



Using Choice Experiments to Estimate the Value of Differentiated Cow's Milk in Puerto Rico

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In Puerto Rico, we use a choice experiment method through in-person interviews to estimate consumer willingness to pay (WTP) for a half gallon of cow's milk that is produced locally, friendly to the environment and with ethics in animal management. The results from a random parameters logit model show that consumers are willing to pay a premium of up to 41% for differentiated milk, indicating a potential market for these products. We also find that consumer's income and education, and number of dependents affect WTP estimates. Implications for the development of differentiated milk products are discussed.

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INTRODUCTION

Sustainable production systems in the dairy industry are increasingly needed in the Caribbean due to vulnerability to environmental disturbances. For example, cyclone intensity and temperature are expected to increase in the region due to climate change (Biasutti et al., 2012). Also, greater water scarcity may be expected because of changes in precipitation (Campbell et al., 2011), and a shutdown of the electrical system, caused by hurricane damage, is likely. Thus, it is crucial to implement production systems that will strengthen the resilience of dairy production to environmental challenges, as dairy production is highly dependent on electric power. Production systems that are friendly to the environment, such as those incorporating solar energy and rainwater harvesting systems, can be beneficial to mitigate the adverse effects of environmental disturbances and promote both milk production and animal welfare. However, studies on WTP for cow's milk that is produced in an eco-friendly way and promotes animal welfare are needed to compare associated costs through cost-benefit analyses. The literature on this topic in the Caribbean is scarce, even though there is a growing movement toward conservation of the environment. This study seeks to estimate consumer willingness to pay (WTP) for cow's milk that is produced in Puerto Rico in an environmentally friendly way and promotes animal health and welfare.

Differentiated products fulfill the same basic function relative to conventional products, but have different attributes such as type, style, quality, reputation, appearance, and location (Álamo, 2012). Over the past decades, researchers have devoted considerable efforts to understanding consumer preferences and WTP for differentiated products, including those produced locally (Gil et al., 2000; Loureiro and Hine, 2002; Darby et al., 2008; Printezis and Grebitus, 2020), friendly to the environment (McCluskey and Loureiro, 2003; Jensen et al., 2004; Oh et al., 2015), organic (Loureiro and Hine, 2002; James et al., 2009; Janssen and Hamm, 2012; Narine et al., 2015; Katz et al., 2019), in compliance with fair trade (McCluskey and Loureiro, 2003; Didier and Lucie, 2008), with

traceability (Loureiro and Umberger, 2007; Abidoye et al., 2011; Zhang et al., 2012), of better quality (Hsu et al., 2009; Wann et al., 2018), supporting animal welfare (Bennett, 1996; Olynk et al., 2010; Clark et al., 2017), and free of genetically modified organisms (Loureiro and Hine, 2002). However, despite the contribution of prior studies on differentiated products in agriculture, more research needs to be conducted in the Caribbean to better understand consumer WTP for cow's milk that is produced in an eco-friendly manner and follows animal welfare standards that support sustainable dairy production.

Prior studies in agriculture have found that there are groups of consumers who are willing to pay a higher price for differentiated products. However, despite considerable research on this subject, most of the studies published have been conducted in Europe and the United States, limiting the development of agricultural policies regarding differentiated products in other regions. The fact is that regional tastes, preferences, and characteristics affect the WTP for differentiated products. In the Caribbean, to our knowledge, the literature on these products is limited. Narine et al. (2015) estimated consumer WTP for organic tomatoes in Trinidad. They found that consumers are willing to pay a 20% premium for organic tomatoes. Boys et al. (2014) examined consumer WTP for organic and locally grown produce on Dominica and found that consumers are willing to pay 17.5% more for organic, and 12% more for locally grown produce. Tavárez et al. (2020) estimated consumer WTP for multiple characteristics of a differentiated coffee in Puerto Rico. The authors found that consumers are willing to pay up to \$4.38, over the current price, for an 8-ounce package of coffee that is produced with a single differentiated characteristic.

U.S. per capita consumption of fluid milk products has declined because of competition from non-dairy plant-based beverages and a decline in the number of children in the population (Stewart et al., 2020; U.S. Department of Agriculture-ERS, 2020). Many consumers prefer non-dairy plant-based beverages based on their perceptions of animal mistreatment and environmental impacts of fluid milk production (McCarthy et al., 2017). Even so, the number of fluid-milk product choices in U.S. supermarkets has expanded considerably in the last decade. Health considerations have triggered increased demand for low-fat milk as well as for specialty products, such as organic and lactose-free milk (López and López, 2009). At the Caribbean level, the dairy industry is currently dominated by fresh milk production, with a range of artesian dairy by-products, including milk drinks and yogurt. However, local production of dairy products is often short of domestic demand for fresh milk and processed products (Campbell et al., 2015).

In Puerto Rico, the fluid milk market has two components: fresh milk and ultra-high temperature milk (UHT) (Lara, 2004; P.R. Department of Agriculture, 2012). There is currently a consumer trend toward low-fat and lactose-free milk, which is one reason sales of regular fresh fluid milk have been decreasing (P.R. Department of Agriculture, 2012). However, the decrease in consumption may also respond to changes in consumer tastes and preferences for non-dairy plant-based beverages.

This study uses a choice experiment method to estimate consumer WTP for cow's milk that is produced locally, friendly

to the environment, and with ethics in animal management. We use this approach because it is a convenient and widely used method to evaluate multiple attributes when performing an economic valuation of non-market goods and services (Alpizar et al., 2003; Hoyos, 2010), including differentiated products. Multiple econometric models are used to analyze choice experiments results.

The rest of the article is structured as follows. In section two we describe the study region. Section three describes the methodology, including the survey instrument, experimental design, and econometric specification. Section four discusses the results, and section five provides concluding remarks.

STUDY REGION

Puerto Rico is an island located in the Caribbean region with a total estimated population of 3.2 million (U.S. Census Bureau, 2018). Dairy production is the main agricultural commodity in Puerto Rico (P.R. Department of Agriculture, 2017). However, reductions in consumption have been reported. The Milk Industry Regulation Office in Puerto Rico reported that the industry has observed a decline in the number of operations from 329 in 2012 to 262 in 2018, matched by an increase in the number of cows per operation (P.R. Department of Agriculture, 2012, 2019). There are currently three private processing plants for fresh milk resulting in an oligopoly market structure. The Dairy Industry of Puerto Rico, Inc. (INDULAC) is a private corporation, governed by a Board of Directors, composed of seven representatives of the dairy ranchers and two private citizens (P.R. Department of Agriculture, 2012). INDULAC channels surplus milk into dairy products, such as cheese, butter, powdered milk, UHT milk, and others.

In Puerto Rico, the majority of farmers have adopted environmentally friendly production practices, such as nutrient management, planting and utilization of forages adapted to drought conditions, and land management aimed at reducing greenhouse gas emissions (Dr. Suzika Pagán, agricultural agent at the Agricultural Extension Service, personal communication). However, most farmers do not use rainwater harvesting, and they use non-renewable energy in their production systems, mainly due to economic challenges; and farm residual material can be slightly modified to better control water pollution. Additionally, although personnel of the University of Puerto Rico and the private sector are collaborating to improve and promote animal health in the future, further improvements in animal welfare are needed.

MATERIALS AND METHODS

Study and Questionnaire Design

We used inputs from the literature (McCluskey and Loureiro, 2003; Jensen et al., 2004; Darby et al., 2008; Elbakidze et al., 2014), experts and agricultural agents of the University of Puerto Rico in Mayagüez to identify the characteristics of differentiated cow's milk that may be of interest to consumers in Puerto Rico. This information was used to develop a questionnaire, which includes the choice experiment method.

TABLE 1 | Attributes, definitions, and levels used in the choice experiment.

Attributes	Definitions	Levels
Origin of product	Place where milk is produced. Imported milk is produced outside the island. Local milk is produced in Puerto Rico.	Local Imported
Environmentally friendly	A product is considered Environmentally friendly if the production system uses management practices that contribute to the protection of the environment, such as solar energy, water harvesting, and waste material management of the same farm to reduce sedimentation and water pollution. A product that does not meet these characteristics is considered Standard.	Environmentally friendly Standard
Ethics in animal management	Avoiding animal abuse and promoting proper animal care is necessary for Ethics in animal management. "No claim" indicates that the production system may mistreat animals or do not provide adequate treatment when they are sick.	With ethics in animal management No claim
Additional cost for a half gallon of milk	The additional cost you would pay for a half-gallon container of milk (64 ounces) with the set of characteristics in each option.	\$0 \$0.25 \$0.50 \$0.75 \$1.50

The questionnaire was validated by two focus groups that tested the vocabulary, length of the survey, acceptance of respondents to the subject, and comprehension of the valuation method. Then, the questionnaire was modified according to the information obtained in the focus groups and was distributed in-person by two interviewers who were trained in interviewing protocol including the potential for interviewer bias¹. The questionnaires were distributed in three supermarkets of the same company (anonymous) located in different regions of the island to account for preference heterogeneity. Although a fourth location was originally considered for the study, it was not possible to connect with the administrators.

The questionnaire includes the questions of the choice experiment, Likert-scale questions and questions designed to obtain sociodemographic information of the survey respondents. The Likert-scale questions are used to understand respondents' perceptions of the importance of differentiated products. The questions associated with sociodemographic information of the respondents are used to understand the profile of the participants and to better understand the answers in the choice experiment. At the end of the survey respondents were asked to express any concerns related to the study or survey instrument.

In the choice experiments, respondents received multiple choice sets composed of three alternatives (including the opt-out option) and were asked to choose the best option in each choice set, given the characteristics describing each alternative. The respondent may choose not to select any of the options if he/she does not agree to pay the price in the available options. **Table 1** shows the selected characteristics of a differentiated milk product and their respective definitions and levels. We limited the total number of characteristics to four and the number of alternatives to three to keep the choice experiment simple and to avoid biases in the estimates (DeShazo and Fermo, 2002; Hoyos, 2010). As for the price of milk, in focus groups we identified that the maximum WTP for characteristics of differentiated milk, in addition to the current price of a half-gallon (64 ounces), is \$0.75.

¹The survey design does not allow us to verify whether interviewer bias is present.

We decided to include a higher amount to take into account other prices that were not identified in focus group meetings. To reduce potential cognitive bias (Howard and Salked, 2009; Kragt and Bennett, 2012), prices were presented in both absolute and relative terms. The current price for a half gallon of fresh milk is \$3.06.

Figure 1 shows an example of a choice set used in the experiment. Before completing the choice sets, participants obtained information on the attributes under consideration that refer to the characteristics of differentiated cow's milk. Then, they received a practice choice set (not part of the experimental design itself) to familiarize themselves with the valuation method. This choice set was invariant across respondents and was not considered for the statistical analysis. To reduce hypothetical bias, an introductory paragraph (i.e., cheap-talk technique) was inserted to explain the problems associated with this type of methodology based on hypothetical markets (Cummings and Taylor, 1999; Lusk, 2003). In this introductory paragraph the respondent is asked to answer the survey as if he/she really had to incur the costs presented in each option (i.e., product).

According to the number of attributes and levels used in the choice experiment, the full factorial design of this study includes 32 possibilities. Because each choice set in the choice experiment is composed of two alternatives, in addition to the opt-out option, the complete factorial design would include too many possibilities to evaluate ($32 \times 32 = 1,024$). Evaluating this number of choice sets by a respondent is not recommended. Orthogonal fractional factorial designs are regularly used to reduce the cognitive effort of respondents. This design uses a subset of choice sets of the full factorial design without losing important information for the estimates (Louviere et al., 2000). To this end, we use Sawtooth Software. The software provides well-balanced and near-orthogonal fractions of the full design (Johnson et al., 2013). It does not formally estimate D-efficiency, but it assumes that designs that are level balanced and near orthogonal will properly lead to estimate model parameters. In this study, each participant receives six different choice sets from the subset of choice sets.

Characteristics	Option A	Option B	Option C
Origin of product	Imported	Local	
Environmentally friendly	Environmentally friendly	Standard	None: I would not buy any of these products
Ethics in animal management	Ethics in animal management	No claim	
Additional cost for a half gallon of milk	\$0.75 (Price will be: \$3.81)	\$0.25 (Price will be: \$3.31)	
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

FIGURE 1 | Example of a choice set used in this study^a. ^aModified from Spanish version.

The questionnaire also includes an additional choice set to evaluate respondent comprehension of the choice experiment exercise. In this choice set, alternative B contains the same differentiated attributes as alternative A, but at a lower price. The respondents who understand the valuation exercise should not select alternative A in this choice set. The purpose of including this choice set is to flag respondents who select the inferior choice. Perhaps, respondents selecting the inferior choice do not understand the valuation exercise or are not taking the study seriously and may be speeding through rather than answering thoughtfully.

Econometric Specification

In the choice experiments it is assumed that people obtain utility from the characteristics that describe a product and not by the product itself (Lancaster, 1966). Respondents analyze and compare the alternatives available in the choice experiment and select the one that provides the highest utility. One model most frequently used to analyze the data from choice experiments is the random parameter logit model, because its specification is flexible enough to understand respondents' preferences. The model formulation is based on the conditional logit model, in which the utility of individual *i* to select the alternative *j* in a choice situation *t* described by *k* observable attributes $X_{ijt} = \{X_{ijt}^1, \dots, X_{ijt}^k\}$ can be presented as McFadden, 1974:

$$U_{ijt} = ASC_j + \beta'X_{ijt} + \varepsilon_{ijt} \tag{1}$$

where ASC_j is an alternative specific constant, β are coefficients, and ε_{ijt} is the error term with an independent and identically distributed extreme value. The probability of selecting an alternative is given by:

$$\Pr(y_{it} = j) = \exp(ASC_j + \beta'X_{ijt}) / \sum_{q=1}^j \exp(ASC_q + X_{iqt}) \tag{2}$$

In the random parameter logit model, β varies among individuals with a specified density *f*. This specification represents a variation in population preferences. Contrary to the conditional logit

model, the probability that person *i* chooses a sequence of alternatives $j = (j_1 \dots j_T)$ is given by:

$$P_{ij} = \int \prod_{t=1}^T (\exp(\beta'X_{ijt}) / \sum_{j=1}^J \exp(\beta'X_{ijt})) f(\beta) d\beta \tag{3}$$

and cannot be obtained analytically. Instead, it has to be obtained by approximation using simulation methods (Train, 2003). In this study we use Halton draws with 500 repetitions to estimate the maximum simulated likelihood (Hole, 2007).

The conditional logit model assumes that the ratio of the probability of selecting any two alternatives is not affected by adding or removing an alternative (Louviere et al., 2000), an assumption that is often not met. This assumption is known as the Independence of Irrelevant Alternatives (IIA) and implies that the preferences of individuals are homogeneous; that is, the variances associated with the random term of the utility of each alternative are identical. We evaluated whether the conditional logit model estimates are independent of IIA using the test developed by Hausman and McFadden (1984) and find that the IIA assumption is not met when the opt-out alternative is removed². Therefore, more flexible models should be used, such as the random parameter logit model.

In this study, three models are estimated: a conditional logit model with main effects only, a random parameter logit model with main effects only, and a random parameter logit model that includes the characteristics of respondents as interaction effects with the ASC³. The conditional logit model provides an initial assessment to determine whether the selected attributes affect decision-making in the experiment. The random parameter logit model is used to account for preference heterogeneity across respondents and to obtain coefficients when the IIA assumption is relaxed (Train, 2003; Hoyos, 2010). Sociodemographic characteristics of respondents are included in the random parameters logit model to evaluate the effect

²The results of the Hausman and McFadden tests for the IIA property are available upon request.

³The ASC takes the value of 1 for differentiated milk alternatives and zero for the opt-out option.

TABLE 2 | Sociodemographic profile of the participants.

Sociodemographic characteristics	Definition	Average (SD) N = 134
Income	Net monthly household income (1, <\$ 500/month; 2, \$500–\$1,500/month; 3, \$1,501–\$3,000/month; 4, \$3,001–\$5,000/month; 5, \$5,001–\$7,000/month; 6, more than 7,000/month)	3.17 (1.24)
Education	Level of education (1, none; 5, master's or doctorate)	4.14 (0.74)
Age	Age of participant	41.5 (16.55)
Sex	1, male; 0, female	0.48 (0.50)
Environment	If the respondent works or studies in an institution focused on environmental protection (1, Yes; 0, No)	0.28 (0.45)
Milk consumption	Half-gallon containers purchased monthly	4.98 (4.68)
Size	Number of people in the household	2.64 (1.44)

SD, Standard Deviation.

of respondent characteristics on attitudes toward differentiated cow's milk attributes.

Characteristics of differentiated milk in the choice experiment are binary coded variables and the cost attribute is defined as a continuous variable in the estimated models. Additionally, in the random parameter logit model, all differentiated characteristics are defined as random parameters, while the cost attribute is a non-random parameter (Revelt and Train, 2000 provide multiple reasons for keeping the price coefficient fixed).

RESULTS AND DISCUSSION

A total of 143 consumers completed questionnaires between June and October 2018. However, nine respondents did not complete the full questionnaire, and their questionnaires were removed from the data. Only one respondent did not adequately understand the choice experiment exercise as he/she selected an inferior choice in the test choice set. Since each respondent received six choice sets composed of three alternatives, a total of 2,412 observations are used for the choice experiment analysis. Although we originally planned to distribute more questionnaires, lack of funds, and time restricted us. Puerto Rico was adversely affected by hurricanes Irma and Maria during the period of the investigation, which significantly delayed data collection and project timelines.

The sociodemographic characteristics of the sample surveyed are as follows (**Table 2**): the average income of the participants is between \$1,501 and \$3,000 per month; 48% of respondents are men; the average age is 41.5; 82% of respondents have a University degree or higher; 28% of respondents work or study in an institution focused on environmental protection; the size of the household or number of people per household is 2.64; and milk consumption is 4.98 in half-gallon containers purchased per month. With the exception of the level of education, the sociodemographic characteristics are in proportion to those of the general population of Puerto Rico (U.S. Census Bureau, 2012; P.R. Planning Board, 2017). The education level of the respondents in this study is higher than the education level of the population of Puerto Rico. In this sense, our sample may not be representative of the broader population. Nevertheless, it is

TABLE 3 | Consumer perceptions of characteristics of a differentiated product*.

Product characteristics	Mean (SD)	Min–Max	I don't know (N = 134)
Local product	1.45 (0.76)	1–5	0
Organic	2.00 (0.96)	1–5	2
Produced in an environmentally friendly system	1.41 (0.70)	1–5	0
Complying with fair trade	1.48 (0.74)	1–5	0
Free of child labor	1.38 (0.80)	1–5	1
Animal friendly	1.32 (0.90)	1–3	0
Free of rBST hormone	1.35 (0.84)	1–5	29
More detailed product information on package	1.43 (0.83)	1–5	0

*Likert-scale questions: 1, Very important; 5, Not important; SD, standard deviation.

unclear how our sample differs from the population of consumers visiting grocery stores.

We use Likert-scale type questions (1 = Very important, 5 = Not important) to assess the general perception of consumers for characteristics of a differentiated product. In this question, respondents can express if they are unaware of the importance of some characteristics of a differentiated product. The majority of respondents consider that the characteristics of a differentiated product are very important or important (**Table 3**). The three characteristics perceived as most important are that the product is produced in an animal-friendly system, free of the rBST hormone and free of child labor. However, a relatively high percentage of consumers indicate that they are unaware of the importance of milk not containing the rBST hormone.

Choice experiment data show that the conditional logit and random parameters logit models provide similar results (**Table 4**)⁴. In all models the signs of the coefficients associated

⁴We also estimate an additional model to examine whether sampling location influences choice experiment results. In this model, we generate binary variables corresponding to the different sampling locations, which are interacted with the ASC. The variables are insignificant, indicating that sampling location does not affect choice experiment results.

TABLE 4 | Results of conditional logit and random parameters logit models.

Variables	Conditional Logit model	Random parameter Logit model	Random parameter Logit model with SDC
VARIABLES (RANDOM PARAMETERS IN THE RPLM)			
Local	1.366 (0.131)***	1.493 (0.229)***	1.441 (0.211)***
Environment	1.185 (0.130)***	1.293 (0.209)***	1.256 (0.201)***
Animal	2.035 (0.142)***	2.218 (0.300)***	2.179 (0.287)***
ASC	-0.870 (0.184)***	-0.892 (0.234)***	-0.965 (0.250)***
STANDARD DEVIATION OF RANDOM PARAMETERS			
Local	-	-0.528 (0.617)	0.512 (0.702)
Environment	-	0.530 (0.559)**	0.599 (0.590)**
Animal	-	0.511 (0.700)**	0.297 (1.099)**
ASC	-	0.505 (0.886)	0.123 (0.823)
NON-RANDOM PARAMETERS			
Cost	-1.612 (0.158)***	-1.763 (0.279)***	-1.741 (0.264)***
Gender ^a	-	-	0.244 (0.205)
Dependents	-	-	0.236 (0.116)**
Income	-	-	-0.925 (0.516)*
Education	-	-	-0.420 (0.224)*
Observations	2,412	2,412	2,322
AIC	1,198.25	1,203.47	1,178.53

Standard Error in parentheses. RPLM, Random Parameter logit model; ASC, Alternative Specific Constant.

^aSociodemographic characteristics of respondents are interacted with the ASC.

*Significant at 0.10.

**Significant at 0.05.

***Significant at 0.01.

with the characteristics of differentiated cow's milk are positive and significant. This implies that those alternatives in the choice experiment that have characteristics of differentiated cow's milk are more likely to be selected. The sign of the cost coefficient is negative and significant, indicating that the probability of selecting an alternative decreases as the cost increases. This result is aligned with the microeconomic theory, which states that the quantity demanded for a product decreases as the cost increases.

The results of the standard deviation of the random coefficients in the random parameter logit models are significant, except for local milk. These results are indicative of unobservable heterogeneity among respondents for cow's milk that is produced in an environmentally friendly manner and promotes animal welfare. According to the Akaike Information Criteria (AIC), the random parameter logit model that includes the characteristics of respondents fits the data best in the choice experiment.

The ASC is a binary variable that takes the value of one if the respondent selects an alternative with differentiated cow's milk, and zero otherwise. The coefficient of this variable is significant and negative, which is a result commonly found in the choice experiment literature. The negative sign of the coefficient of the ASC indicates that the utility of respondents decreases when they move from the opt-out option (Option C). This outcome is often considered a type of bias in choice experiments (Adamowicz et al., 1998; Hoyos, 2010). To verify whether a bias exists, we explore the frequency of the opt-out option selection. The

opt-out option was selected 183 times out of a total of 798 choice sets, representing 23% of respondents' choices. This outcome is a bit high but still reasonable for choice experiments. Greater percentages of the opt-out selection in choice experiments can be found in the literature of differentiated products (Lusk and Schroeder, 2004) and public goods (Meyerhoff and Liebe, 2009; Rolfe and Bennett, 2009). A negative ASC may also indicate a preference for non-differentiated milk. The utility associated with the ASC could also be due to respondents' perception of the administrator's inability to implement a program aimed at developing differentiated products.

Sociodemographic characteristics of respondents are interacted with the ASC to analyze the effect of each characteristic on respondent choices. Sociodemographic characteristics that are found to affect choices in the literature of differentiated products are included in the random parameter logit model (Loureiro and Hine, 2002; Darby et al., 2008; Katz et al., 2019). The results suggest that the gender of respondents does not affect selection of differentiated characteristics in our study. However, we find that consumers with higher household income and higher education level are less likely to select differentiated milk alternatives. Households with greater income and education levels may be more likely to support other, maybe substitute, products like non-dairy plant-based beverages. However, lack of variability in the income and education data may contribute to these unexpected results. We also find that respondents with higher number of dependents are more likely to select differentiated milk alternatives. One hypothesis derived from our results may be that consumers with babies or infants are more likely to support differentiated cow's milk as they may perceive this milk is of a better quality. Unfortunately, our survey design does not allow us to test this hypothesis.

The WTP for the characteristics of differentiated cow's milk in this study is obtained by dividing the negative of the coefficient of interest by the cost coefficient (Hoyos, 2010). **Table 5** provides WTP values and corresponding confidence intervals for differentiated milk attributes. Although we relax the IIA assumption, the results do not differ in the random parameter logit model. Using the non-overlapping confidence intervals method (Park et al., 1991), we find differences in WTP estimates across differentiated attributes. Consumers are willing to pay significantly more for cow's milk produced following animal welfare standards than for milk produced in a system friendly to the environment.

Within the range of attributes evaluated in this study, consumers value most cow's milk that is produced following animal welfare standards. Surveyed respondents are willing to pay \$1.25 over the current price for a half gallon of milk produced in a system that promotes animal welfare. This result is lower than those reported by Wolf and Tonsor (2017) who found that consumers in U.S. are willing to pay about \$3.74/gallon (or \$1.87/half gallon), over the current price, for a combination of two animal welfare-related practices (treat or euthanize, and no hitting) that relate to the definition of animal welfare in this study. Income differences may explain this outcome since annual household income in Puerto Rico is lower than income in the United States (U.S. Census Bureau, 2018).

TABLE 5 | Willingness to pay (\$) for different characteristics of differentiated cow's milk^a.

	Conditional Logit model	Random parameter Logit model	Random parameter Logit model with SDC
Local	0.85 (0.65–1.05)	0.85 (0.64–1.05)	0.83 (0.63–1.03)
Environment	0.74 (0.55–0.92)	0.73 (0.55–0.92)	0.72 (0.54–0.91)
Animal	1.26 (1.01–1.53)	1.26 (1.01–1.52)	1.25 (1.00–1.50)

Confidence intervals (in parentheses) are estimated using the Krinsky and Robb (1986, 1990) procedure.

^aIn addition to the current price of a half-gallon of fresh milk.

Consumers are willing to pay \$0.83 over the current price for a half gallon of locally produced milk. This result is slightly lower than that reported by Forbes-Brown et al. (2016), who found that consumers are willing to pay about \$1.00, in addition to the current price, for a 2-L (i.e., half-gallon) container of milk produced locally in other regions like Canada. We expect a relatively high WTP for locally produced milk due to the existing propaganda and information provided to island residents (Tavárez et al., 2020). For example, the Puerto Rico Products Association promotes locally made products under the label “Made in Puerto Rico” (translated from Spanish) that identifies many local products. Also, personnel from the College of Agricultural Sciences of the University of Puerto Rico work actively in most island municipalities to emphasize, among other things, the importance of supporting locally made products. These efforts have likely contributed to overall awareness of the significance of buying locally and its effect on local economies.

Surveyed respondents are willing to pay \$0.72 over the current price for a half gallon of milk produced in an environmentally friendly manner. Yet, consumers place less value on eco-friendly cow's milk than that of local origin or with animal welfare practices. Similar results can be found in Feucht and Zander (2017) who, overall, found that consumers are willing to pay more for locally sourced and organic milk than for milk produced in an environmentally friendly way. Sustainable agricultural practices are crucial to all regions, but particularly to a small island like Puerto Rico where space and natural resources are limited. Yet, the results of this study show that consumers are more willing to support production attributes other than eco-friendliness.

The WTP of consumers for differentiated milk represents a belief in and preference for the characteristics under consideration that do not carry a direct benefit, only indirect. For example, the taste of milk is not likely to vary significantly by its production in an ecofriendly manner or by following animal welfare standards. Thus, we expect a lower WTP relative to milk with a different taste. Pérez-Torres (2020) used a contingent valuation method to examine consumers' WTP for high-quality fresh milk, which was expected to improve its taste and smell. The author found that consumers are willing to pay \$1.88 (CI: \$1.60–\$2.20) for a half-gallon (64 oz) of high-quality fresh

milk, in addition to current price, which is significantly greater than the WTP for differentiated milk attributes found in this study. The disparities in WTP may be due to differences in the valuation methods employed. However, the disparity may indicate that homogeneous products (with no notable variations in the product itself) may be less valued than heterogenous ones (with variations in taste and smell).

The results of the choice experiment coincide with the data obtained from the Likert-scale questions indicating that consumers perceive those products produced promoting animal welfare as more important than the other attributes. However, the results of the Likert-Scale questions suggest that products produced in environmentally friendly systems are perceived as more important than locally produced products, which differs from the results of the choice experiment in which participants are willing to pay a higher price for local products. Although these results are inconsistent, past studies in the choice experiment literature have documented differences between the stated importance and WTP by attributes in choice experiments (Decker and Watson, 2017; Tavárez et al., 2020).

Over the past years, dairy consumption has decreased in some countries, while the consumption of non-dairy plant-based beverages has increased (U.S. Department of Agriculture-ERS, 2014; Stewart et al., 2020). Health concerns, and increased awareness and interest in protecting animals and reducing environmental impact have probably contributed to the growth of nondairy plant-based beverage consumption (see McCarthy et al., 2017). Although pesticides used for producing nondairy beverages, such as soy and almond “milk,” contribute to the degradation of the land, the production of cow's milk is often perceived to have a higher impact on the environment due to deforestation trends, greenhouse gas emissions, and soil compaction. In this regard, adopting new marketing strategies promoting products that are friendly to the environment and animals to meet consumer demand is beneficial to both dairy producers and consumers. The results from this study show that consumers are willing to pay a premium price for differentiated milk, indicating a potential market for these products.

Maintaining a system to avoid animal mistreatment and investing in production systems friendly to the environment promote sustainable production, but they could be expensive. Although the results of this study indicate that consumers are willing to pay an additional amount for milk produced promoting animal welfare and the environment, this amount may be too small to compensate ranchers for changing their production systems, particularly to one friendly to the environment. Ranchers must incur in additional expenditures, such as installation, maintenance and labor costs, and income generated from the new production strategy needs to compensate costs to be economically viable. Since these new alternatives provide social benefits that cannot be measured directly, the government may consider programs that incentivize their commercialization if costs are greater than associated benefits.

The results of this study can be used in cost-benefit analyses to determine whether implementing new production systems is feasible. However, we acknowledge that further studies are needed to explore the potential income generation of

commercializing differentiated cow's milk as estimating demand size is not the main purpose of this study. We also acknowledge that the sample size in this study might be too small to represent the general population. Thus, this study may be used as an initial assessment of this topic in the region.

CONCLUSIONS

Due to the vulnerability of agriculture around the globe, it is important to evaluate new marketing strategies that contribute to economic development and farmers' livelihood, and also meet consumer demand. Differentiated products can contribute to these purposes. Differentiated products differ from other similar products in the market when they fulfill the same basic function, but they have different attributes such as quality, reputation, location, etc. Previous literature around the world has shown that there are groups of consumers willing to pay a premium for differentiated products. In this study we use the choice experiment method to estimate consumer WTP for characteristics of a differentiated cow's milk. The results indicate that consumers are willing to pay between \$0.72 and \$1.25, in addition to the current price of a half-gallon container, for differentiated cow's milk, depending on the characteristic under consideration. In addition, in marginal terms, we find that consumers are willing to pay almost double for milk produced with ethics in animal handling, compared with milk produced in an environmentally friendly manner.

The results show that there is a potential market for differentiated dairy products in Puerto Rico. Additional studies are necessary to determine the economic viability of producing and processing differentiated cow's milk in Puerto Rico. To provide recommendations to stakeholders and policymakers, it is necessary to know the cost of adopting new production systems.

To fulfill market potential, developing a cooperative alliance between milk producers and the processing plant sector is recommended. The fresh milk processing sector in Puerto Rico,

and in many other countries, has an oligopoly market structure, thus an alliance between producers and the processing plants is necessary for market access. Another potential alternative to access the market would be for ranchers of differentiated cow's milk to form a cooperative to establish small-scale processing plants.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article is available upon request.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board University of Puerto Rico at Mayagüez. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

HT organized the database, performed the statistical analysis, and wrote the first draft of the manuscript. CÁ wrote sections of the manuscript. HT and CÁ contributed to the design of the survey instrument, contributed to manuscript revision, read, and approved the submitted version.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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