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Article

Market-Based Instruments for the Conservation of Underutilized Crops: In-Store Experimental Auction of Native Chili Products in Bolivia

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Abstract: Native chilies (*Capsicum spp.*) are currently underutilized in Bolivia, one of this crop's centers of diversity. Fewer local farmers cultivate native chilies annually due to low market demand. Increasing its private use value can lead to the *in-situ* conservation of this crop. The objective of the paper is to evaluate the market acceptability of three native chili products: (a) chili marmalade; (b) chili cooking paste; and (c) pickled chilies. Multi-product Becker-DeGroot-Marschak experimental auctions and hedonic tests were conducted with 337 participants in La Paz and Santa Cruz. Data were analyzed using seemingly unrelated regressions. Results suggest that consumers are willing to pay price premiums of about 25–50 percent. Biodiversity conservation and improvements in farmers' quality of life statements would not have influence on first purchase decisions but rather on repurchase decisions and therefore on consumers' product loyalty. This in turn could lead to sustainable agro-biodiversity conservation, centered on consumers' purchase of these products over time.

Keywords: experimental auction; willingness to pay; *in-situ* conservation; agro-biodiversity; underutilized crop; native crop; chili peppers; Bolivia

1. Introduction

Several native chilies are currently underutilized and many are at the risk of extinction in Bolivia [1], one of the countries, which is considered a center of biodiversity for this crop [2]. Underutilized crops

are defined as local and traditional crops widely grown in the past but today falling into disuse; whose distribution, cultivation and uses are poorly documented; and have received little attention from policy and decision makers [3,4]. By and large, agro-biodiversity loss is a problem of inadequate economic incentives for farmers [5]. Every year, fewer Bolivian farmers cultivate native chilies due to low internal demand for their native chili produce [1,6] and almost null exportation [7]. In general, the erosion of agro-diversity has two serious implications for agriculture: loss of resilience in the face of climate change and a reduction in ecosystem functionality [8]. Native crops are often well adapted to marginal and heterogeneous environments and resistant to local pests and diseases. Consequently, large-scale agro-biodiversity loss could translate into lower and unsustainable crop yields, and in turn, to local (or national-level) economic and social shocks over time [8].

In particular, supporting the *in-situ* conservation of native chili varieties can also help address current and future direct societal needs. *In situ* conservation is formally defined by FAO [9] as "the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties." Native chili varieties are rich in health-related compounds, such as vitamins and antioxidants [10] and capsaicin, a component used for medicinal applications [11,12]. The great variation in the genetic resources of native chilies has yet to be fully taken advantage of by society [13,14]. Nevertheless, farmers' conservation decisions are based on crop variety traits that are observable and also individually relevant. Farmers only conserve agro-diversity to the extent that it meets their private needs; when they are not directly rewarded for preserving agro-diversity (a public good) and thus contributing to the good of society, this diversity is under-produced. Consequently, there is a conservation gap: the difference between the level of agro-biodiversity that is actually maintained by farmers and the level that needs to be maintained in order to capture all its current and potential public benefits [5].

Market-based instruments (MBIs) are gaining importance in the promotion of *in-situ* conservation of underutilized crops worldwide [15]. The exact definition of MBIs is still an unsettled matter [16]. In the context of this research, MBIs relate to those mechanisms that rely on enhancing the monetary value of underutilized crops, which in turn could provide economic incentives to farmers who continue cultivation of these underutilized crops. MBIs, therefore, could help to re-align the mismatch between the private interests of farmers and those of society at large [17]. At the present, consumers seem to be more aware of the multiple benefits of biodiversity and show a greater appreciation for native crop varieties, especially if they feel that these crops are linked to their own roots and identity [18].

MBIs also offer a unique opportunity to link agro-biodiversity conservation objectives with poverty reduction objectives in emerging and developing countries. As such, agro-biodiversity conservation is not just a matter of ensuring the continuous maintenance of native crop varieties but also of sustaining and enhancing the incomes and livelihood strategies of the rural people with which crop genetic resources are associated. The challenge is to develop approaches that are workable compromises between what is advantageous for farmers and what will benefit biological diversity and society at the large [5]. Unfortunately the *in situ* conservation of native crops by rural families has not been given the recognition it deserves by governmental, research, and academic institutions [19]. More needs to be done to ensure that underutilized native crops are no longer ignored by both markets and researchers [8].

Promoting the cultivation of native crops, which must be consumed fresh, could be difficult. Producers without access to processing technologies would avoid growing native crops that need to be consumed (relatively) soon after harvesting. The *Instituto de Tecnología de Alimentos* (Food Technology Institute, ITA) in Bolivia developed three new products based on underutilized native chilies: (a) chili marmalade; (b) chili cooking paste; and (c) pickled chilies. In the second stage, ITA expects to transfer the processing technology to local industries, thus serving as an initial link between farmers and local manufacturing companies. Thus, the objective of this research is to evaluate the acceptability of the potential introduction of these products to the domestic market. As such, this study seeks to generate information on which types of native crop traits are appreciated most by consumers. This kind of information would support generation of sustainable sources of agro-biodiversity conservation funding by promoting to farmers the cultivation of native crop varieties corresponding to the preferences of consumers. This information would also facilitate the provision of differentiated products derived from these varieties to potential high-value markets.

2. Experimental Auctions and Hedonic Tests

Introducing new products into the market is expensive. Different new food products are introduced worldwide every year with very poor performance. The success rates are as low as 10 percent in developed countries like the U.S. [20]. Therefore, assessing households' acceptability of new products beforehand is critical. Over the last four decades, researchers have developed valuation methods to elicit how consumers value goods and services. These methods can be broadly categorized as revealed and stated preference methods [21]. Revealed preference methods use real choices to derive implicit values (e.g., experimental auctions). In contrast, stated preference methods use opinion surveys that ask a person to state his/her individual value for a good or service (e.g., contingent valuation or choice experiments).

As such, in food product valuation, experimental auctions are generally preferred to stated preference methods as the latter have been subject to criticism due to their hypothetical nature [21]. The principal advantage of experimental auctions versus other stated preference methods is that real products and money are used in the assessment. Thus, this methodology replicates more closely actual purchase decisions [22]. In an experimental auction, participants are requested to indicate the maximum amount of money they would spend on a product. Participants are able to purchase the product at selling price, provided the maximum amount of money they "bid" is higher or equal to the selling price. In this sense, experimental auctions are demand revealing. Participants maximize individual expected payoff during the auction procedure because an actual monetary transaction is involved [21]. It is in participants' best interest to reveal their maximum willingness to pay (WTP) for the product. Understating their WTP could result in the loss of the opportunity to buy a product they like; overstating WTP could result in paying more than they would have preferred [23]. In exchange for their time, participants are typically compensated monetarily from which their WTP is deducted if they "win" the auction [24].

The majority of experimental auctions to-date have taken place in laboratories, although recent experimental auction work has begun to move from laboratories to the field [21]. In this research, an in-store field setting was preferred to a laboratory setting. The former offers the following advantages [25,26]: (1) it allows targeting the population of interest more specifically by conducting the experiment where purchase decisions are actually made; (2) sample selection bias may be smaller than in laboratory settings

because respondents' participation is less inconvenient; (3) it facilitates larger sample sizes (small samples have long been a concern in economic experiments); and (4) decreases bias related to high compensatory fees for participation in the experiment. The Becker-DeGroot-Marschak (BDM) auction is the experimental methodology more suitable for in-store studies because subjects participate individually (the product is auctioned to a single participant); therefore the experiment is easier and faster to implement in real settings [27]. Other experimental auction mechanisms, such as the Vickery second-price auction, require multiple participants at the same time [21]. Hence, the BDM method is being increasingly used by researchers of consumer behavior to elicit consumers' valuation of food products for in-store studies [25,27,28].

Sensory characteristics of the products should not be overlooked because they carry large weight in food purchase decisions [23]. Before a product's introduction to the market, information on the influence of particular sensory attributes of this new product on households' WTP helps optimize the product in order to guarantee its commercial viability. In general, researchers of the behaviors of food consumers have been mainly interested in processes before the purchase, such as decision making that does not involve tasting the product. In contrast, researchers of sensory evaluation have studied the effect of taste and have mainly dealt with processes that occur after the first purchase [29], including repurchasing decisions. However, both the acceptability of products to and taste preferences of households can be elicited within an experimental design that includes experimental auctions and hedonic tests [30]. There are different types of hedonic tests currently in use by researchers to evaluate food products; however, most of them share the common strategy of asking consumers to evaluate the main characteristics of the products (e.g., flavor, color) on one or more rating scales, for example from 1 = dislike extremely to 9 = like extremely [31].

In coupled assessments using experimental auction methods, several studies have assessed and found a statistically significant association between sensory properties and the WTP for a product (e.g., [23,31,32]). Experimental auctions (whether or not coupled with sensory evaluations) have been applied in diverse situations in developed countries, but little experimental auction evidence is available from developing countries. Also experimental auction studies related with chilies are rare. One exception is Liaukonyte *et al.* [33], who studied the effect of advertisement on the consumption of fruit and vegetables, including chili peppers (but not native chilies), through experimental auctions. An example of an experimental auction and hedonic test conducted in a developing country is Demont *et al.* [34], who studied consumer valuation of different qualities of locally processed rice, including a post-cooking rice tasting in Benin. They found that the testing session had a non-significant effect on the WTPs. They argued that in the case of rice, taste is of low relevance. Consumers usually eat rice in combination with other foods, which mostly mask the overall taste of the rice. As such, this research expects to contribute to the scarce literature on consumer valuation of native crops through experimental auctions in developing countries.

3. Hypotheses and Methods

As indicated before, three chili products were developed by ITA in Bolivia: (a) chili marmalade; (b) chili cooking paste; and (c) pickled chilies. The decision of which types of products was mainly associated with the technological capabilities and knowhow of ITA. None of these products were

manufactured under a complicated food processing technology, and all were relatively easy to standardize. Both chili marmalade and chili cooking paste are novel products in Bolivian markets. Chili marmalade could be appealing to a young population interested in experimenting with new flavors and perhaps dislike high levels of sweetness. In general, capsaicin, a component present in native chilies, has a suppressive effect on sweet intensity [35]. In the case of chili cooking paste, it is expected this product will facilitate traditional Bolivian cooking in local households, who will not need to prepare such a paste before cooking. In contrast to chili marmalade and chili cooking paste, pickled chilies are currently available in the market but are mostly imported from neighboring countries, such as Argentina. Pickled chilies are a side condiment to main dishes. As such, pickled chilies allow consumers to spice their own food according to individual preferences. Therefore, the main hypotheses in this research are that young consumers who are not fond of sweet flavors, female consumers who cook often with native chilies, and households that currently consume large quantities of pickled chilies, will pay (high) price premiums for chili marmalade, chili paste, and pickled chilies, respectively. Also it is expected that consumers with high incomes; education; a fondness for the overall taste of the products (information to be obtained from the hedonic tests); and in support of biodiversity conservation, buying native products from Bolivia, and improvements in farmers' quality of life will pay high price premiums for these three products.

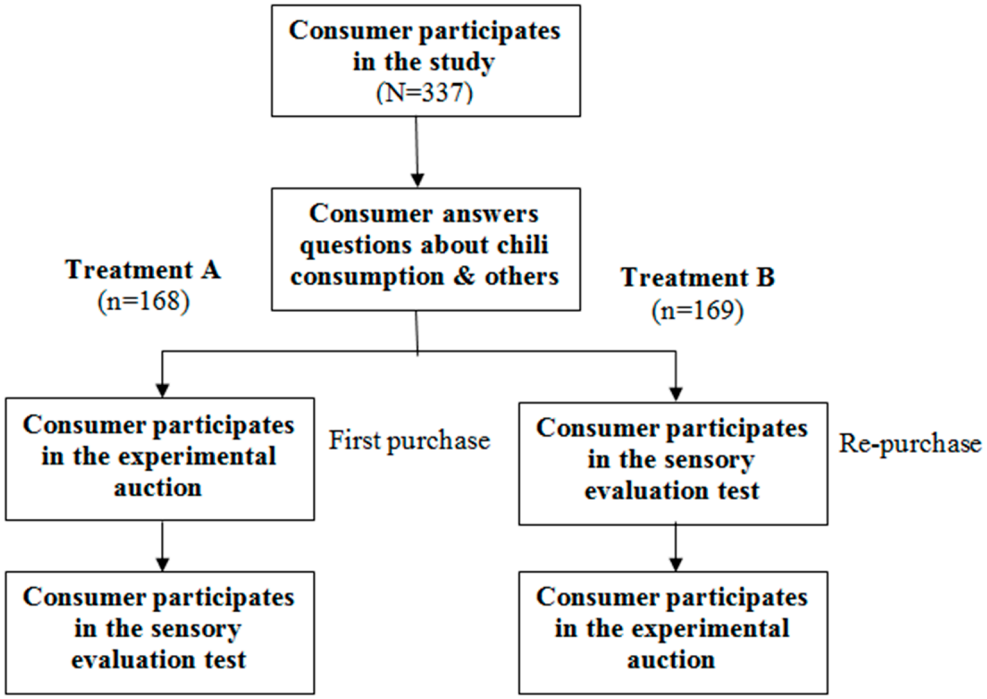
3.1. Products and Setting

The final presentation of these three products was uniform: a glass jar with a capacity of 300 grams with a metal cap and without labels. Different colors of the final products were manufactured based on the natural colors of the native chilies. Marmalade was offered in yellow, orange, red and brown; cooking paste in yellow, orange and red; and pickled chilies in yellow, orange, red, green and combined colors. Unsalted crackers were chosen as the uniform food matrix for the three products during the hedonic tests since they were easier to handle in a supermarket setting than other potential food matrices such as boiled potatoes or cooked white rice. A table was set up at the entrance of two supermarket stores located inside two malls in the major cities of Bolivia, La Paz and Santa Cruz, in 2012. Consumers were recruited and screened for eligibility from shoppers who passed by the table. Eligibility criteria were age (at least 18-years-old) and household food-related responsibility (serve as the primary person for either buying or preparing the household's food). The experimental auction and hedonic tests took place on workdays and weekends during the mornings, afternoons, and evenings in order to avoid time effects and achieve a diverse subject pool. Bids at experimental auctions can change with the day and time of conduction, which may reflect differences inherent to the participant samples (e.g., greater number of young participants on weekend evenings than on workdays), fatigue and hunger (e.g., in surveys conducted during lunch time), and others [36]. A compensation of 30Bs (approx. US$4.34) was offered to subjects as an incentive to participate. At first sight, this compensation may seem to be relatively low. However, the estimated average price for similar products (e.g., marmalade of other flavors, and pickled chilies from alternative brands) is about 15 Bs each in Bolivia. Therefore, overall the monetary compensation was reasonable. On average, 70 percent of those invited to participate completed the procedure. Following Lusk *et al.* [25], consumers participated one at a time without knowledge of the previous respondent's answers. Each session lasted approximately 45 min.

3.2. Research Procedure

The research procedure consisted of a written survey, hedonic test, and the WTP experimental auction. The written survey collected data on consumers' personal and household characteristics, (fresh, dried, and pickled) chili and marmalade consumption behavior, and ratings of the importance of biodiversity conservation, buying native products from Bolivia, and improvements in farmers' quality of life. The study was designed to integrate purchase decisions, consumption, and simulated repurchase decisions and therefore involved two treatments. In treatment A, the experimental auction took place before the hedonic test (first purchase situation, where consumers are not aware of the taste of the products), and in treatment B, the experimental auction took place after the hedonic test (similar to a repurchase situation, where consumers already know the taste of the products before deciding to buy again). A flow diagram of the research procedure is shown in Figure 1.

Figure 1. Flow diagram of the research procedure.



3.2.1. Experimental Auction Procedure

First the auctioneer explained the BDM mechanism, answered questions from the participants, and helped participants complete a training session with candies. The experimental auction procedure was practiced using candies with the participants to avoid potential misunderstandings during the actual experimental auction with native chilies, as recommended by Lusk and Shogren [21]. Then, the three products were auctioned simultaneously; participants were requested to indicate on a bid sheet that "The most I am willing to pay for…

Chili marmalade is _____Bs.

Chili paste is_____Bs.

Chili pickles is_____Bs."

The auctioneer clarified to participants that the average market price for each product was about 15 Bs and that it was in their best interest to bid exactly what they were willing to pay for each product. The main problem with using a reference price is that these prices can cause anchoring effects (*i.e.*, participants mostly offer bids which are close to the reference price). Nevertheless, Briesch *et al.* [37] have found that empirical models that consider reference prices perform better than models that do not. The authors concluded that the inclusion of reference price explains consumer choices better than a simpler model because consumers make comparisons among the prices of different products before purchasing. In order to avoid possible income effects in a multi-product BDM experimental auction (*i.e.*, wealth constraints for subsequent products after bidding for the first product), participants were explained beforehand that even though they are requested to provide a bid for each of the three products, they will be able to buy only one of them, which will be randomly selected at the end of the session [38]. After participants placed their bids and one of the products was randomly selected as valid, participants were requested to randomly draw a selling price (ranging from 5 Bs to 30 Bs). If the participant's bid for the valid product was greater than or equal to the selling price, the participant "won" the auction and purchased the valid product at the selling price. Conversely, if a participant's bid for the valid product was lower than the selling price, the participant was not allowed to purchase the product. At the end of the procedure, the "winners" received the valid product for the compensation fee minus the selling price. Otherwise, the participants received the whole amount of their compensation fee (30 Bs).

3.2.2. Hedonic Test Procedure

Following Hernandez and Lawless [39], samples of the three products were tasted at 1.5 min intervals during the sensory evaluation procedure. A glass of water was provided for palate-cleaning between samples. The time interval was established based on a compromise between the needs for a cost-efficient sensory method, desensitization, and carry-over effects. Repeat applications of capsaicin—the pungent component of chilies—desensitize the oral and nasal cavities to subsequent applications of capsaicin, which could influence the perceived overall taste of the products [40]. In particular, desensitization could lead to underestimation of the perceived heat intensity of those items that are presented later on in a sequence of chili products [39]. Karrer and Bartoshuk [40] found that capsaicin burn intensities rated in an ascending series were similar to capsaicin burn intensities rated as a single concentration given on separate days. Their results support an ascending series rating as a valid way for conducting sensory evaluations of products containing capsaicin. Consequently, the three products were ordered by degree of heat intensity (from low to high). Participants first tasted the chili marmalade, then the chili paste, and finally the pickled chilies. After testing each of the samples, participants rated particular sensory characteristics of each of the products (sweetness, consistency, acidity, degree of heat, and overall flavor) on a nine-point hedonic scale (1 = extremely dislike to 9 = extremely like).

3.3. Econometric Analysis

Tobit regressions are relevant when the dependent variable is a mixture of zeros and positive values [41]. This type of regression is commonly used to evaluate the determinants of WTP in experimental auctions. However, in this research, almost all the respondents indicated a positive WTP. Therefore, the percentage of zero values was less than five percent for marmalade and paste and seven

percent for pickled chilies (see Table 2). Under these circumstances, an ordinary least-squares regression (OLS) is expected to yield consistent parameters, and so there is no need to run Tobit regressions.

A seemingly unrelated regression (SUR) allows for estimating multiple OLS equations simultaneously by controlling for the correlation across the residuals in different regressions [42]. The SUR method estimates the parameters of all the equations simultaneously. The parameters of each individual equation consider the information provided by the other equations included in the system. This results in a greater efficiency of the parameter estimates due to the additional information provided in the calculation [43]. Therefore, in this research, SURs for the determinants of WTP for marmalade, paste and pickles were estimated.

Following Cameron and Trivedi [41], the SUR model comprises m linear regression equations for N individuals. The jth equation for individual i is $y_{ij} = X'_{ij}\beta_j + u_{ij}$. After stacking the m equations the SUR model has a compact representation:

$$Y = X\beta + u$$

The error terms are assumed to have zero mean, be independent across individuals, and homoscedastic. In this model for a given individual, the errors are correlated across equations, with $E(u_{ij}u_{ij}'|\boldsymbol{X}) = \sigma_{jj}'$ and $\sigma_{jj}' \neq 0$ when $j \neq j'$. In this research, $\boldsymbol{Y}$ represents the WTP for either marmalade, paste, or pickled chilies; the $\boldsymbol{X}$s include socio economic characteristics such as age, gender, education, family size, and income; quantities purchased of different products per week such as chili, marmalade, pickled chilies, and also frequency of chili consumption per week; rating results of the sensorial characteristics of the product such as flavor, degree of sweetness, hotness, fluidness and acidity; preferences for yellow, orange, red, brown, green, and combined colors; and personal preferences for biodiversity conservation and the consumers' assigned importance to native products from Bolivia; and the βs are the mean parameter estimates to be obtained from the models.

4. Results and Discussions

4.1. Descriptive Statistics

Descriptive statistics of the participants are shown in Table 1.

There were no significant differences between the mean values of the participants in the two treatments (A and B) in any of the characteristics included in Table 1 (results from Mann-Whitney tests at 0.05 significance level). Therefore one can assume that the differences observed in how the participants in the two groups respond to the treatments are due to the treatments alone and not to other differences between participants in the groups. The average age of participants was 45 years, with 15 years of education and an annual income per capita of US$6246. The participants were older, more educated, and had higher incomes than the average population in Bolivia. This was expected given that the supermarkets are located inside malls, which are frequented by high-income population. In addition, since all participants were screened to be the primary shoppers for households, most of the participants were female (76 percent). The participants consumed chilies more than twice per week and purchased about 0.75 kilograms of chilies, 1 kilogram of different types of marmalade, and 0.23 kilograms of pickled chilies per week. The participants considered that in average biodiversity conservation, buying

native products from Bolivia, and improvements in farmers' quality of life were important or very important issues (4.60, 4.59, and 4.45, respectively from 1 = not important at all to 5 = very important).

Table 1. Descriptive statistics of the participants.

Variable	Description	Treat. A (Exp. Auction before Hedonic Test)	Treat. B (Exp. Auction after Hedonic Test)	All Respondents	Population in Bolivia [(a)]
Socio-Economic Characteristics					
Age	Respondent age in years	44.61 (13.03)	44.56 (12.56)	44.58 (12.81)	23.1
Male	=1 if respondent is male; 0 otherwise	0.26	0.22	0.24	0.5
Education	Respondent number of years of education	15.24 (2.58)	15.62 (2.74)	15.43 (2.67)	8.6
Family size	Number of family members in the household	4.73 (1.94)	4.51 (1.92)	4.62 (1.93)	n.a.
Income	Annual income before taxes in US$	6351.9 (2782.04)	6142.01 (2880.86)	6246.29 (2838.17)	2374.0
Chili and Marmalade Consumption Behavior					
Chili consumption per week	Kg of chili bought per week	0.79 (0.71)	0.71 (0.50)	0.75 (0.62)	n.a.
Marmalade consumption per week	Kg of marmalade bought per week	1.00 (0.75)	1.06 (0.83)	1.03 (0.79)	n.a.
Pickled chilies consumption per week	Kg of pickled chilies bought per week	0.18 (0.34)	0.29 (0.44)	0.23 (0.39)	n.a.
Frequency of chili consumption per week	Number of days per week the respondent consumes chili	2.10 (1.64)	2.27 (1.74)	2.19 (1.7)	n.a.
Importance of Biodiversity Conservation and Native Product from Bolivia					
Biodiversity conservation	Importance of biodiversity conservation (from 1 = no important at all to 5 = very important)	4.58 (0.61)	4.62 (0.56)	4.60 (0.59)	n.a.
Native product	Importance of buying native products from Bolivia from 1 = no important at all to 5 = very important)	4.53 (0.81)	4.65 (0.69)	4.59 (0.76)	n.a.
Farmers' quality of life	Importance of farmers' quality of life (from 1 = no important at all to 5 = very important)	4.44 (0.68)	4.46 (0.66)	4.45 (0.67)	n.a.
Others					
La Paz	=1 if respondent lives in La Paz; 0 otherwise	0.55	0.55	0.55	-
Santa Cruz	=1 if respondent lives in Santa Cruz; 0 otherwise	0.45	0.45	0.45	-

Standard deviation in parentheses. [(a)] Source: Instituto Nacional de Estadística de Bolivia [44]. n.a. = not available.

The descriptive statistics of the WTP values from the experimental auctions are provided in Table 2.

Table 2. Descriptive statistics of WTP.

		Marmalade	**Paste**	**Pickles**
Treat. A (Exp. auction before hedonic test) (*n* = 168)	Mean (in Bs)	18.59	19.38	21.54 **
	Stand. deviation	6.95	6.65	9.10
	% 0 bids	3.57	1.79	6.55
Treat. B (Exp. auction after hedonic test) (*n* = 169)	Mean (in Bs)	19.04	18.35	23.33 **
	Stand. deviation	6.77	8.21	9.90
	% 0 bids	1.78	7.10	6.51
All (*n* = 337)	Mean (in Bs)	18.82	18.86	22.44
	Stand. deviation	6.88	7.50	9.57
	% 0 bids	2.67	4.45	6.53

** Differences between means significant at 0.05 (Mann-Whitney test).

Mean WTPs were about 18.8 Bs (corresponding to a 25 percent price premium), 18.9 (26 percent), and 22.4 (49 percent) for marmalade, paste and pickled chilies, respectively. There were no statistically significant differences between the mean WTP values for marmalade and cooking paste between the participants in Treatment A and B. However, in the case of pickled chilies, the mean WTP value after tasting the product (Treatment B) was statistically significantly higher than the mean WTP before tasting this product (Treatment A); it is possible that this occurred because pickled chilies can be very hot, and without trying the product first, participants might have been afraid of bidding too high and buying a product too hot for their personal taste.

The descriptive statistics of the results of the hedonic tests are provided in Table 3.

In almost all the sensory characteristics under evaluation, the three products were rated at the middle point (5) or slightly above, meaning that on average, the participants "neither liked nor disliked" or slightly liked the products. Exceptions were flavor and red color for all three products, and combined color for pickled chilies. Consumer "liked" these characteristics. On the contrary, the brown color for marmalade was slightly disliked.

Table 3. Descriptive statistics of hedonic tests.

Variable	Description	Marmalade			Paste			Pickles		
		Treat. A	**Treat. B**	**All**	**Treat. A**	**Treat. B**	**All**	**Treat. A**	**Treat. B**	**All**
Sweetness	From 1 = extremely unsweet to 9 = extremely sweet	5.11 (0.55)	5.18 (0.67)	5.14 (0.61)	-	-	-	-	-	-
Consistency	From 1 = extremely fluid to 9 = extremely thick	5.05 ** (0.30)	4.97 ** (0.35)	5.01 (0.33)	5.12 (0.46)	5.10 (0.42)	5.11 (0.44)	-	-	-
Acidity	From 1 = extremely low acid strength to 9 = extremely high acid strength	-	-	-	-	-	-	5.18 (0.60)	5.16 (0.56)	5.17 (0.58)
Heat	From 1 = extremely mild to 9 = extremely hot	5.13 (0.58)	5.10 (0.70)	5.11 (0.65)	4.96 (0.87)	4.87 (0.86)	4.91 (0.87)	5.33 (0.94)	5.43 (0.90)	5.38 (0.92)
Flavor	From 1=extremely dislike to 9 = extremely like	6.55 ** (0.79)	6.33 ** (0.66)	6.44 (0.74)	6.17 * (0.88)	6.02 * (0.70)	6.10 (0.80)	6.46 (0.98)	6.33 (0.70)	6.40 (0.85)
Yellow color	From 1 = extremely dislike to 9 = extremely like	5.23 (0.79)	5.22 (0.91)	5.22 (0.85)	5.59 (0.88)	5.68 (0.88)	5.63 (0.88)	5.60 (0.86)	5.45 (0.85)	5.52 (0.86)
Orange color	From 1 = extremely dislike to 9 = extremely like	5.66 (0.95)	5.66 (0.91)	5.66 (0.93)	5.51 (0.94)	5.38 (0.85)	5.44 (0.90)	5.94 (0.93)	5.90 (0.75)	5.92 (0.85)
Red color	From 1 = extremely dislike to 9 = extremely like	6.21 (1.15)	6.14 (0.99)	6.18 (1.07)	6.35 (1.16)	6.28 (0.86)	6.31 (1.02)	6.27 (1.11)	6.14 (0.96)	6.20 (1.04)
Brown color	From 1 = extremely dislike to 9 = extremely like	4.93 *** (0.94)	4.66 *** (0.98)	4.80 (0.97)	-	-	-	-	-	-
Green color	From 1 = extremely dislike to 9 = extremely like	-	-	-	-	-	-	5.56 (1.02)	5.55 (0.94)	5.55 (0.98)
Combined colors	From 1 = extremely dislike to 9 = extremely like	-	-	-	-	-	-	6.25 (1.15)	6.21 (1.09)	6.23 (1.12)

Standard deviations in parentheses. Means statistically significantly different at * 0.1, ** 0.05, *** 0.01 (Mann-Whitney tests).

Interestingly, the results of the hedonic tests were statistically significantly higher for consistency, flavor, and brown color in marmalade and for flavor of the paste for the group who answered the experimental auction before the hedonic test (Treatment A). Fulfilled expectations about the quality/characteristics of the products, which matched the monetary amount already paid for them, could have played a role in this outcome (e.g., having initial low expectations about the characteristics of a product could have made it seem slightly better and thus ranked higher during the subsequent hedonic test). The relatively low reference price could have lowered expectations about the characteristics of the products. Nevertheless, it seems that this effect was minor and did not actually translate to statistically significant differences in the mean WTPs for either marmalade or chili paste between Treatment A and B (see WTP results in Table 2).

4.2. Econometric Model Results

The results for the SURs evaluating the determinants for WTP for the three types of processed chilies for treatments A and B are shown in Table 4. For obvious reasons, the sensory characteristics were only included as explanatory variables in Treatment B (hedonic test followed by experimental auction), and not in Treatment A (experimental auction followed by hedonic test). Note that also a pooled regression (Treatment A + Treatment B) was not attempted because one would need to drop the hedonic test results from Treatment B in order to do so.

The results suggest that age significantly influences the WTP only for "first purchase" (Treatment A), while gender is significant when it comes to both first purchase and repurchase decisions (Treatment A and B). In general, young respondents and females are willing to pay more for these products than their counterparts. Young people are usually more adventurous about trying new foods [45], including native chilies [46]. This could have translated into high WTP for the participants in a first purchase situation but not in a simulated repurchase situation (after tasting the product, young consumers would be no longer "curious" about the product's taste). Processed food saves time mostly for females, who are usually in charge of preparing meals. Alternatively, education and income are significant factors but only for the first purchase decision (the higher the education and income, the higher the WTP). One of the reasons why education and income are not significant during a simulated repurchase situation could be related to the strong effect of taste. This latter variable is highly significant; as such, education and income become secondary and therefore no significant in the Treatment B's regression.

In general, the higher the consumption of chilies, marmalade, and the frequency of chili consumption, the higher the WTP for chili marmalade and chili cooking paste. In the case of pickled chilies, the higher the current consumption of pickled chilies and the frequency of chili consumption, the lower the WTP for this product in a simulated repurchase situation. In effect, households that consume more pickled chilies would be willing to pay less for this product. The reason for this is that pickled chilies, in contrast to chili marmalade and chili paste, already have perfect substitutes in the market (pickled chilies from other brands). The implication is that our product is not perceived to be different from similar products offered by competitive brands, and therefore there is no reason to pay a premium for it. Color does not influence the WTP for the products with the exception of pickled chilies. Consumers slightly disliked yellow pickled chilies. Also the lower the perceived acid strength of the pickled chilies, the more the consumers will pay for this particular product.

Table 4. Determinants of WTP for chili products.

	Experimental Auction before Hedonic Test (Treat. A)			Experimental Auction after Hedonic Test (Treat. B)		
	Marmalade	**Paste**	**Pickled Chilies**	**Marmalade**	**Paste**	**Pickled Chilies**
Age	0.0052 (0.0432)	−0.0658 * (0.0380)	−0.0827* (0.0516)	0.0239 (0.0438)	−0.0358 (0.0510)	0.0385 (0.0587)
Male	−3.7059 *** (1.3399)	−2.0215 * (1.1926)	−3.6529 ** (1.6228)	−0.6795 (1.4602)	−3.5700 ** (1.7085)	−1.4895 (1.9604)
Education	0.1398 (0.2327)	−0.0402 (0.2088)	0.4326 * (0.2854)	0.0102 (0.2316)	0.0315 (0.2588)	0.2490 (0.3037)
Family size	−0.3628 (0.2955)	−0.3167 (0.2631)	0.2521 (0.3606)	0.1310 (0.3011)	−0.2473 (0.3356)	0.1377 (0.3989)
Income (log)	1.2478 (1.1986)	1.7095 * (1.0759)	2.2414 * (1.4573)	−0.9737 (1.1468)	−1.1102 (1.2826)	−2.1602 (1.4985)
Chili consumption per week (log)	0.7185 (1.9478)	2.4292 (1.7477)	−0.1027 (2.3802)	0.5147 (2.1384)	0.6977 (2.4521)	6.0886 ** (2.9012)
Marmalade consumption per week (log)	2.1823 * (1.4572)			0.1190 (1.3211)		
Pickled chilies consumption per week (log)			3.9791 * (2.7180)			−4.0137 * (2.6242)
Frequency of chili consumption per week	0.6218 * (0.3670)	1.0208 *** (0.3279)	0.0998 (0.4446)	−0.0607 (0.3813)	0.1940 (0.4237	−0.8061 * (0.5041)
Flavor				2.3749 *** (0.6658)	3.2849 *** (0.6490)	3.1921 *** (0.8015)
Sweetness				0.5915 (0.8341)		
Heat				0.9117 (0.8436)	0.1749 (0.6445)	−0.7864 (0.7441)
Fluidness				−1.0791 (1.5626)	−1.3146 (1.2104)	
Acidity						−2.5993 ** (1.1277)
Yellow color				0.0234 (0.6027)	−0.2339 (0.6803)	−2.0738 ** (0.8771)
Orange color				0.0232 (0.6005)	0.5338 (0.6160	0.8784 (0.9253)
Red color				0.4140 (0.4257)	−0.0577 (0.4767)	0.2880 (0.7213)
Brown color				−0.1887 (0.4978)		
Green color						−0.3937 (0.7452)
Combined colors						0.7356 (0.7318)

Table 4. *Cont.*

	Experimental Auction before Hedonic Test (Treat. A)			Experimental Auction after Hedonic Test (Treat. B)		
	Marmalade	**Paste**	**Pickled Chilies**	**Marmalade**	**Paste**	**Pickled Chilies**
Biodiversity conservation	−0.3082 (1.0240)	0.0072 (0.9192)	−0.4658 (1.2456)	2.0459 * (1.0650)	0.3977 (1.2653)	1.2490 (1.4542)
Native product	−0.0600 (0.7305)	0.5865 (0.6533)	−0.6256 (0.8850)	−1.1271 (1.0018)	−0.0243 (1.1488)	−1.9395 (1.3725)
Quality of life of farmers	0.0971 (0.9606)	0.1503 (0.8623)	1.3804 (1.1698)	0.0928 (0.8236)	1.8103 * (0.9454)	0.2657 (1.1472)
La Paz	−1.9238 * (1.2331)	−0.7789 (1.1001)	−4.8746 *** (1.4941)	−1.4106 (1.2427)	−0.8607 (1.3398)	−3.0775 * (1.6738)
Constant	7.4750 (9.9738)	4.0797 (8.9230)	0.0737 (12.0928)	2.2147 (16.4242)	5.4987 (14.7890)	3.8924 ** (1.7567)
Number of observations	159	159	159	152	152	152
R-squared	0.0878	0.1444	0.1607	0.1162	0.2043	0.2391

Significant at * 0.1, ** 0.05, *** 0.01. Standard errors in parentheses. Breusch-Pagan test of independence: $chi^2(3) = 85.132$ (prob = 0.0000, set of equations in Treat. A are dependent) 111.937 (prob = 0.0000, set of equations in Treat. B are dependent).

The relative importance of biodiversity conservation and improvements in farmers' quality of life were only significant factors for the simulated repurchase situation. As such, including statements on the product labels about biodiversity conservation and improvements in farmers' quality of life statements on the labels of the products would not have an influence on first purchase decisions—only on re-purchase decisions. Repurchase decisions are associated with consumers' product loyalty [29]. Consequently, adding these statements to the product labels could be relevant due to the promotion of sustainable consumption of these products over time. Consumers showed slightly higher WTP for biodiversity conservation (Bs 2.0) than for improvements in farmers' quality of life (Bs 1.8). Garcia-Yi [47] conducted a choice experiment among native chili consumers in Peru, a neighboring country (which, along with Bolivia, is also one of the centers of origin for this crop). The author's results also suggested that consumers are willing to pay more for environmental-related attributes than for improvements in farmers' quality of life. This may imply that consumers are more aware of environmental attributes than social attributes in the Andean region. Buying native products from Bolivia was not a significant factor for a first purchase or a simulated repurchasing situation (Treatment A or B). In another research, Garcia-Yi [48] also found that middle- and high-income consumers in Peru did not show a significant WTP for chilies labeled as native. It seems that—as in the case of Peru—consumers in Bolivia are still not entirely aware that chilies are native to the country and consequently are not interested in purchasing products that highlight this attribute. Finally, consumers from La Paz showed lower WTP for the products than consumers from Santa Cruz. This is closely related to local eating habits. Households in La Paz tend to consume dried chilies, while households in Santa Cruz are more used to consuming fresh and processed chilies [49].

5. Summary and Conclusions

Bolivia is one of the centers of diversity of native chilies. Currently, native chili varieties are underutilized mainly because local farmers lack the economic incentives to continue cultivating them. MBIs, such as the introduction and commercialization of processed native chilies to the domestic market, could help to promote *in-situ* conservation of this crop. The results of experimental auctions and hedonic tests to assess the acceptability of three processed native chili products (chili marmalade, chili paste, and pickled chilies) suggest that: (1) young people would buy the products the first time but would probably not repurchase them; (2) marketing campaigns should target female consumers as it is this demographic group that is likely to purchase the products not only the first time but also on a repeat bases over time; (3) improvements in the taste of the products would translate into higher WTP, and it is worthwhile for public organizations and companies to continue investing in sensory evaluation and analysis (e.g., optimization in the appropriate combination of native chilies based on taste); (4) consumers do not have significant preferences in relation to color, which translate to changes in WTP. It means that almost any type of native chili could be used for manufacturing these products (with the exception of yellow chilies for pickled chilies for which consumers may underpay); and (5) using statements on product labels concerning biodiversity conservation and improvements in the farmers' quality of life statements would not have influence in first purchase decisions but rather in repurchase decisions, which in turn could have a positive effect on consumer product loyalty. This is particularly important, as new brands could appear in the market over time.

Overall, the results indicate a potential high-value market for products derived from underutilized crops in Bolivia. Nevertheless, in order to maximize economic benefits, new products should be developed according to the specific preferences of final consumers, as suggested above. The commercial use of underutilized crops, which depends on the market value of derived products, is becoming one of the major strategies for achieving sustainable agro-diversity conservation. Where commercial potential exists, supporting the development of diversified and niche local product markets will help protect and use underutilized crop varieties through public-private partnerships [5]. One limitation of this research is that it is a case study, and therefore the results may not be extrapolated beyond similar study areas. Also, more research is needed, as this study could only target consumers in high-income neighborhoods. Medium- and low-income populations could have different preferences regarding these products. In addition, sustainable markets for underutilized native crops need to be developed and strengthened not only at the local and national level but also at the international level while at the same time ensuring that benefits are shared fairly. Support in the development of effective local and international value chains for products derived from agro-biodiversity (through enhanced vertical and horizontal integration) is needed [8], but this kind of analysis is beyond the scope of this research. For moral reasons, it is essential to enhance the comparative advantages of native crops so that farmers can earn better incomes. The poor cannot afford to bear the opportunity costs of agro-biodiversity conservation on behalf of society [50]. Auspiciously, market-driven methods of agro-biodiversity conservation could be acceptable and beneficial to actors involved in the value chain as they are based on economic incentives and real opportunity costs.

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Conflicts of Interest

The author declares no conflict of interest.

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