



## Backyard eggs: an income opportunity window in communities in Texcoco, Mexico



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### Abstract:

Backyard egg production provides food and extra income to rural families. The resulting eggs are produced under conditions analogous to organic eggs, suggesting the possibility of a price premium for backyard eggs. The contingent valuation method was applied in a willingness-to-pay study of backyard eggs in four locations in the State of Mexico, Mexico. Results of a survey of 126 heads-of-household was analyzed using a binomial logit model. Most (70 %) interviewees were willing to pay a premium of 25 % for backyard eggs over the price for commercial eggs. The most significant variables were health awareness, fruit and vegetable consumption, monthly income and age. In the study area, backyard eggs could be sold at a premium price, potentially providing greater income to the rural families producing them.

**Key words:** Willingness to pay, Backyard eggs, Binomial logit, Contingent valuation.

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Due in part to their high protein index and broad availability, eggs are one of the primary agricultural products of the human diet<sup>(1,2)</sup>. In Mexico, eggs are the cheapest and most complete protein source<sup>(2)</sup>, and have become the most accessible animal source protein<sup>(3)</sup>. Per capita egg consumption in Mexico in 2012 was 20.8 kg, one of the world's highest<sup>(2)</sup>. By 2016, it had increased to 23.1 kg, representing an average annual growth rate of 1.5 % from 1994 to 2016<sup>(4)</sup>. More current egg consumption data from the National Poultry Producers Union (Unión Nacional de Avicultores) shows that consumption remained at 23 kg per capita in 2020<sup>(5)</sup>, keeping Mexico in first place worldwide. The primacy of eggs in the Mexican diet can be linked to factors such as high poverty rates and their continued status as the relatively lowest-priced animal protein, which is a consequence of technological improvements, genetic selection, and laying hen nutrition and health<sup>(1,6,7)</sup>. Increases in egg consumption have essentially plateaued, and any future growth in total demand will be driven by population growth.

Slower growth in the egg market will disproportionately affect small and medium-sized producers, who will be unable to compete with the economies of scale available to large companies. Product differentiation is one possible strategy for small and medium-sized producers to remain viable<sup>(8)</sup>. Niche markets for differentiated eggs do exist in Mexico. These include eggs with higher nutrient content (mainly fatty acids, omega 3, vitamins and minerals), and eggs produced using specific systems such as a vegetarian diet, organic inputs, and free-range and cage-free systems, among others. In some cases, the price premium for these alternative products is triple that of generic or commercial eggs<sup>(8)</sup>.

Homegrown, or backyard, eggs produced at a very small scale using locally-adapted chickens can be considered a differentiated product. The hens (*Gallus gallus domesticus*) involved are an indeterminate mixture of breeds of different origins that have been adapted to rustic conditions through extensive backyard management<sup>(9)</sup>. Diet in these systems consists of free grazing or semi-grazing supplemented in some cases with grains, kitchen waste and harvest residues, and essentially free of chemicals<sup>(10,11)</sup>. Eggs from these systems have distinct organoleptic characteristics, are perceived by consumers as being healthier<sup>(9)</sup>, and share some characteristics with organic eggs; the difference being that the latter are subject to a certification process<sup>(12)</sup>.

Backyard eggs are largely produced on family poultry farms mainly located in rural and peri-urban areas. In Mexico, more than 80 % of rural families keep chickens in their backyards<sup>(13)</sup>. The resulting egg production is mostly used for a family's subsistence. However, surpluses are sold in local markets, or among relatives and neighbors, frequently at prices higher than commercial eggs, and thus represent a supplemental income source<sup>(8,9)</sup>. Existence of a premium for natural or organic products is due to their higher production and processing costs, but also to the higher level of utility they represent for consumers, who perceive them as higher quality, more beneficial to health or environmentally-friendly<sup>(14,15)</sup>.

Backyard eggs may therefore have a potentially higher market value than commercial eggs because consumers perceive them as having characteristics similar to those of organic eggs. This perception may translate into a willingness-to-pay (WTP) a premium over the price of commercial eggs, depending on consumer age, number of members per family unit, income level, health awareness and fruit and vegetable consumption. The present study objective was to quantify willingness-to-pay a premium for backyard eggs in four locations in Texcoco Municipality, State of Mexico, Mexico, using the contingent valuation method, with the goal of generating useful data for backyard poultry farmers and proposing a better substantiated sale price to the public.

The study was done in four towns (San Bernardino, San Miguel Coatlinchán, Montecillos and San Luis Huexotla) in the east of the State of Mexico where backyard poultry farming still occurs.

The contingent valuation method (CVM) was applied, which is based on construction of a hypothetical market through application of surveys in which individuals express their WTP for a certain benefit in a specific product. The referendum type format was used, which is the most common format used in CVM<sup>(16)</sup>. In this format the interviewee decides the premium amount determining their WTP, in this case for the differentiated product. The model's dependent variable is the individual's utility (U), and the independent variables are backyard egg consumption (Q), income (Y) and a vector of variables (S):  $U = f(Q, Y, S)$ .

Initial utility ( $U_0$ ) corresponds to a state of non-consumption of backyard eggs ( $Q_0$ ) which can change to ( $U_1$ ) through consumption ( $Q_1$ ). An additional amount (P) must be paid for this consumption, which comes from disposable income (Y). If the consumer agrees to pay "P" to maintain the proposed scenario, then the following must be true:  $V_1(Q = 1, Y - P; S) - V_0(Q = 0, Y; S) > e_0 - e_1$ <sup>(16)</sup>; where  $e_0$  and  $e_1$  are assumed to be independent and identically distributed random variables.

The change in U is equal to the difference between the final and initial utilities. The interviewer must propose a certain amount to be paid to arrive at the final situation. The general logistic model is expressed as:

$$\text{Prob}(S_i) = \text{Prob}(V_1 - V_0 > \eta) = \text{prob}(\alpha - \beta P > \eta) = \frac{1}{1 + \exp(-\alpha + \beta P)}$$

Calculation of WTP was done using a binomial logit model estimated by maximum likelihood with the NLOGIT version 4.1 program. This was then used to estimate the variable parameters explaining interviewee WTP. The econometric model applied was:

$$\text{PrOb}(S_i) = \alpha + \beta_1(\text{SPrec}) + \beta_2(\text{CSal}) + \beta_3(\text{FVer}) + \beta_4(\text{Edd}) + \beta_5(\text{IntF}) + \beta_6(\text{Ing}) + \varepsilon$$

Where the binary dependent variable  $\text{PrOb}(S_i)$  represents the probability of a “Yes” answer to the question of willingness to pay for the differentiated product, which depends on the hypothetical premium to be paid (SPrec), health awareness (CSal), fruit and vegetable consumption in home [(FVer) as an indicator of healthy eating habits], interviewee age (Edd), number of family members (IntF) and income level (Ing). Unobservable error is represented by  $\varepsilon$ .

The explanatory variables were obtained directly from the survey, which was applied in July 2018. A total of 126 valid interviews were conducted through random sampling with an infinite population. Five price levels (Mexican pesos - MXP/kg) were used: \$25, \$27, \$29, \$31, and \$33. The first corresponded to the price of backyard eggs in the region at the time of the survey, which was slightly higher than the \$23 charged for commercial eggs.

The methodology involves three stages: questionnaire design, survey application and data analysis using econometric methods. The questionnaire was designed considering recommendations for revealed preference assessment methods focused on consumption preferences and willingness-to-pay<sup>(17,18)</sup>. It was organized into three sections<sup>(19)</sup>. The first included closed questions about knowledge and perception of the products to be assessed, in this case backyard eggs (a natural product obtained without the use of chemicals which shares some aspects with organic eggs). In the second, the interviewee was asked about their WTP, and in the third about socioeconomic information. The WTP item was:

“Based on your income level, expenses and preferences, would you be willing to pay \_\_\_ pesos for one kilogram of backyard eggs, which, according to production management techniques, share some characteristics with organic products (without being one), and is produced in different locations in Texcoco Municipality, State of Mexico?”

Of the total number of interviewees, three quarters were women, with a mean age of 48 yr and an education level of 9.0 yr (junior high); the latter is lower than the 9.7 average for Texcoco municipality and the 9.1 for the state<sup>(19)</sup>. About half of the interviewees fell within the 2,500 to 3,000 MXP monthly income bracket, and another third were within the 3,000 to 5,000 MXP bracket. According to the National Council for the Evaluation of Social Policy

(Consejo Nacional para la Evaluación de la Política Social - CONEVAL)<sup>(20)</sup>, more than half the interviewees can be classified as in conditions of food poverty.

Interviewee perceptions of backyard egg attributes showed that most had no knowledge of natural, chemical-free products, one third stated they had some idea as to what they are, and less than 10 % clearly understood what they are. When an explanation was provided of the characteristics of this product type and that backyard eggs can fulfill several characteristics of an organic product, 70 % of the interviewees indicated they were willing to pay a premium for backyard eggs. These results document behavior similar to that reported in a study of WTP for organic tortillas in which only 28 % of interviewees knew about the organic product in question, but, after an explanation of what it was, three quarters were willing to pay a premium price for the product<sup>(15)</sup>.

Of the 126 interviewees, almost two thirds stated that at some point they had consumed backyard eggs; of these, 79 % rated product quality as good to very good and 21 % as fair. One important result was that just over a quarter (28 %) of those who consume backyard eggs produce them in their backyards and 88 % of those who buy them do so at the home of a relative or friend. There was also a clear preference for backyard eggs since, under the condition that the price of backyard eggs was the same as commercial eggs, 83 % of the interviewees would prefer backyard eggs while 17 % would prefer commercial ones. These consumption preferences are consistent with those documented in rural locations, where people generally prefer backyard eggs to commercial eggs<sup>(12)</sup>.

The goodness-of-fit indicators for the results were within acceptable ranges. The McFadden  $R^2$  was 0.187, acceptable for this model, close to the recommended value range for this type of research (0.20 to 0.40) and equivalent to an  $R^2$  of 0.70–0.90 for an ordinary least squares regression<sup>(16,21)</sup>. Restricted and unrestricted likelihood were used for the dependency test and produced a value of 28.41. This represents an acceptable  $\chi^2$  dependency test, and confirms the hypothesis that the model slopes are equal to zero ( $P \leq 0.05$ ). The most significant variables ( $P \leq 0.05$ ) were income level, fruit and vegetable consumption, and age. The least significant variable was number of family members (Table 1).

**Table 1:** Binomial logit model results

Variable	Label	Coefficient	SE <sup>1</sup>
Constant	Const	1.836551	3.0493
Premium	SPrec	-0.168070*	0.0909
Fruit and vegetable consumption	FVer	1.088604**	0.5008
Health awareness	CSal	0.969891*	0.5656
Age	Edd	0.369013**	0.0172
Family members	IntF	-0.148933	0.1468
Income	Ing	0.791453**	0.3498

$\chi^2 = 28.41933$ ; Restricted likelihood logarithm = -75.92961; Unrestricted likelihood logarithm = -61.7199; McFadden pseudo  $R^2 = 0.1871426$ . <sup>1</sup> SE = Standard error.  
 \*\*\* $P < 0.001$ ; \*\*  $P < 0.005$ ; \*  $P < 0.01$ .

Model prediction tests produced a value of 79.20 %, indicating the model to be adequate for quantifying backyard egg WTP. The following model was built using variables coefficients (Table 2):

**Table 2:** Variable marginal effects and elasticity

Variable	Marginal effect	Elasticity
Prec	-0.02993	-1.12987373
CSal	0.19998	0.21867067
FVer	0.22056	0.22050975
Edd	0.00657	0.39705464
IntF	-0.02652	-0.13837615
Ing	0.14094	0.34052117

$$DAP = 1.836 - 0.168Prec + 1.088FVer + 0.969CSal + 0.369Edd - 0.148 IntF + 0.791Ing.$$

The price (Prec) variable coefficient was negative, indicating that as the price of backyard eggs increases consumers will be less willing to pay the premium. In contrast, the variables related to good eating habits and interviewee health awareness exhibited a positive coefficient, reflecting consumer WTP for backyard eggs. This result is consistent with willingness-to-pay research on organic products, which shows that lifestyle variables tend to have a greater influence than socioeconomic variables<sup>(15,22,23)</sup>. The values consumers consider when making decisions about consumption include (in descending order of importance) health, nutrition, environmental friendliness and animal welfare<sup>(24)</sup>.

Also positive was the age (Edd) variable coefficient, indicating that older interviewees were more willing to pay for backyard eggs. This agrees with WTP research<sup>(14,25)</sup>, showing that consumer behavior is affected by age in purchases of differentiated products<sup>(14,15)</sup>. The

income (Ing) variable coefficient was positive, meaning higher interviewee income level was linked to a greater WTP for backyard eggs.

Since economic conditions tend to change constantly, the marginal effects and WTP elasticities were calculated for each explanatory variable in the econometric model (Table 2). Variable elasticities were linked to lifestyle (health awareness and fruit and vegetable consumption). This means that as the value of each of these variables increases by one percent, the rest of the variables being constant, WTP probability increases by 0.21 (health awareness) and 0.22 % (fruit and vegetable consumption). The relationship is inverse for the price variable, indicating that, when the price of backyard eggs rises by one percentage point, the WTP probability decreases by 1.12 %. The remaining variables are interpreted in the same way.

To calculate WTP, it was estimated for each interviewee, using to the formula<sup>(26)</sup>:

$$WTP = \frac{\alpha + \beta_2(CSal) + \beta_3(FVer) + \beta_4(Edd) + \beta_5(IntF) + \beta_6(Ing)}{\beta_1(SPrec)}$$

The resulting estimated WTP for one kilogram of backyard eggs in the surveyed communities was \$28.75 pesos, with a confidence interval of ( $\$27.5 \leq \mu \leq \$29.9$ ) MXP and 95 % reliability. This represents a 25 % premium on the price of one kilogram of commercial eggs (\$23 pesos), and 15 % premium on the actual price of backyard eggs (\$25 pesos) at the time of the survey. Analogous studies of WTP for differentiated products in Mexico have reported a 16 % premium for organic rabbit meat in Iztapalapa<sup>(27)</sup>, and for organic tortillas in Puebla<sup>(15)</sup>. Even higher premiums have been reported elsewhere: 30 % for organic apples in Santiago de Chile<sup>(28)</sup>; 53 % for lettuce in Texcoco, Mexico<sup>(29)</sup>; and 88 % for a variety of cabbage in Thailand<sup>(30)</sup>. Myriad factors affect a product's price premium, including the product studied, and consumer educational level and socioeconomic status, among many other factors.

Most of the respondents in the present study said they were willing to pay a higher price for backyard eggs versus commercial eggs; the variables affecting this WTP were health awareness, fruit and vegetable consumption, monthly income and age. Variables related to eating habits and health awareness were more influential than socioeconomic variables. These results suggest a possible market niche for backyard eggs focused on older consumers in higher income levels.

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