

CONSUMER PREFERENCES AND WILLINGNESS TO PAY FOR TRADITIONAL TORTILLA USING CONTINGENT VALUATION

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ABSTRACT

The tortilla is a staple food in the Mexican diet. However, in recent years, it has been declining in quality and nutritional value due to the use of flour and the industrialization of production processes. Fresh traditional tortillas are known to possess superior nutritional and nutraceutical properties compared to commercially produced tortillas, along with unmatched flavor and texture. Consumers have increased their preferences for local, more natural products produced in an eco-friendly agricultural manner. Thus, soil degradation, water pollution, and the loss of biodiversity are avoided. However, the price consumers are willing to pay for a tortilla with these attributes is unknown. Using the contingent valuation method (CVM) in its referendum and double-bounded formats, the aim of this investigation was to estimate consumers' willingness to pay (WTP) for the tortilla they consume with the following attributes: native maize content, organic production, and traditional nixtamalization. Moreover, the variables that explained the behavior of the WTP were determined. A total of 216 surveys were conducted between January and March 2024 in 15 municipalities of the State of Mexico belonging to the metropolitan area of the Valley of Mexico. The double-bounded CVM displayed the highest theoretical consistency. The variables of price, monetary income, gender, education level, economic dependents, and age of the respondent helped estimate the WTP. The estimated value was MXN 36.12 per kg of tortilla.

Keywords: food, nutrition, local product, natural, *Zea mays* L.

INTRODUCTION

The tortilla is part of the identity of Mexicans. It has a cultural and mythical origin and has accompanied the Mexican culinary culture, both in rural and urban spheres. It is a key ingredient in the majority of everyday and festive dishes (Calleja-Pinedo and Valenzuela, 2016; Torres-Sombra, 2018). However, not all maize tortillas are the same,

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as their quality and nutritional content depend on decisions taken in the field and the food transformation processes.

According to Sainz-Trapaga *et al.* (2022), out of the total of pre-packaged maize tortillas, 93 % are made with nixtamalized flour, and only 7 % claim they are made with nixtamalized maize. These authors identified 145 additives in pre-packaged tortillas and tostadas, out of which 119 were sold without a clear and detailed declaration of the ingredients or substances they are made of. The most common ones are preservatives (21 %), softeners (13 %), anti-stick agents (12 %), bleaching agents (12 %), and texturizers (8.4 %). These tortillas made with nixtamalized maize flour show significant differences in their nutritional contributions compared to traditional tortillas, particularly in terms of reduced calcium content (Colín-Chávez *et al.*, 2020).

Out of all the tortillas consumed in Mexico, 90.4 % contain sequences of transgenic maize. This is also the case for 82 % of the tostadas, flours, cereals, and snacks produced with this grain. The presence of glyphosate has also been found in industrial tortillas. In contrast, traditional tortillas made with native maize present a much lower frequency of transgenes and do not contain glyphosate (González-Ortega *et al.*, 2017). Fresh traditional tortillas have nutritional and nutraceutical properties far superior to the industrial tortilla, such as a higher content of free phenols, dietary fiber, calcium, and antioxidant capacity. Handmade tortillas made from blue maize have a ferulic acid content 4.5 times higher than the commercially produced white maize tortillas and thus may be a good source of phenolic antioxidants, particularly ferulic acid (Colín-Chávez *et al.*, 2020).

In recent years, consumers tend to prefer healthier and more eco-friendly products. Environmental awareness has increased and become more popular worldwide. Most countries apply laws to protect it and develop a sustainable economy (Kipāne and Vilks, 2022), such as the United States, Colombia, Peru, South Korea, and Mexico (OECD, 2024). Aprile *et al.* (2016) mention that a recent consumer preference expression includes locally produced foods, driven by their demand for sensory perception, nostalgia for local processes, healthy attributes, environmental care, and dietary habit changes.

Recent studies on consumer preferences in common tortillas (produced with nixtamalized flour, nixtamal dough, or a mixture of dough and flour) show that the consumers prefer nixtamalized maize dough tortillas (Espejel-García *et al.*, 2016; Escobedo-Garrido and Jaramillo-Villanueva, 2019). However, there are not many studies on the preferences for differentiated tortillas, such as the traditional tortilla. Jaramillo-Villanueva (2016) conducted a study on preferences and willingness to pay (WTP) for organic maize tortilla consumption in Puebla and reported that consumers are willing to pay MXN 1.6 kg⁻¹, equivalent to 16 % above-the floor price per kilogram of tortillas. Blare *et al.* (2020) report that, in Texcoco, State of Mexico, consumers were willing to pay 42 % more for blue maize tortillas when they ate out, but not for everyday home consumption.

Based on the above information, a niche market is found for eco-friendly, traditional tortillas made from native maize. However, the price that consumers are willing to pay and the attributes they value the most are unknown. One of the most widely used methods to obtain this information is the contingent valuation method (CVM), which used a flexible stated-preference approach applied to the valuation of non-market goods across a range of contexts and policies (Haab *et al.*, 2020). To apply it, a market is simulated using surveys to potential customers, with the purpose of measuring the changes in the well-being of people and societies against variations in goods and services, with these goods and services being monetized in order to determine WTP. Within the CVM, there are two formats to estimate the WTP: referendum and double-bound. According to Brugnaro (2010), Gelo and Koch (2015), and Tudela-Mamani *et al.* (2018), the double-bound format helps obtain more efficient and accurate estimations. The aim of this investigation is to estimate, using the CVM in its referendum and double bound formats, the WTP of consumers for hand-produced tortillas made with native organic maize and traditional nixtamalization, as well as to determine the variables that explain the behavior of the WTP. The hypothesis is that consumers are willing to pay an upcharge price for the traditional, native, organic, and nixtamalization attributes, and that the magnitude of this overprice is explained by the price, income, consumer tastes, and preferences, as well as their sociodemographic characteristics.

MATERIALS AND METHODS

The study was held between January and March 2024 in 15 municipalities of the State of Mexico, belonging to the metropolitan area of the Valley of Mexico: Chalco, Chicoloapan, Chimalhuacán, Coacalco de Berriozábal, Ecatepec de Morelos, Ixtapaluca, Cuautitlán Izcalli, Naucalpan de Juárez, Nezahualcóyotl, La Paz, Tecámac, Texcoco, Tlalnepantla, Tultitlán, and Valle de Chalco Solidaridad.

To estimate the sample, the population of interest (individuals over the age of 18) was identified from the total population of the State of Mexico, which stands at 16 992 418 inhabitants according to the Population and Household Survey (INEGI, 2020). Following recommendations by Ahmed (2024), the sample size was determined using an equation for large or infinite populations:

$$n = \frac{Z^2 pq}{d^2}$$

where n is the sample size, Z is the value z associated with the desired confidence level (1.96 for 95 % confidence), p is the proportion of the population willing to pay for the improvement (equal to 0.5), q is the proportion of the population not willing to pay (equal to 0.5), and d is the allowable estimation error or precision (7 %).

The questionnaires used were based on focus group discussions between housewives, consumers, and experts on the topic. Subsequently, preliminary studies were held

on 100 consumers to find erroneous interpretations of the questions. Based on the equation for calculating sample size, an estimated 196 questionnaires were conducted. However, since four prices were evaluated, 216 surveys were administered, distributed as 54 for each proposed price.

Referendum model of willingness to pay

The model is a popular method in the dichotomous choice design; its popularity stems from the recommendations of the United States National Oceanic and Atmospheric Administration (NOAA) (Arrow *et al.*, 1993), and it uses a “take it or leave it” format. According to Tudela-Mamani *et al.* (2018), the modelling process considers the random utility approach through the following expression:

$$U_{ih} = v_{ih}(p_h, M_i, s_i) + \varepsilon_{ih}$$

where the utility (U) of the alternative (h) for the individual (i) is based on s , which represents the individual characteristics; p_h is the price of alternative h , and M is the individual's income. The utility is composed of a deterministic component (v_{ih}) and a non-observable random error component (ε_{ih}), independent and identically distributed, with a mean of zero and a constant variance. Individual i chooses the alternative that provides the greatest utility. Therefore, the behavior establishes that the alternative h is chosen if and only if: $U_{ih} > U_{ij} \forall h \neq j$. The probability (Pr) of the individual choosing alternative h is given by the following equations:

$$\Pr(h) = \Pr\{U_{ih} > U_{ij}\}$$

$$\Pr(h) = \Pr\{\varepsilon_{ij} - \varepsilon_{ih} < v_{ih}(p_h, Z_{ih}, M_i, s_i) - v_{ij}(p_j, Z_{ij}, M_i, s_i)\}$$

In order to estimate the impacts on well-being, that is, the WTP for a change from the status quo (alternative j) to the chosen state (alternative h), the following equation is used:

$$\Delta v = v_{ih}(p_h, M_i - VC, s_i) - v_{ij}(p_j, M_i, s_i)$$

where VC is the compensatory variation, which is interpreted as the highest amount of money that an individual would be willing to pay to access a favorable change. In this case, for individual i , alternative h improves their well-being in comparison to alternative j .

The willingness to pay (WTP) for each respondent was estimated using the following equation:

$$WTP_i = \frac{\alpha + \beta_2(INC) + \beta_3(GEN) + \beta_4(EDL) + \beta_5(DEP) + \beta_6(PRICEKG)}{-\beta_1}$$

$$i = 1, 2, \dots, 216$$

where INC is the respondent's income level, GEN corresponds to the gender, EDL is the education level, DEP is the number of economic dependents of the household, and PRICEKG is the price per kilogram of tortilla (MXN). The referendum model consists in giving the respondent two answer alternatives: yes or no. The dependent variable is discrete; therefore, the regression is carried out using a logit or probit model. This investigation uses the logit model.

The estimation is solved with the maximum likelihood method with the log-likelihood (LL) function:

$$LL = \prod_{i=1}^n [(1 - y_i) \ln(1 - F(\beta'x_i)) + y_i \ln(F(\beta'x_i))]$$

where y_i is the dependent binary variable that takes the value of one if the response to the WTP is "yes" and, otherwise, zero. The maximum likelihood estimator is obtained by maximizing this function.

Double-bounded willingness-to-pay model

When assuming that an individual faces two "take it or leave it" offers related to their WTP, an initial offer is first presented, and they respond yes or no. Based on this response, a second offer is made: if they reject the first, a lower one is made; if they accept it, a higher offer is made (Gelo and Koch, 2015). The initial question is asked again in this second step as PMA or PME, where PMA corresponds to the price proposed after a positive response and PME, to the price proposed after a negative response (Tudela-Mamani, 2017).

According to Hanemann *et al.* (1991) and Aikoh *et al.* (2018), responses in terms of probability can be expressed as shown in the following equations:

$$\begin{aligned} \Pr(YES, YES) &= 1 - F(\beta'x_i^u) \\ \Pr(YES, NO) &= F(\beta'x_i^u) - F(\beta'x_i) \\ \Pr(NO, YES) &= F(\beta'x_i) - F(\beta'x_i^d) \\ \Pr(NO, NO) &= F(\beta'x_i^d) \end{aligned}$$

For the double-bounded case, the log-likelihood function is stated as follows:

$$LL = \sum_{i=1}^n \left\{ \begin{array}{l} d_i^{ss} \ln \left(1 - \frac{1}{1 + \exp^{-(\beta'x_i^u)}} \right) + d_i^{sn} \ln \left(\frac{1}{1 + \exp^{-(\beta'x_i^u)}} - \frac{1}{1 + \exp^{-(\beta'x_i)}} \right) + \\ d_i^{ns} \ln \left(\frac{1}{1 + \exp^{-(\beta'x_i)}} - \frac{1}{1 + \exp^{-(\beta'x_i^d)}} \right) + d_i^{nn} \ln \left(\frac{1}{1 + \exp^{-(\beta'x_i^d)}} \right) \end{array} \right\}$$

where d_i^{ss} , d_i^{sn} , d_i^{ns} , d_i^{nn} , are binary variables that take the value of one when the respondent's answer corresponds to that category and zero otherwise. The maximum likelihood estimator is obtained by maximizing this function. Once the estimations of the parameters are obtained, the monetary measure of welfare is calculated. The formulas to calculate the WTP, both in the referendum and double-bounded formats, are derived from the functional form of Δv (Vásquez-Lavín *et al.*, 2007).

The questionnaire was split into three sections. The first one included the sociodemographic aspects and the consumption patterns of the respondents (age, gender, civil status, education, monthly household income, and number of members). The second one addresses the consumption frequency and preferences related to the attributes of the maize tortilla considered important by consumers: organic, native, color, nixtamalization, and traditional production. In the third section, the valuation scenario was presented, and the respondents were informed about the proposed improvements for the tortillas as well as the social benefits associated with their consumption. The central question was, "Suppose a new presentation is about to be released with the following characteristics: native maize-based, produced organically, nixtamalized, and produced traditionally (by hand and on a hot plate). For one kilogram of this tortilla, would you be willing to pay X?"

In the first round, the poll taker applied the initial bid price (PPI) with four values: 20, 30, 40, and 50, conducting 54 surveys for each one. Based on the response of each individual ("yes" or "no"), the second question was asked. If the initial response was "yes," the high bid vector (PMA) was used: 22, 32, 42, and 52. If the initial response was "no," the low bid vector (PME) was applied: 18, 28, 38, and 48. In both the double-bounded and the referendum formats, the variables were used to calculate the econometric logit model (Table 1).

RESULTS AND DISCUSSION

In the referendum contingent valuation, out of 216 participants, 58 % claimed to be willing to pay an overprice to consume a tortilla produced with native maize, produced organically, nixtamalized with the traditional process, and prepared traditionally (by hand and on a hotplate). In particular, 70 % of all respondents were willing to pay a price of MXN 30 kg⁻¹, whereas only 20 % answered affirmatively to a cost of MXN 50 kg⁻¹. As the price increased, the proportion of positive answers decreased (Table 2).

Table 1. Description of variables used in the analysis.

Variable	Description	Response
PSI	Probability of answering YES to the willingness to pay	1 = if the response in first round is YES, 0 = Negative response
PPI	Initial proposed price (MXN)	20, 30, 40, and 50
PME	Lower price (MXN)	18, 28, 38, and 48
PMA	Higher price (MXN)	22, 32, 42, and 52
DYY	Dummy variable for YES-YES	If the response in the first round is YES, 1 = if the response in second round is YES; 0 = otherwise
DYN	Dummy variable for YES-NO	If response in the first round is YES, 1 = if the response in the second round is NO; 0 = otherwise
DNY	Dummy variable for NO-YES	If the response in the first round is NO, 1 = if the response in the second round is YES; 0 = otherwise
DNN	Dummy variable for NO-NO	If the response in first round is NO, 1 = if the response in second round is NO; 0 = otherwise
INC	Income level (MXN)	1 = less than 5000, 2 = between 5000 and 7000, 3 = between 7001 and 9000, 4 = between 9001 and 11000, 5 = between 11001 and 13000, 6 = between 13001 and 15000, 7 = between 15001 and 17000, 8 = between 17001 and 20000, 9 = between 20001 and 25000, 10 = between 25001 and 30000, 11 = over 30000
INCR	Monetary income (MXN)	Whole number (arithmetic average of each category of the ING variable)
MUNICIP	Municipality in which respondent lives	1 = Ecatepec de Morelos, 2 = Nezahualcóyotl, 3 = Naucalpan de Juárez, 4 = Chimalhuacán, 5 = Tlalnepantla, 6 = Cuautitlán Izcalli, 7 = Tecámac, 8 = Ixtapaluca, 10 = Tultitlán 12 = Chalco, 13 = Valle de Chalco Solidaridad, 14 = La Paz, 15 = Coacalco de Berriozábal, 18 = Texcoco, 19 = Chicoloapan
GEN	Gender	Woman = 1, Man = 0
CIVSTAT	Civil status	1 = Single, 2 = Married, 3 = Widowed, 4 = Divorced, 5 = Free union
AGE	Age	Whole number (years)
EDL	Education level	1 = Elementary, 2 = Middle high, 3 = Highschool, 4 = Technical degree, 5 = Bachelors, 6 = Graduate school, 7 = No studies
INTEGRAN	Number of individuals in the respondent's household	Whole number
DEP	Number of economic dependents of the head of household	Whole number
PRICEKG	Price of a kilogram of tortillas (MXN) at the place where the respondent buys them.	Whole number
FREQ	Frequency with which respondent buys tortillas	1 = Every day, 2 = Every third day, 3 = Once a week, 4 = Occasionally, 5 = Does not buy tortillas
CONORG	Knowledge on organic products	1 = yes, 0 = no

Table 1. Continued

Variable	Description	Response
CONCONVE	Knowledge on conventional agriculture	1 = yes, 0 = no
CONHIB	Knowledge on hybrid maize	1 = yes, 0 = no
CONCRI	Knowledge on native maize	1 = yes, 0 = no
CONNIX	Knowledge on the nixtamalization process	1 = yes, 0 = no
ELAB	Knowledge on the raw materials used to make the tortilla	1 = Maize flour, 2 = Hybrid maize dough, 3 = Native maize dough, 4 = Mixture of maize flour/hybrid maize dough

Table 2. Frequency of affirmative responses to the initial prices proposed.

Initial price (PPI)	Number of surveys	Affirmative responses	
		Number	%
20	54	52	96
30	54	38	70
40	54	24	44
50	54	11	20
Total	216	125	58

In the second round (double-bound), 48 % responded affirmatively to the valuation question (YES/YES, NO/YES) (Table 3). Diverse econometric models were estimated, and the selection of the optimum model was based on the following criteria: 1) the coefficients must present the expected signs, reflecting a logical relation with the dependent variable; 2) the coefficients must be significant at an acceptable reliability level; and 3) the maximum log-likelihood must reach a high value.

In the referendum and double-bounded format, the results of the regressions of the logit binomial models (Table 4) indicated a selection of a linear model. In the referendum format, the model displayed a percentage of prediction of 74.53 % and

Table 3. Frequency of responses in the contingent valuation survey (referendum and double-bounded).

Format	Price	18	20	22	28	30	32	38	40	42	48	50	52	Total
Referendum	YES		52			38			24			11		125
	NO		2			16			30			43		91
Double-bounded	YES/YES			45			26			11			7	89
	YES/NO			7			12			13			4	36
	NO/YES	1			6			3			4			14
	NO/NO	1			10			27			39			77

Table 4. Econometric estimations referendum model and double-bounded.

Variables	Referendum	Double-bounded
Constant	5.457 (3.007)***	3.935 (2.807)***
PPI	-0.139 (-7.229)***	-0.168 (-9.408)***
INCR	0.00005 (1.590)	0.00004 (1.330)
GEN	0.593 (1.497)	0.306 (0.851)
EDL	0.126 (0.943)	0.196 (1.463)
DEP	-0.092 (-0.758)	-0.191 (-1.621)
PRICEKG	-0.065 (-0.811)	0.055 (0.914)
Logarithm of likelihood	-102.982	229.515
Reason for likelihood	88.100	459.030
Pseudo R	0.299	
Correct prediction (%)	74.537	

*** Significance at 1 %. The Z statistic is found in parentheses. PPI: hypothetical initial price; INCR: monetary income; GEN: gender of respondent; EDL: education level; DEP: number of economic dependents of the head of the household; PRICEKG: price per kilogram of tortilla in the establishment where the respondent makes the purchase.

a McFadden's R^2 of 0.299, a value within the expected range for this type of studies (0.2–0.4), equivalent to an R^2 of 0.7–0.9 in an ordinary squared minimum regression (Tudela-Mamani *et al.*, 2011, 2018; Melo-Guerrero *et al.*, 2020).

In the models estimated with the double-bounded format, the linear model was selected, as it registered the highest value of the log-likelihood and, consequently, the highest likelihood ratio. In most cases, the absolute value of the "Z" statistic was higher than that of the referendum models, which indicates lower variances in the coefficients and greater statistical significance. This suggests a better approximation to the respondents' true WTP. These results are consistent with those reported by Tudela-Mamani *et al.* (2018), Cahui-Cahui *et al.* (2019), and Torres-Ramírez *et al.* (2023). The results of the double-bounded model showed the expected signs of the coefficients. The PPI coefficient was negative, indicating that the higher the price of tortillas, the lower the probability of getting a positive response. The price was the variable with the least significance in comparison with the rest. The income variable (INCR) presented a positive sign; therefore, a higher income increases the probability of an affirmative response. The coefficient associated with gender was also positive, which implies a higher probability of a positive response when the respondent is female. This result

is consistent with the one by Brugnaro (2010), Hernández-Valdivia *et al.* (2019), and Torres-Ramírez *et al.* (2023).

The EDL coefficient displayed a positive sign, in such a way that a higher education level increases the probability of an affirmative answer, as reported by Hernández-Valdivia *et al.* (2019) and Lugo-Sandoval *et al.* (2020). By contrast, the variable DEP presented a negative sign, as expected. The greater the number of economic dependents, the lower the WTP, since tortillas are a staple food. A larger household typically results in higher overall spending. The variable PRICEKG presented a positive sign, indicating that the higher the tortilla price in the habitual venue of purchase, the higher the WTP for the valued product.

The WTP obtained using the double-bounded format was MXN 36.11 (Table 5), equivalent to an overprice of 77 % relative to the average price of MXN 20.37 in the surveyed areas and of 56 % in regard to the national average of MXN 23.15 (SNIIM, 2024). Jaramillo-Villanueva (2016) found that consumers in Puebla would pay an overprice of MXN 1.6 kg⁻¹ for organic maize tortillas, equivalent to 16 % of the base price.

Table 5. Estimation of the mean willingness to pay (WTP) in the referendum and double-bounded models.

Format	Mean	Standard deviation	Minimum	Maximum
Linear referendum	38.548	3.711	28.237	54.125
Double-bounded	36.110	3.452	24.466	46.919

In general, consumers were found to be willing to pay a higher premium when their consumption was occasional; however, their WTP decreased with daily consumption. This coincides with Blare *et al.* (2020), who found a WTP 42 % higher for blue maize tortillas eaten outside the household but lower for everyday consumption at home. Altogether, consumers are willing to pay an overprice for organic (Jaramillo-Villanueva, 2016; Marozzo *et al.*, 2023), eco-friendly (Tokuoka *et al.*, 2024), or traditional products (Aprile *et al.*, 2016; Ortez *et al.*, 2024).

The data adjusted to a normal distribution. In the referendum model (Figure 1A), the highest frequency of WTP was concentrated between MXN 34.709 and 41.181. In contrast, the double-bounded model (Figure 1B) showed a concentration between MXN 30.882 and 40.504. Most values were clustered around the mean. According to Czajkowski *et al.* (2024), the selection of the adequate parametric distribution depends fundamentally on the behavior of the data.

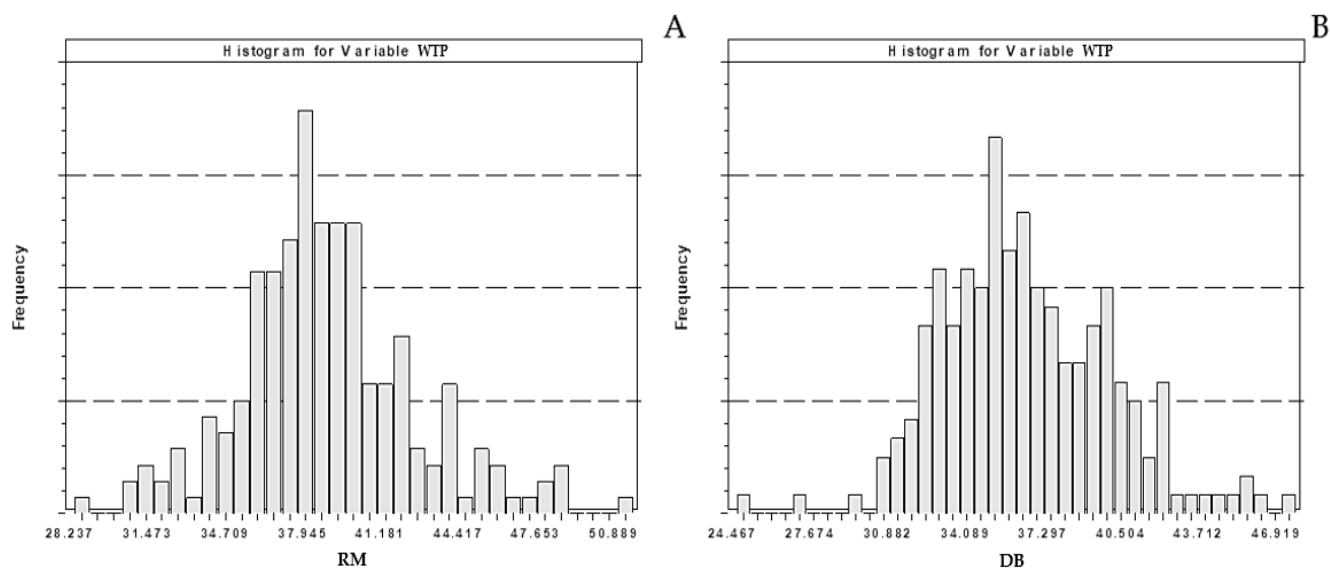


Figure 1. Distribution of the estimated willingness to pay (WTP). A: Referendum model (RM); B: Double-bounded (DB) model.

CONCLUSIONS

The double-bounded contingent valuation model displayed a higher individual and joint significance of the parameters than the referendum model. Consumers are willing to pay an overprice for a tortilla produced with native maize, produced organically, and nixtamalized and prepared in the traditional way. On average, consumers expressed a willingness to pay MXN 36.12 kg⁻¹, which represents a 77 % premium over the average price of MXN 20.37 in the surveyed areas and a 56 % premium compared to the national average of MXN 23.15. The variables of price, income, gender, education level, economic dependents, and age had an influence when determining the WTP.

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