



## Determinants of the consumption of bovine milk and milk substitutes in the municipality of Texcoco, State of Mexico



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Fabiola Ramírez Cordero <sup>a</sup>

José Saturnino Mora Flores <sup>a\*</sup>

Miguel Ángel Martínez Damián <sup>a</sup>

José Alberto García Salazar <sup>a</sup>

Omar Hernández Mendo <sup>b</sup>

Esteban Valtierra Pacheco <sup>c</sup>

<sup>a</sup> Colegio de Postgraduados. Campus Montecillo. Programa de Economía. Carretera México-Texcoco km 36.5. Montecillo, Texcoco. 56230. Estado de México, México.

<sup>b</sup> Colegio de Postgraduados. Campus Montecillo. Programa de Ganadería. Estado de México, México.

<sup>c</sup> Colegio de Postgraduados. Campus Montecillo. Programa de Desarrollo Rural. Estado de México, México.

\*Corresponding author: [saturmf@colpos.mx](mailto:saturmf@colpos.mx)

### Abstract:

Bovine milk and plant-based drinks are substitute products that are currently competing in the market. This study aimed to analyze the factors influencing the consumption of both bovine milk and milk substitutes in the municipality of Texcoco, State of Mexico. The methodology used consisted of a survey of 400 consumers of milk and milk substitutes; the information obtained was used to perform a qualitative regression modeling (bivariate Probit or Biprobit). The results showed that bovine milk consumption is mainly conditioned by the variables female sex, schooling, and family income; in contrast, for the consumption of milk

substitutes, the significant variables were female sex, age, schooling, number of members per family, and household income. Furthermore, it was found that the consumption of milk and the consumption of milk substitutes are reciprocally related by 23.31 %.

**Keywords:** Consumer, Bovine milk, Substitutes, Plant-based drinks, Biprobit.

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## Introduction

Currently, there are several innovations in the consumption of dairy foods and plant-based drinks, better known as plant-based milks, but in reality they are not milk because they are made from grains, seeds, nuts, or fresh fruits and do not contain animal fat; for its part, only the secretions of the mammary glands of mammals are known as milk; therefore, all beverages that replace it should be called plant-based drinks<sup>(1)</sup>.

Milk is one of the most consumed staple food products worldwide due to its high nutrient content, and because it is a rich source of calcium, which is vital for bones and teeth; it also contains proteins of high biological value and other nutrients (vitamins, fatty acids, etc.) that can be beneficial to health<sup>(2)</sup>. However, its consumption has been questioned in recent years because it has generated some damage to health in general, which is related to the protein (casein) and fats contained in milk, which is why affected people have resorted to using milk substitutes that contain some of its nutrients in similar amounts to ensure adequate nutrition<sup>(3)</sup>. In 2023, the leading countries with the highest consumption of bovine milk were India in the first place with 87,500 t, followed by the European Union (as a region) with a consumption of 23,700 t, the United States with 20,650 t ranked third, and Mexico ranked eighth with a consumption of 4,210 t<sup>(4)</sup>. In Mexico, the annual per capita consumption of milk is 124.3 L, and per day, it is 370 ml on average, which, according to the Food and Agriculture Organization of the United Nations (FAO), is still a low consumption if it is considered that it recommends a daily consumption of 500 ml<sup>(5)</sup>.

Consumption habits have changed and consequently the demand for milk and derivatives has also change, because today consumers are looking for products that contribute to improving their health conditions, such as dairy products reduced in fat or sugar, as well as products that contain vitamins, pre- and probiotics, or fiber; in general, products that are free of

components that come directly from bovine milk, but that enriched or modified represent a functional option to improve their diet, not only because of what milk provides as food, but also what it obtains in the industrialization and transformation of products derived from it, such as yogurts and cheeses<sup>(6)</sup>.

Therefore, the niche market of plant-based drinks is increasingly broad in the country; between 2013 and 2018, the demand for plant-based beverages increased by 33.5 %, and its annual growth rate was 14.0 %, with an annual per capita consumption of 10 L<sup>(7)</sup>; therefore, multinational companies such as Nestlé, Danone, and Coca Cola are looking to invest in the production and marketing of these types of drinks<sup>(8)</sup>. Plant-based beverages, whether based on cereals, nuts, or legumes, do not have the same nutritional or protein contribution as bovine milk, since they are prepared based on water and cereals (rice or oats), legumes (soybeans), nuts (almond), or fresh fruits (coconut) and are enriched with sugars, emulsifiers, thickeners, and nutrients; this is done to resemble vitamins and minerals, such as calcium, contained in bovine milk. The plant-based drink that most closely resembles bovine milk in terms of protein contribution is the soybean-based drink, which provides 3.2 g per 100 ml, whereas bovine milk provides 3.5 g per 100 ml<sup>(9)</sup>. Therefore, it is essential that consumers are informed about the ingredients contained in the drinks they are consuming, to prevent health conditions, mainly in children and the elderly, who have an urgent need for high-quality proteins for bone development.

Most studies on bovine milk and plant-based drinks agree that plant-based drinks do not replace bovine milk in terms of nutritional level. Nevertheless, the consumption of these drinks has increased, and they have captured an increasingly important volume of consumers, which is related to health, economic, environmental, or fashion issues, affecting the consumption of bovine milk, and consequently, impacting the producing companies, which face market challenges for their milk<sup>(10)</sup>.

The importance of this work is that, to date, there are no studies related to the consumption of milk substitutes and the way in which consumers prefer these products to the detriment of traditional consumption of bovine milk. Therefore, it is crucial to analyze both markets and the factors that condition them in order to show whether both markets are correlated.

This study aimed to identify the factors that most explain the consumption of bovine milk and milk substitutes in the municipality of Texcoco, State of Mexico. According to economic theory, which establishes that the primary factors determining the demand or consumption of goods are price, income, and population, the research hypothesis was that the main factors conditioning the consumption of milk and milk substitutes are the price and income of consumers.

## Material and methods

The study was conducted in the municipality of Texcoco, State of Mexico. Ten of the 105 localities belonging to the municipality were taken into account, and those with the largest population were chosen: the municipal capital of Texcoco de Mora, followed by San Miguel Coatlinchán, San Miguel Tocuila, San Luis Huexotla, Villa Santiago Cuautlalpan, Santa Martha, San Bernardino, San Miguel Tlaixpan, San Jerónimo Amanalco, and San Diego. The sample calculation considered the total population to be interviewed in the municipality of Texcoco, which was 277,562 inhabitants, according to the INEGI Population and Housing Survey<sup>(11)</sup>. The sample size was obtained as indicated in formula 1<sup>(12)</sup>:

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

Where: n= sample size; p= estimated percentage of positive variability (50 %); q= 1-p (negative variability); N= total population of the study universe (277,562 inhabitants); Z= confidence level in the Z-distribution tables (at 95 % confidence), Z=1.96. E= allowed estimation error or precision (5 %).

Substituting the above values in formula 1 yielded the sample size (formula 2):

$$n = \frac{(0.50)(0.50)(277,562)(1.96)^2}{0.05^2(277,562 - 1) + 4(0.50)(0.50)} = 384 \text{ people} \quad (2)$$

The calculated sample size was 384 people; however, 400 questionnaires were administered. The number of questionnaires was distributed in 10 localities of the municipality of Texcoco, mainly in the municipal capital; these localities were selected by their population number, since the localities that make up the municipality were hierarchized from highest to lowest according to their population density; the questionnaires were administered in February, March, and April 2024. The individuals were interviewed in places such as squares, neighborhood stores, public markets, shopping centers, and grocery stores, as these are the main places where consumers go to buy food, including milk. The selection criterion for the individuals was their willingness to complete the questionnaire; although the sample was not obtained through a probabilistic process, the data obtained do provide relevant information for the phenomenon under study.

The independent variables used to build the model and the survey are described in Table 1. The data obtained from the questionnaires were entered into a structured template in an Excel spreadsheet.

**Table 1:** Characteristics of the independent variables of the model

Variable	Label	Unit of measure	Scale of measurement
Sex	SEX	Sex	0 = Male 1 = Female
Age	AGE	Whole number	Years completed (18+)
Schooling	SCH	School level	0 = No studies 1 = Incomplete basic and high school level 2 = Complete basic and high school level 3 = Undergraduate and Postgraduate
Price of milk and milk substitutes	PCM / PMS	Pesos	Price in pesos
Number of members per family	NMF	Whole number	People who make up the family 1 = Low (less than 2,100) 2 = Medium - Low (2,101 to 5,000)
Monthly household income	HINC	Pesos	3 = Medium (5,001 to 8,500) 4 = Medium - High (8,501 to 15,000) 5 = High (over 15,000)

The statistical analysis was performed using a bivariate Probit or Biprobit regression model, an extension of the classical multi-equation regression models, which considers a system of equations whose errors are correlated. According to Greene<sup>(13)</sup>, the general specification of a model with two equations is represented by formula 3:

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} x_1 & 0 \\ 0 & x_2 \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \end{bmatrix} \quad (3)$$

$$\begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \end{bmatrix} \sim N \left[ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right]$$

$$E[\varepsilon_1] = E[\varepsilon_2] = 0,$$

$$Var[\varepsilon_1] = Var[\varepsilon_2] = 1,$$

$$Cov[\varepsilon_1, \varepsilon_2] = \rho.$$

Where:

$y_i$ : are dependent or explanatory variables, both dichotomous. Where,  $Y_1$ = the individual does or does not consume bovine milk, 0= probability that they do not consume, 1= they do consume milk;  $Y_2$ = the individual consumes or does not consume milk substitutes, 0= probability that they do not consume, 1= they do consume substitutes.

$x_j$  = are the independent or explanatory variables of the model. Where  $X_1, X_2$  = matrix of independent variables (SEX, AGE, SCH, PCM/PMS, NMF, and HINC) associated with the consumption of bovine milk and milk substitutes, respectively.

$\beta_j$  = are the parameters that quantify marginal effects.

$\varepsilon_1, \varepsilon_2$  are perturbations or unobservable characteristics that affect the dependent variables and that are modeled as correlated.

The assumption that the random perturbations of the equations are correlated allows to model those decisions that involve common environments. Incorporating this correlation between perturbations enables to obtain more efficient estimators than if each equation were estimated separately<sup>(14)</sup>.

For the independent variable price (PRIC) of both dependent variables, a mean imputation was applied to the data obtained, as those who do not consume milk or milk substitutes did not give any response. Imputation is the process of converting missing data into simulated (or probable) data, in order not to interfere or minimize in the best way the impact on the expected result<sup>(15)</sup>; by means of a data imputation code generated in the statistical software RStudio 4.1.1, the substitute values for the missing data on the price of milk and milk substitutes were obtained, resulting in 29.17 and 39.91, respectively.

The predictive value of the estimated model is judged by the Akaike (AIC) value, a measure of the relative quality of a statistical model for a given set of data; this method selects the best model from a set of models. The model selected in terms of relative quality will be the one with the minimum AIC value<sup>(16)</sup>; this parameter was estimated using SAS statistical software, version 9.4.

## Results

Initially, an analysis of the relative frequencies of the variables in the survey applied to the inhabitants of the municipality of Texcoco, State of Mexico, was conducted (Table 2). Seventy-six percent of the interviewees were women, with an age range between 18 and 68 years and an average age of 34 years. Fifty-three point seven (53.7) percent of the families were made up of 3 to 4 members; the income level of 37.6 % of the interviewees was medium (from \$5,000.00 to \$8,500.00), and only 6.5 % stated that they had a high income (more than \$15,000). This is consistent with what was reported in a study<sup>(17)</sup>, carried out in the same municipality, on the willingness to pay for organic products, which found that the average income of the sample population was between \$4,000.00 and \$8,000.00.

**Table 2:** General data of the interviewees

Item	Milk consumers		Consumers of milk substitutes	
	Frequency	Percentage	Frequency	Percentage
Sex:				
Female	287	74.0	300	78.0
Male	97	26.0	84	22.0
Age:				
Average age	34		33	
Schooling:				
No studies	7	1.8	0	0
Incomplete basic-high school education	22	5.7	62	16.1
Complete basic-high school education	185	48.1	132	34.3
Undergraduate and postgraduate	170	44.2	190	49.4
Members per family:				
1 - 2	80	20.8	56	14.5
3 - 4	198	51.5	219	57.0
5 - 6	96	25.0	88	22.9
7 - 8	10	2.6	21	5.4
Monthly household income:				
Low (less than \$2,100)	14	3.6	75	19.5
Medium - low (\$2,101-\$5,000)	68	17.7	58	15.1
Medium (\$5,001 - 8,500)	166	43.2	125	32.5
Medium - high (\$8,501 - \$15,000)	106	27.6	106	27.6
High (more than \$15,000)	30	7.8	20	5.2

It was found that 66.75 % spend between 24.0 and 50.0 % of family income on food consumption; 29.5 % allocate more than 50.0 %; and only 3.15 % of the population allocates less than 20.0 % of family income to this item. Fifty-four point four (54.4) percent have no restrictions on milk consumption; nevertheless, 45.6 %, represented by people aged 21-65, show limitations for its consumption, and one of the leading causes is lactose intolerance (15.5 %). Regarding consumers of milk substitutes, 60.6 % said they consumed these types of beverages mainly for health reasons.

For milk consumption, when analyzing the estimated coefficients and the probability of finding values of that coefficient greater than the Z distribution, which must be less than 5.0 %, three of the six variables considered were statistically significant, that is, with a Pr

( $>|Z|$ ) < 0.05; these variables were sex, schooling, and household income. In contrast, for the consumption of milk substitutes, the significant variables were sex, schooling, household income, age, and the number of members per family. In contrast, variables that were not statistically significant were excluded from the model, with a Pr ( $>|Z|$ ) > 0.05. Table 3 presents the results of the bivariate Probit model for both milk consumers and milk-substitute consumers.

**Table 3:** Estimates of the coefficients of the bivariate Probit model

Parameter	Bovine milk consumption			Consumption of milk substitutes		
	Coefficient	Z value	Pr ( $> z $ )	Coefficient	Z value	Pr ( $> z $ )
Intercept	1.711739	3.19	0.0014	-0.793649	-1.76	0.0782
SEX	-0.443205	-2.77	0.0056	0.519201	3.00	0.0027
AGE	0.010702	1.42	0.1546	-0.018855	-3.08	0.0021
SCH	-0.412437	-3.49	0.0005	0.247375	2.31	0.0209
PRIC	0.000128	0.03	0.9749	0.000472	0.11	0.9157
NMF	0.075962	1.61	0.1082	-0.117527	-2.47	0.0137
HINC	-0.291608	-3.71	0.0002	0.433316	6.13	<0.0001
RHO	0.233103	2.55	0.0106	0.233103	2.55	0.0106

Sex (SEX); age (AGE); schooling (SCH); price (PRIC); number of members per family (NMF), household income (HINC); RHO= Spearman's rank correlation coefficient.

Taking the estimates in Table 3 of the significant variables of the Biprobit model for the probability of occurrence of the event bovine milk consumption (SEX, SCH, and HINC) and consumption of milk substitutes (SEX, AGE, SCH, NMF, and HINC), the following models 1 and 2 are proposed:

**Bovine milk consumption**

$$y_1^* = F(1.711 - 0.443SEX - 0.412SCH - 0.291HINC) + \varepsilon_1, \tag{1}$$

**Consumption of milk substitutes**

$$y_2^* = F(-0.793 + 0.519SEX - 0.018 AGE + 0.247SCH - 0.117NMF + 0.433HINC) + \varepsilon_2, \tag{2}$$

F( ) : Represents the function of the normal distribution

$$\begin{aligned} E[\varepsilon_1] &= E[\varepsilon_2] = 0, \\ Var[\varepsilon_1] &= Var[\varepsilon_2] = 1, \\ Cov[\varepsilon_1, \varepsilon_2] &= \rho. \end{aligned}$$

As shown, the jointly estimated models are consistent and can be used for prediction. According to the value of  $Rho = 23.31\%$ , it is observed that both markets are positively correlated, that is, both consumers of bovine milk can also consume milk substitutes, and vice versa; it may even be that there are some consumers who prefer the consumption of both products, as shown in Table 4.

**Table 4:** Frequencies of consumption of bovine milk and milk substitutes

Milk substitutes	Bovine milk	Frequency	Percentage
0	1	65	16.9
1	0	89	23.2
0	0	86	22.4
1	1	144	37.5
Total		384	100

0= they do not consume bovine milk or milk substitutes, and 1= they do consume bovine milk or milk substitutes.

The signs of the coefficients of each variable indicate the direction in which the probability of consumption of both products moves when the explanatory variable increases. For milk consumption, the variable schooling (SCH) and the variable household income (HINC) had a negative sign in their coefficient, which indicates that with an increase in either of the two variables, provided all the others remain constant (*ceteris paribus*), the probability of consumption of bovine milk and vice versa will be lower. This is contrary to the case of milk substitutes, where these variables had positive coefficients, which means that, in the event of an increase either in schooling or in household income, the probability of consuming milk substitutes will also increase, *ceteris paribus*.

The coefficients obtained for the explanatory variables of the model can be used to quantify the marginal effects that they have on both consumptions. Marginal effects indicate the proportion to which the probability of consumption of both bovine milk and milk substitutes will be affected when one of the explanatory variables changes and the other variables remain constant (Table 5).

**Table 5:** Marginal effects

<b>Variable</b>	<b>Bovine milk consumption</b>	<b>Consumption of milk substitutes</b>
SEX	-0.1149	0.1610
AGE	0.0037	-0.0058
SCH	-0.1446	0.0767
PRIC	0.00004	0.0001
NMF	0.0266	-0.0364
HINC	-0.1022	0.1343

Sex (SEX); age (AGE); schooling (SCH); price (PRIC); number of members per family (NMF); family income (HINC).

The marginal effect for the variable gender indicates that, if the female sex increases by 1 %, while all other variables remain constant, the probability of consuming bovine milk will decrease by -0.1149; in contrast, the consumption of milk substitutes will increase by 0.1610.

The variable household income (HINC) has a marginal effect of -0.1022 for the consumption of bovine milk and 0.1343 for the consumption of milk substitutes, which indicates that in the face of a 1 % increase in their income, consumers decrease or increase their consumption of milk or milk substitutes in those proportions, respectively.

Finally, it is necessary to highlight that the research generated specific information on the behavior of consumers of bovine milk and milk substitutes in the municipality of Texcoco, State of Mexico. According to the study's results, the female sex discourages the probability of consuming bovine milk; likewise, schooling and family income limit it. The opposite is true for milk substitutes, where the female sex encourages their consumption, as do schooling and household income; on the other hand, age and the number of members per family discourage it.

## Discussion

González<sup>(18)</sup> mentions that milk consumption in Mexico is three times lower than in the United States, and that Mexican daily per capita consumption is 250 ml, which is low compared to countries such as the Netherlands (900 ml), the United States (740 ml), or New Zealand (600 ml). In addition, only 4.9 % of national production is marketed unpasteurized (raw).

The reasons why the interviewed population said they did not consume bovine milk were dislike for milk (11.5 %), following a diet (8.0 %), medical recommendation (6.25 %), or another (3.25 %), such as allergy to the consumption of bovine milk; in this regard, Menghi<sup>(19)</sup> found that this type of impact has been increasing in the general population. Varela<sup>(20)</sup> mentions that milk can help prevent certain diseases, but it can also cause them, such as lactose intolerance or allergy to bovine milk protein, pathologies that are increasingly common today and whose symptoms are similar and can be confused.

The highest frequency of consumption of milk substitutes was 1 to 2 times a week (56 %), and the main reason for consuming these types of drinks is for taste (49 %), that is, by one's own decision, and for medical recommendation or illness, as is the case of lactose intolerance (25 %). This coincides with Prytulska *et al*<sup>(21)</sup>, who conducted a survey of 436 people in Ukraine for a study on consumer preferences in the market of plant-based milk analogues; they found that 37.7 % of respondents consume plant-based drinks regularly, whereas 47.7 % consume them occasionally, and about 15 % of them have never consumed them. According to Silva *et al*<sup>(22)</sup>, a growing number of consumers have chosen to consume plant-based bovine milk substitutes for medical reasons, such as allergy to bovine milk protein, lactose intolerance, or as a lifestyle choice. In addition, it has been mentioned that the rise of these types of drinks is related to the growing trend of following vegan diets, which causes a decrease in dairy consumption<sup>(19)</sup>.

One of the variables that determined the probability of consuming milk in the municipality of Texcoco was sex, which was defined as 1 if it was a woman and as 0 if it was a man; this variable had a coefficient with a negative sign. This indicates that it is women who are willing to consume less milk. In a study, the Spanish Nutrition Foundation [FEN]<sup>(23)</sup> differentiated consumers by sex and found that women are the primary consumers of bovine milk and dairy products; a result that is the opposite of that found in this study.

In the case of the consumption of milk substitutes, considering the sign of the estimated coefficient for the variable gender, it is observed that it is women who most consume milk substitutes, which coincides with the results of Prytulska *et al*<sup>(21)</sup>, who found that the consumption of plant-based drinks by women (52.4 %) is higher than that of men (47.6 %); results that were obtained from a survey of 436 people carried out between 2019 and 2020 in Ukraine.

In this study, schooling (SCH) had an inverse relationship with the consumption of bovine milk and a direct relationship with the consumption of milk substitutes; that is, the higher the schooling, the lower the probability of consuming milk, but the greater the probability of consuming milk substitutes. Similar results were found by Valencia, Mora, and Martínez<sup>(24)</sup>, who found that schooling influences the consumer when deciding to buy and consume bovine milk, as well as when choosing the milk brand to buy.

Household income (HINC) was another variable that negatively affected the probability of bovine milk consumption, but it had a positive effect on the probability of consuming milk substitutes. This indicates that consumers with higher incomes tend to reduce milk consumption; in contrast, people with higher incomes can increase the consumption of milk substitutes. Some research<sup>(25)</sup> indicates that families with greater purchasing power have a greater advantage in deciding on their consumption (milk or milk substitutes).

Other factors analyzed were age (AGE), price (PRIC), and number of members per family (NMF); they were not significant in the case of milk consumption; on the other hand, for the consumption of milk substitutes, the variables age and number of members per family were relevant with a positive impact, but this was not the case for the price; this is because, it is a cross-sectional study, since, being a survey, there is no variability in the price, so the price was not statistically significant. This is similar to the results of Valencia *et al*<sup>(26)</sup>, who found that, in Mexico City, the price of milk and income were not significant, but the size of the families was relevant.

Given the results of the models and the percentage of milk consumers (43.2 %) and the proportion of those who consume milk substitutes (32.5 %), it is observed that in the future milk consumption will continue to decrease; on the contrary, the consumption of milk substitutes, or better known as plant-based drinks, will gradually increase.

## **Conclusions and implications**

The study concludes that the consumption of bovine milk and the consumption of milk substitutes are positively correlated; that is, the consumer can choose one or the other product; however, milk consumption is decreasing, and milk substitute consumption is increasing. The consumption of milk substitutes and the factors that condition it in relation to milk consumption were characterized for the first time. The main variables that discourage the consumption of bovine milk are female sex, schooling, and household income, whereas in the case of the consumption of milk substitutes, they encourage it. Based on the hypothesis raised, it is proven that income is an essential factor in the consumption of both products, and that price does not influence the decision to consume them. For future research, it is recommended to conduct more detailed studies by consumer strata in relation to age and sex.

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#### Literature cited:

1. Miranda, A. Definitivo: es leche solo si viene de la vaca. Edairynews. Chile. 9 de abril 2019. <https://es.edairynews.com/definitivo-es-leche-solo-si-viene-de-la-vaca/>.
2. FAO. Food and Agriculture Organization Composición de la leche. 2022. <http://www.fao.org/dairy-production-products/products/composicion-de-la-leche/es/>.
3. Eroski Consumer. Bebidas vegetales: sucedáneos milenarios. Eroski Consumer 2015;200:13–21.
4. Statista. Ranking de los países que más leche líquida consumieron en el mundo en 2023 (miles de toneladas). 2024. <https://es.statista.com/estadisticas/499197/principales-paises-consumidores-de-leche-liquida-de-vaca-del-mundo/>.
5. Méndez, E. Día Mundial de la Leche; ingesta en México es de 370 mililitros por día. Expansión. 01 de junio 2023.  
<https://www.excelsior.com.mx/nacional/dia-mundial-de-la-leche-ingesta-nacional/1590027#:~:text=El%20consumo%20per%20c%C3%A1pita%20de%20leche%20en%20M%C3%A9xico,destac%C3%B3%20la%20Confederaci%C3%B3n%20Nacional%20de%20Organizaciones%20Ganaderas%20%28CNOG%29>.
6. Flores CAG, Hinojosa RAML. Desarrollo de un queso cottage a partir de leche descremada en polvo con fresa y fructofibras (inulina y oligofruktosa) [Tesis Ingeniería]. Cuautitlán Izcalli, Estado de México. México. Universidad Nacional Autónoma de México; 2015.
7. El Financiero. El nutritivo negocio de la leche vegetal. El Financiero. México, 3 de septiembre 2018. <https://www.elfinanciero.com.mx/opinion/de-jefes/el-nutritivo-negocio-de-la-leche-vegetal/>.
8. Sánchez-Fermín Sh. El boom de la leche que no es leche. Expansión. 5 de abril 2019. México. <https://expansion.mx/empresas/2019/04/05/el-boom-de-la-leche-que-no-es-leche>.
9. Fructuoso I, Romao B, Han H, Raposo A, Ariza MA, Araya CL Puppín ZR. Una visión general de los aspectos nutricionales de las bebidas de origen vegetal utilizadas como sustitutos de la leche bovina. Nutrientes 2021;13(8):2650.

10. Ramírez CM. Grupo Lala y el desafío de recuperar el consumo de leche en México. *El Economista*. 4 de junio 2025. México. <https://www.eleconomista.com.mx/opinion/grupo-lala-desafio-recuperar-consumo-leche-mexico-20250604-762114.html>.
11. INEGI. Instituto Nacional de Estadística y Geografía. Base de datos. México, 2020. <http://www.inegi.org.mx/>.
12. Torres M. Tamaño de una muestra para una investigación de mercado. Guatemala, Universidad Rafael Landívar, 2021. [http://moodlelandivar.url.edu.gt/url/oa/fi/ProbabilidadEstadistica/URL\\_02\\_BAS02%20DETERMINACION%20TAMA%C3%91O%20MUESTRA.pdf](http://moodlelandivar.url.edu.gt/url/oa/fi/ProbabilidadEstadistica/URL_02_BAS02%20DETERMINACION%20TAMA%C3%91O%20MUESTRA.pdf).
13. Greene W. *Econometrics analysis*. Fifth ed. New Jersey: Prentice Hall; 2003.
14. Zellner A, Haug D. Further properties of efficient estimators for seemingly unrelated regression equations. *Int Economic Rev* 1962;3:300–313.
15. Araneda P. Imputación de datos. RPubs by RStudio. 2021. <https://www.rpubs.com/paraneda/imputacion>.
16. Akaike H. A new look at the statistical model identification. *IEEE Transactions on Automatic Control* 1974;19:716–723.
17. Trujillo MJ, Hernández OJ, Martínez DMÁ. Disposición a pagar por productos orgánicos en Texcoco, Estado de México. *Rev Mex Cienc Agr* 2019;10(7):1685–1691.
18. González L. Consumo per cápita de leche, tres veces menor que en EU. *El Economista*. México. 25 de octubre 2021. <https://www.eleconomista.com.mx/empresas/Produccion-mexicana-de-leche-se-incremento-en-2.1-en-2020-dice-la-Canilec-20211025-0075.html>.
19. Menghi A. Alergias e intolerancias alimentarias. Universidad del Centro Educativo Latinoamericano. Rosario, Argentina. *Invenio* 2002;5(8):123–132.
20. Varela MG. La leche como vehículo de salud para la población. *Nutrición hospitalaria* 2018;35(6):49–53.
21. Prytulska N, Motuzka I, Koshelnyk A, Motuzka O, Yáshchenko L, Jarossová M, *et al*. Preferencias de los consumidores en el mercado de la leche de origen vegetal. *Potravinárstvo Rev Eslovaca Cienc Aliment* 2021;15:131–142. doi: <https://doi.org/10.5219/1485>.

22. Silva ARA, Silva MMN, Ribeiro BD. Problemas de salud y aspectos tecnológicos de la leche alternativa de origen vegetal. *Food Res Int.* Ottawa, Ontario. 2020;131(108972):13. DOI: <https://doi.org/10.1016/j.foodres.2019.108972>.
23. FEN. Fundación Española de la Nutrición. El consumo de la leche y derivados como indicador de calidad de la dieta y estilos de vida de la población. España, 2020. <https://www.fen.org.es/storage/app/uploads/public/5f5/f4c/2d3/5f5f4c2d363c8807709452.pdf>.
24. Valencia SK, Mora FJS, Martínez DMA. Asociación de variables que determinan el consumo de leche bovina en la Ciudad de México. *Texcoco. Rev Mex Agroneg México*, 2021;48:656–666. <https://www.redalyc.org/articulo.oa?id=14167610007>.
25. Rodríguez SJM, Armenta RAB. Panorama sobre la producción y el consumo de leche y lácteos en México. *Hitos de Ciencias Económico Administrativo* 2018;24(70):518– 534. doi: <https://doi.org/10.19136/hitos.a24n70.2949>.
26. Valencia SK, Mora FJS; Brambila PJJ, Martínez DMÁ, Vaquera HH. Factores que determinan el consumo de leche en el Distrito Federal, México. *Rev Científica* 2015; 15(1):74–80.