* 2020;11(11):93-118. <https://doi.org/10.1146/annurev-food-032519-051708>
6. Martirosyan DM, Singh J. A new definition of functional food by FCC: what makes a new definition unique? *J Funct Food Health Dis.* 2015;5(6):209-23. <https://doi.org/10.31989/ffhd.v5i6.183>
7. Roberfroid MB. Global view on functional foods: European perspectives. *Br J Nutr.* 2002;88(S2):S133-S8. <https://doi.org/10.1079/BJN2002677>
8. Siró I, Kápolna E, Kápolna B, Lugasi A. Functional food. Product development, marketing and consumer acceptance—A review. *Appetite.* 2008;51(3):456-67. <https://doi.org/10.1016/j.appet.2008.05.060>
9. Deborah B, Rotordam M, Giacomo S, Giulia C, Adele F. Understanding consumption choices of innovative products: an outlook on the Italian functional food market. *AIMS Agric Food.* 2021;6(3):818-37. <https://doi.org/10.3934/agrfood.2021050>
10. Siegrist M, Shi J, Giusto A, Hartmann C. Worlds apart. Consumer acceptance of functional foods and beverages in Germany and China. *Appetite.* 2015;92:87-93. <https://doi.org/10.1016/j.appet.2015.05.017>
11. Huang L, Bai L, Zhang X, Gong S. Re-understanding the antecedents of functional foods purchase: Mediating effect of purchase attitude and moderating effect of food neophobia. *Food Qual Prefer.* 2019;73:266-75. <https://doi.org/10.1016/j.foodqual.2018.11.001>
12. Fernandes MCO, Bomfim RdS, Santos JC, Vidigal M, Nascimento RQ, Mamede ME O. Development of a mixed beverage with the addition of prebiotics: consumer acceptance and focus groups. *J Culin Sci Technol.* 2020;18(4):288-305. <https://doi.org/10.1080/15428052.2019.1582447>
13. Nguyen N, Nguyen HV, Nguyen PT, Tran VT, Nguyen HN, Nguyen TM, et al. Some key factors affecting consumers' intentions to purchase functional foods: a case study of functional yogurts in Vietnam. *Foods.* 2020;9(1):24. <https://doi.org/10.3390/foods9010024>
14. Hernández-Nieto RA. Contributions to statistical analysis: the coefficients of proportional variance, content validity and kappa. Mérida, Venezuela: Booksurge Publishing; 2002.
15. González-Santamaría J, Arámburo-Gálvez JG, Beltrán-Cárdenas CE, Mora-Melgem JA, Figueroa-Salcido OG, Ramírez-Torres GI, et al. Design, assessment, and validation of a questionnaire to estimate food-dependent exercise-induced anaphylaxis prevalence in Latin American population. *Healthcare.* 2020;8(4):519. <https://doi.org/10.3390/healthcare8040519>

16. Arámburo-Gálvez JG, Carvalho-Gomes I, André TG, Beltrán-Cárdenas CE, Macêdo-Callou MA, Braga-Rocha ÉM, et al. Translation, cultural adaptation, and evaluation of a Brazilian Portuguese questionnaire to estimate the self-reported prevalence of gluten-related disorders and adherence to gluten-free diet. *Medicina*. 2019;55(9):593. <https://doi.org/10.3390/medicina55090593>
17. Dougherty KL, Ragan R. Borda count in a forward agenda. *Public Choice*. 2023;199:27-44. <https://doi.org/10.1007/s11127-022-01037-6>
18. Saari DG. Selecting a voting method: the case for the Borda count. *Const Political Econ*. 2023;34(3):357-66. <https://doi.org/10.1007/s10602-022-09380-y>
19. Noble C, Corney M, Eves A, Kipps M, Lumbers M. Food choice and school meals: primary schoolchildren's perceptions of the healthiness of foods and the nutritional implications of food choices. *Int J Hosp Manag*. 2000;19(4):413-32. [https://doi.org/10.1016/S0278-4319\(00\)00038-4](https://doi.org/10.1016/S0278-4319(00)00038-4)
20. Rojas-Rivas E, Espinoza-Ortega A, Martínez-García CG, Moctezuma-Pérez S, Thomé-Ortiz H. Exploring the perception of Mexican urban consumers toward functional foods using the Free Word Association technique. *J Sens Stud*. 2018;33(5):e12439. <https://doi.org/10.1111/joss.12439>
21. Alzamora SM, Salvatori D, Tapia MS, López-Malo A, Welti-Chanes J, Fito P. Novel functional foods from vegetable matrices impregnated with biologically active compounds. *J Food Eng*. 2005;67(1-2):205-14. <https://doi.org/10.1016/j.jfoodeng.2004.05.067>
22. Çetin B, Tümer El. The factors affecting willingness to consume functional foods in Mersin Province. *Kahramannaraş Sütçü İmam univ doğa bilim derg*. 2021;24(4):871-7. <https://doi.org/10.18016/ksutarimdogavi.780845>
23. Tsartsou E, Proutsos N, Papadopoulos I, Tzouvelekas V, Castanas E, Kampa M. Consumers' attitude toward dietary supplements and functional food: a prospective survey in a Greek population sample. *Hormones*. 2021;20(1):177-88. <https://doi.org/10.1007/s42000-020-00209-7>
24. Vrgović P, Pojić M, Teslić N, Mandić A, Kljakić AC, Pavlić B, et al. Communicating function and co-creating healthy food: designing a functional food product together with consumers. *Foods*. 2022;11(7):961. <https://doi.org/10.3390/foods11070961>
25. Vella MN, Stratton LM, Sheeshka J, Duncan AM. Functional food awareness and perceptions in relation to information sources in older adults. *Nutr J*. 2014;13:44. <https://doi.org/10.1186/1475-2891-13-44>
26. Nystrand BT, Olsen SO. Consumers' attitudes and intentions toward consuming functional foods in Norway. *Food Qual Prefer*. 2020;80:103827. <https://doi.org/10.1016/j.foodqual.2019.103827>
27. Natarajan T, Jayadevan GR, Jayapal J. Consumption of branded functional beverages post-COVID pandemic: an empirical investigation in a developing economy using behavioral change models. *J Food Prod Mark*. 2022;28(3):132-51. <https://doi.org/10.1080/10454446.2022.2058900>
28. Büyükkaragöz A, Bas M, Sağlam D, Cengiz ŞE. Consumers' awareness, acceptance and attitudes towards functional foods in Turkey. *Int J Consum Stud*. 2014;38(6):628-35. <https://doi.org/10.1111/ijcs.12134>
29. The Food Tech. Alimentos funcionales ganan terreno en mercado mexicano. *The Food Tech*. 2020 Nov 23 [cited November 24, 2023]. Available from: <https://thefoodtech.com/tendencias-de-consumo/alimentos-funcionales-ganan-terreno-en-mercado-mexicano/>
30. Camargo-Herrera ÁD, Bernal-Castro C, Gutiérrez-Cortés C, Castro CN, Díaz-Moreno C. Bio-yogurt with the inclusion of phytochemicals from carrots (*Daucus carota*): a strategy in the design of functional dairy beverage with probiotics. *J Food Technol*. 2023;60(9):2297-308. <https://doi.org/10.1007/s13197-022-05510-4>
31. Nakov G, Ninova-Nikolova N, Ivanova N, Raykova V, Trajkovska B, Colić ML, et al. Yogurt enriched with chia seeds: physicochemical, microbiological, and sensory changes during storage. *Fermentation*. 2024;10(8):431. <https://doi.org/10.3390/fermentation10080431>
32. Corbo MR, Bevilacqua A, Petrucci L, Casanova FP, Sinigaglia M. Functional beverages: the emerging side of functional foods. *Compr Rev Food Sci Food Saf*. 2014;13(6):1192-206. <https://doi.org/10.1111/1541-4337.12109>
33. Toorani A, Moodi M, Zeinali T, Salmani F, Norozi E. Consumption status of functional drinks based on the theory of planned behavior and the stages of change model in female employees. *Sci. Rep*. 2024;14(1):14197. <https://doi.org/10.1038/s41598-024-64888-7>
34. Figueiredo CCM, Granero FO, Silva LP, Nogueira IFA, de Souza JF, Escaramboni B, et al. Solid-state fermentation using wheat bran to produce glucose syrup and functional cereal bars. *Bioprocess Biosyst Eng*. 2024;47(7):1081-94. <https://doi.org/10.1007/s00449-024-03032-1>
35. Tombini C, Dacoreggio MV, Kempka AP, Feltes MMC, De Mello JMM, Dalcanton F. High-dietary fibers cereal bars containing malt bagasse by-product from the brewing industry. *J Food Sci Technol*. 2024;61(7):1326-33. <https://doi.org/10.1007/s13197-023-05902-0>
36. Kraus A. Development of functional food with the participation of the consumer. Motivators for consumption of functional products. *Int J Consum Stud*. 2015;39(1):2-11. <https://doi.org/10.1111/ijcs.12144>
37. Instituto Nacional de Salud Pública. Encuesta Nacional de Salud y Nutrición 2020 sobre Covid-19 2020. México: INSP [cited November 24, 2023]. Available from: <https://ensanut.insp.mx/encuestas/ensanutcontinua2020/doctos/informes/ensanutCovid19ResultadosNacionales.pdf>
38. Miolla R, Ottomano-Palmisano G, Roma R, Caponio F, Difonzo G, De Boni A. Functional foods acceptability: a consumers, survey on bread enriched with oenological by-products. *Foods*. 2023;12(10):2014. <https://doi.org/10.3390/foods12102014>
39. Pappalardo G, Lusk JL. The role of beliefs in purchasing process of functional foods. *Food Qual Prefer*. 2016;53:151-8. <https://doi.org/10.1016/j.foodqual.2016.06.009>
40. Marina T, Marija C, Ida R. Functional foods and the young. *J Food Prod Mark*. 2014;20(5):441-51. <https://doi.org/10.1080/10454446.2013.838535>
41. Diplock AT, Agget PJ, Ashwell M, Borneo F, Fern EB, Roberfroid MB. Scientific concepts of functional foods in Europe: consensus document. *Br J Nutr*. 1999;81 (Suppl 1):S1-S27. <https://doi.org/10.1079/S0007114599000471>