Consumer Preference for Novel Local Food: A Case Study on Cold-hardy Table Grape Cultivars

Manlin Cui[1], Chengyan Yue[2], Erin L. Treiber[3], and Matthew Clark[4]

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Abstract. **This study investigates consumer preferences and willingness to pay (WTP) for novel local food, specifically focusing on cold-hardy table grape cultivars. We conducted the second-price auction with 99 Minnesota participants to compare their preferences and WTP for five newly developed cold-hardy table grapes and three existing warm-climate table grapes. Comparing participants' bids for novel cold-hardy table grapes to existing warm-climate table grapes, we construct three segment groups: "like all new grapes," "mixed," and "dislike all new grapes." The majority of participants (81%) belong to "like all new grapes" and "mixed" groups, indicating a potential market opportunity for the novel local cold-hardy grape cultivars. We also conduct WTP estimates for each table grape cultivar. In addition, by examining the differences in attribute ratings, sociodemographics, table grape purchasing behaviors, and attitudes toward novel foods among three groups, we provide valuable insights into factors that influence consumer WTP for these novel local cold-hardy table grapes and discuss corresponding strategies for promoting and expanding the market.**

Grapes have a long-standing history as a significant economic commodity, making substantial contributions to the overall economy. In 2021, the United States produced a total of 6.05 million tons of grapes for commercial purposes, with a total value of $5.53 billion. California, renowned for its favorable climate, has long been recognized as the leading grape-growing state, accounting for 5.75 million tons of the total grape yield (National Agricultural Statistics Service 2022). Although grapes have the potential to grow in various climate zones across the United States, the cultivation of specific grape varieties for wine, eating, or juice production is limited to specific geographic regions (Agricultural Marketing Resource Center 2023). Grapevines thrive in climates with long, warm summers and rainy winters. The presence of warm weather during the growing season is essential for grapevines to undergo flowering, fruit set, and ripening processes successfully. Most of the successful table grape varieties, such as Thompson seedless, Flame, and Red globe, are primarily cultivated in warm climate regions.

Although the thriving grape production highlights the economic significance and agricultural prowess of the US grape industry, it also raises concerns regarding the cost, carbon footprints and environmental impacts resulted from long-distance transportation. In response to these challenges, local production is increasingly favored by consumers, presenting a potential solution. The demand and preference for locally grown food among consumers has risen for decades, driven by the increasing popularity of the "locavore" movement. This growing trend has triggered extensive empirical research on consumer behavior and preferences regarding the "local" attribute of food, as demonstrated in a meta-analysis conducted by Printezis et al. (2019). The findings of these studies consistently indicated that consumers were generally willing to pay a premium for local food. Feldmann and Hamm (2015) conducted a review from the consumers' perspective and found that although local food was not perceived to be as expensive as organic, consumers were willing to pay a premium for it. This finding aligns with the finding of Yue and Tong (2009), who found that consumers exhibited a similar willingness to pay (WTP) for "organic" and "local" attributes for fresh produce. Several studies suggested that consumers placed a greater value on local production compared with organic production for fresh produce (Costanigro et al. 2011; Hu et al. 2009). Moreover, Onozaka and McFadden (2011) reported that consumers placed a higher value on local claims compared with other value-added claims. In addition, Costanigro et al. (2014) revealed that local and organic were partial substitutes, and they both offered an alternative to the conventional food system.

Preliminary data from the Minnesota Grape Breeding Program and additional table grape programs in other states suggest that there is an enthusiastic market for locally grown table grapes (Clark et al. 2019; Tuck and Gartner 2013). Moreover, with advancements in breeding programs, there is an increasing focus on developing new cold-hardy table grape cultivars that can expand the range of suitable growing regions (Cornell University, 2018). In recent years, the Minnesota table grape breeding team has made significant advancements in breeding new cold-hardy table grapes and developed potential table grape cultivars that are an improvement over earlier varieties with desirable quality and cold-storage attributes (Treiber et al. 2022). New table grape varieties for cold climate will provide locally produced, healthy food for consumers while also creating opportunities for farmers and strengthening rural economies.

Although we have anecdotal evidence that consumers are willing to pay higher prices for locally grown table grapes (i.e., Somerset Seedless, a locally grown cold-hardy table grape, was priced at $3 per pound, which was significantly higher than the average price of $0.82 per pound for wine grapes reported during the same year; Clark et al. 2019), we will need a better understanding of how much they are

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[1]PhD Candidate, Department of Applied Economics, University of Minnesota, St. Paul, MN 55108, USA

[2]Professor, Department of Applied Economics and Department of Horticultural Science, University of Minnesota, St. Paul, MN 55108, USA

[3]Postdoctoral Research Associate, Department of Horticultural Science, University of Minnesota, St. Paul, MN 55108, USA

[4]Associate Professor, Department of Horticultural Science, University of Minnesota, St. Paul, MN 55108, USA

The cold-hardy table grape cultivars used in this study have not yet been publicly released or officially registered. Therefore, cultivar names are not currently available.

C.Y. is the corresponding author. E-mail: yuechy@umn.edu.

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willing to pay for various local grape varieties. Given the climatic conditions of Minnesota (USDA cold hardiness Zone 4a to 5a), cold-hardy table grapes exhibit distinct characteristics compared with traditional warm-climate table grapes due to the hybrid nature relying on other *Vitis* species beyond *V. vinifera* (Clark et al. 2019; Treiber et al. 2022). This is true of the cold-hardy wine grapes developed at the University of Minnesota such as Frontenac, La Crescent, Marquette, and Itasca, which are dominant varieties with multiple species in their backgrounds contributing to cold hardiness as well as disease resistance and fruit quality traits. Notable differences include unique flavor and aroma compounds found in *V. labrusca* such as methyl anthranilate, a smaller berry size, and the round shape, are typically observed in cold-hardy species like *V. riparia*. These adaptations enable the grapes to withstand colder temperatures and thrive in cooler climates, ensuring their successful cultivation in regions where traditional varieties may struggle. However, there is limited information available regarding consumer preferences for these novel cold-hardy table grapes. Conducting a comprehensive analysis to determine consumer WTP for locally grown table grapes will provide valuable insights into potential earnings and market performance. WTP research is particularly crucial for new products or novel product attributes that lack historical information (Lusk and Hudson 2004). It helps explore consumer product adoption, pricing decisions, and market feasibility. The findings from this analysis can be used to set prices, guide growers in cultivar selection, and ensure new products' alignment with consumer preferences.

In this article, we aim to determine consumer WTP for new table grape cultivars through an experimental auction that incentivizes participants to truthfully reveal their preference and WTP. Specifically, we run second-price auctions on both the existing warm-climate and novel cold-hardy table grape cultivars and compared consumer preferences for them. In our analysis, participants were segmented into groups based on their bids. We calculated the WTP for each table grape cultivar and further explored differences in attribute ratings, sociodemographics, table grape purchasing behavior, and attitudes toward novel foods among these segmented groups using analysis of variance (ANOVA) analyses and Student *t* tests. To our knowledge, no studies have investigated these aspects for a local cold-hardy table grape market in the midwestern United States. The outcomes of this research will provide valuable insights into optimizing profitability for table grape production by advising farmers on selecting grape varieties that align with market demand.

Methods

Products. The Minnesota Grape Breeding Program has developed advanced cold-hardy table grape selections (i.e., cultivars) that have improvements over earlier cultivars (Clark et al. 2019; Treiber et al. 2022). Notable cultivars include four novel, cold-hardy table grape cultivars, MN 1325, MN 1296, MN 1369, and MN 1376, and one currently market-available novel cold-hardy table grape cultivar, Somerset Seedless, developed by Elmer Swenson (Table 1). To elicit consumer preference and WTP for these novel cold-hardy table grapes and compare them to existing warm-climate table grape cultivars, we included a total of eight table grape cultivars in our study, including aforementioned five cultivars and three existing warm-climate cultivars purchased in the marketplace.

MN 1325 is a black grape cultivar with a trace of seeds. It has an average cluster length of 14.36 cm and a relatively higher average cluster weight of 158.72 g (~0.35 lb). The compactness measurement of 0.77 indicates a medium compact cluster structure. The average berry weight for MN 1325 is 1.44 g, and the average berry size is 13.47 mm in diameter. In terms of quality, MN 1325 shows an average soluble solids content (SSC; an indicator of sugar content) value of 23.83 °Brix, and its average total acidity (TA) stands at 11.35 g/L. The ratio of SSC and TA, also known as maturity index, suggests a moderately sweet flavor.

MN 1296 is a light red grape variety with a trace of seeds. It has an average cluster length of 15.82 cm and an average cluster weight of 88.8 g (~0.20 lb). Compared with MN 1325, MN 1296 is identified as less compact with a compactness measurement of 0.35. The average berry weight of MN 1296 is 1.65 g, and average berry size is 13.34 mm in diameter. In addition, MN 1296 has an average SSC value of 22.07 °Brix along with a moderate average TA level of 3.37 g/L, resulting in a sweet flavor.

MN 1369 is a green-yellow, seedless grape variety that shares a similar average cluster length of 13.88 cm with MN 1296. It displays an average cluster weight of 124.38 g (~0.27 lb) and a compactness value of 0.63, indicating a medium compact cluster. The average berry weight for MN 1369 is 2.02 g, and it has a slightly larger average berry size of 13.88 mm. In addition, MN 1369 shows an average SSC value of 21.47 °Brix, along with an average TA level of 5.75 g/L, suggesting a balanced sweetness flavor.

MN 1376 is a green-yellow, seeded grape variety with an average cluster length of 15.92 cm and an average cluster weight of 177.77 g (0.39 lb). It has a medium compact cluster with a compactness value of 0.7. The average berry weight is 1.52 g, and the average berry size is 13.11 mm. It has an average SSC value of 18.13 °Brix and an average TA level of 6.51 g/L, indicating a balanced sweetness flavor.

Somerset Seedless is a light-red, seedless grape variety with an average cluster length of 13.52 cm and an average cluster weight of 122.25 g (0.27 lb). It has a medium compact cluster with a compactness value of 0.67. The average berry weight is 1.46 g, and the average berry size is 13.11 mm. It has an average SSC value of 18.97 °Brix and an average TA level of 5.47 g/L, suggesting a balanced sweetness flavor.

The three warm-climate table grape cultivars purchased in-store were in red, green, and black colors, hereafter be referred to as store red, store green, and store black, respectively. They are all seedless grape varieties with an average cluster length ranging from 19.02 to 25.06 cm. The store red and store green grapes are considered medium compact clusters, whereas the store black grape is a compact cluster. The average berry weights of these grapes are larger than previous cold-hardy table grapes, exceeding 7 g, and they have a large average berry size of more than 20 mm. Their average SSC values range from

Table 1. Illustration of novel cold-hardy table grape cultivars developed by the Minnesota Grape Breeding Program.

Photo					
Name	MN 1325	MN 1296	MN 1369	MN 1376	Somerset Seedless
Color	Black	Light red	Green-yellow	Green-yellow	Light red
Seed	Seed trace	Seed trace	Seedless	Seeded	Seedless
Average cluster length (cm)	14.36	15.82	13.88	15.92	13.52
Average cluster weight (g)	158.72	88.8	124.38	177.77	122.25
Average compactness	0.77	0.35	0.63	0.7	0.67
Average berry weight (g)	1.44	1.65	2.02	1.52	1.46
Average berry size (mm)	13.47	13.34	13.88	13.11	13.11
Average soluble solids content (°Brix)	23.83	22.07	21.47	18.13	18.97
Average total acidity (g/L)	11.35	3.37	5.75	6.51	5.47

18.80 to 21.37 °Brix, and their average TA levels range from 2.54 to 3.58 g/L, suggesting a sweet flavor.

Experiment setup and procedure. We conducted an experimental auction to investigate consumer preferences and WTP for eight table grape cultivars in Minnesota in Sep 2022. We recruited 101 participants through various social media outlets. Participants had to be at least 18 years old and produce purchasers to be eligible for the experiment. All participants were compensated $40 for an hour-long session, while auction winners received the 16-ounces table grapes they won and a payment of $40 minus the market price (which was determined in the experimental auction) of the table grapes. We held eight sessions over 2 d, with an average of 15 participants per session. We dropped two participants whose bids were outliers. Thus, the final sample consists of 99 participants and 792 bids on eight samples. We have obtained institutional review board approval for our study.

We conducted a Vickrey second-price auction (hereinafter referred to as second-price auction) in which all bids are sealed and the highest bidder wins the auction but pays the second-highest bid (Lusk and Shogren 2004; Vickrey 1961). Since the second-price auction sets the market price to be independent from what the individual bids, people have the incentive to reveal their preference and WTP truthfully (overcoming the hypothetical bias). During the hour-long session, we began by introducing participants to the second-price auction with concrete examples and practice questions. Additionally, we administered a quiz to test participants' knowledge and ensure their comprehension of the auction procedures. Each participant received eight coded plastic containers containing two berries from each table grape cultivar for them to taste before bidding. At the same time, eight coded packages of 16-oz samples were displayed on a large table so that participants could walk around and examine a commercial packaging display while tasting and bidding. To avoid order effect, we prepared two versions of questionnaires that randomized the order of the eight table grape cultivars and participants could also start their evaluation from any sample.

Participants were asked to write down their bids for each of the 16 oz of table grapes. In each session, after all participants submitted their bids, the moderator sorted the bids and determined the market price and winner for each sample. The winner purchased the sample they won at the market price. In the meantime, participants were asked to rate a comprehensive set of table grape attributes on a 7-point Likert scale for each sample, ranging from "dislike very much" to "like very much" with a midpoint of 4 indicating neither like nor dislike. Following the bidding procedure, participants were asked to complete a survey regarding their attitudes toward new, different, or innovative foods, also using a 7-point Likert scale ranging from "strongly disagree" to "strongly agree," with four being neither agree nor disagree with the statements. Additionally, we collected information about

participants' table grape purchasing behaviors, such as the frequency of consuming table grapes and their preferred purchase locations, and sociodemographic information.

Methods. To compare consumer preference for these novel cold-hardy table grape cultivars to existing warm-climate table grape cultivars, we calculated the average bids of three existing warm-climate table grape cultivars for each participant and compared it to participant's bids for the five novel cold-hardy table grape cultivars. We then segmented the participants into three groups. Specifically, participants whose bids for all five novel cold-hardy table grape cultivars exceeded the average bid of three existing warm-climate table grapes were classified as the "like all new grapes" group; participants whose bids for all five novel cold-hardy table grape cultivars fell below the average bid of three existing warm-climate table grape cultivars were categorized as the "dislike all new grapes" group; participants who expressed a preference for both novel cold-hardy table grape cultivars and the existing warm-climate table grape cultivars were grouped separately as the "mixed" group.

To estimate WTP for sample table grape cultivars, we employed a linear model controlling for individual fixed effects as follows:

$$B_{ij} = \beta_0 + \beta_1 S_j + O_{ij} + \eta_i + \varepsilon_{ij},$$

where B_{ij} is the dependent variable representing the bids (US$) for a 16-oz table grape cultivar coded j for practitioner i, S_j is a vector of table grape cultivar dummies; O_{ij} represents the experiment order indicator; η_i is the individual fixed effect; and ε_{ij} is an error term. We performed the estimations for all participants and each segmented group, respectively. We also conducted ANOVA analysis to examine differences in attribute ratings and used Student t test to explore the effect of attitudes toward new, different, or innovative foods; table grape purchasing behaviors; and sociodemographics across the three groups.

Results

Summary statistics of survey participants. Table 2 presents descriptive statistics of participants' sociodemographic background and their table grape purchasing behaviors. In our sample, the average age of participants was 51 to 60 years. Approximately 76% of participants were female, ~35% of participants held a collage diploma or higher educational level. The majority of participants were married, and their household sizes varied from one to five people. Approximately 14% of participants had children under 12 years old. In terms of household income, slightly more than half of participants reported an annual income of more than $100,000, and 67% had either a full-time or part-time job. Additionally, ~19% of participants were members of an environmental group.

We also collected information on participants' table grape purchasing behaviors. Most of participants reported consuming and purchasing

Table 2. Summary statistics for participants in the second-price auction (N = 99).

	Mean (*SD*)	Frequency	% of sample
Age, years	3.62 (1.50)		
1 = 18–30		10	10.1
2 = 31–40		17	17.2
3 = 41–50		18	18.2
4 = 51–60		19	19.2
5 = 61–70		26	26.3
6 = ≥70		9	9.1
Gender	0.76 (0.42)		
1 = Female		76	76.8
0 = Male		23	23.2
Education	0.35 (0.48)		
1 = College diploma and higher		35	35.4
0 = Other		64	64.7
Marital status	0.69 (0.47)		
1 = Married		68	68.7
0 = Other		31	31.3
Household size	2.14 (1.08)		
1 people		31	31.3
2 people		41	42.4
3 people		11	11.1
4 people		14	14.1
5 people		2	2.0
Presence of children under 12 years at home	0.14 (0.35)		
1 = Yes		14	14.1
0 = No		85	85.9
Household income	2.32 (0.78)		
1 = $50,000 or under		19	19.2
2 = $50,001–$100,000		29	29.3
3 = >$100,000		51	51.5
Employment status	0.67 (0.47)		
1 = Full time/part time		66	66.7
0 = Other		33	33.3
Environmental group membership	0.19 (0.39)		
1 = Yes		19	19.2
0 = No		80	80.8
Frequency of fresh table grape consumption	1.93 (0.73)		
1 = Once a week or more		30	30.3
2 = Once a month or more		46	46.5
3 = Less than once a month		23	23.2
Frequency of fresh table grape purchasing	2.08 (0.72)		
1 = Once a week or more		20	20.2
2 = Once a month or more		53	53.5
3 = Once every half year or more		24	24.2
4 = Less than once every half year		2	2.0
Weight of fresh table grape when purchase	1.46 (0.50)		
1 = 16 oz		53	53.5
2 = More than 16 oz		46	46.5

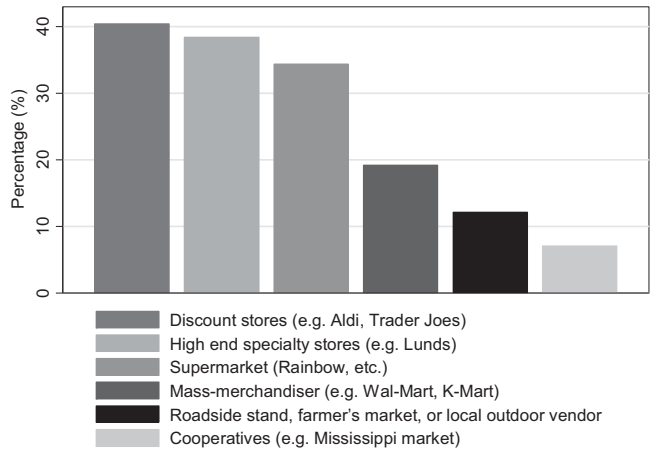

Fig. 1. Participants' primary table grapes purchasing locations, allowing for multiple choices.

table grapes more frequently than once a month. When purchasing table grapes, slightly more than half of the participants preferred a 16-oz weight. Regarding their preferred purchase locations (Fig. 1), most participants preferred purchasing table grapes from discount stores, high-end and specialty stores, and supermarkets. Other market channels, such as mass-merchandiser, roadside stands, farmer's market, or local outdoor vendors and cooperatives, each accounted for less than 20% of participants' table grape purchases.

Consumer willingness to pay for table grapes. Figure 2 shows the distribution of bids using density plots for each table grape cultivar, with the dashed line representing the mean value. The first column presents the bids for three existing warm-climate table grapes purchased from stores, whereas the second and third columns display the bids for novel cold-hardy table grapes. Table grapes within the same row share a similar color. The distribution curves illustrate the frequency of bids at various price points, allowing for an examination of the distribution's shape, range, and any distinctive patterns.

Overall, the bids for all table grape cultivars exhibit a left-skewed distribution, with the mean bids centered ~$2. The majority of participants were willing to pay between $0 and $4 for a 16-oz table grape package with a long tail to the right. However, table grape cultivars' bids showed different patterns in terms of range,

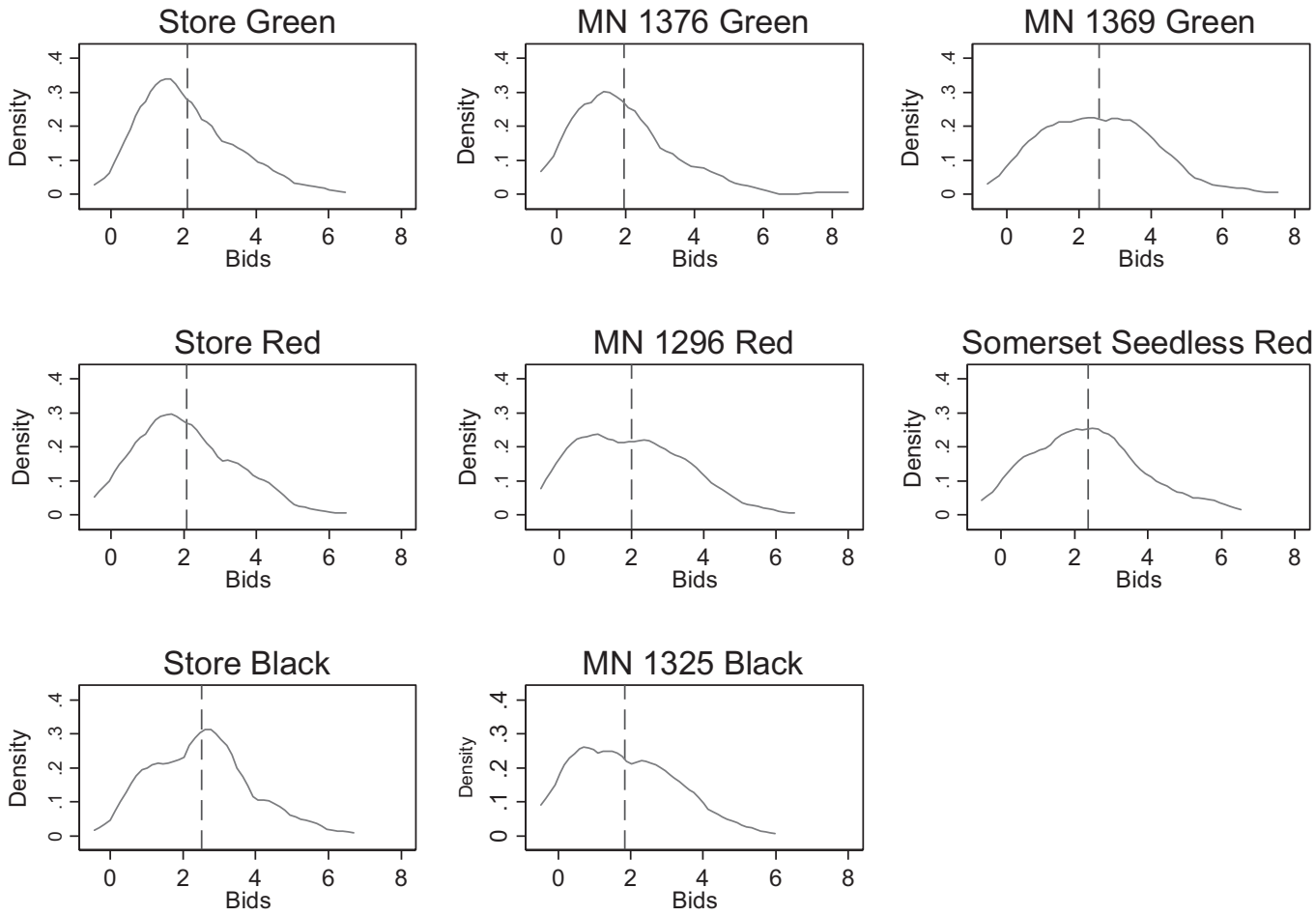

Fig. 2. Distribution of bids (US$) for 16 ounces of table grape by cultivar in the second-price auction, with the mean bid for each cultivar indicated by the dashed line.

number of peaks, and clustering tendency. First, MN 1376, and MN 1369 had the highest maximum bids, reaching ~$8, whereas most other cultivars had maximum bids ~$6. Second, regarding the number of peaks, MN 1296 had two distinct peaks, one below $2 and the other above $2. On the other hand, MN 1369, Somerset Seedless, and store black cultivars had a single peak exceeding $2, whereas others had a single peak around or below $2. Third, the bids for three warm-climate table grape cultivars exhibited a higher degree of clustering, with bids more tightly clustered around the peak points, and the frequencies at the peaks exceeding 40%. This suggests that participants had more consistent valuations and preferences for these warm-climate cultivars. In contrast, the bids for the novel cold-hardy grape cultivars were more spread out, with frequencies at the peak point being less than 30%, except for MN 1376.

We report the mean and standard deviation (*SD*) of bids for each table grape cultivar in Table 3. In the first column, on average for all participants, MN 1369 received the highest mean bid ($2.56), indicating a stronger preference for this cultivar. Store black, Somerset Seedless, store green, store red, and MN 1296 also received average bids higher than $2. However, MN 1376 and MN 1325 received relatively lower average bids, indicating a lower preference among participants.

Table 3 also reports the mean and *SD* of bids for each cultivar by participant segments. Participants were segmented based on their bids for novel cold-hardy table grape cultivars compared with the average bid of three existing warm-climate table grape cultivars. Out of all participants, 21% expressed preferences for all novel cold-hardy table grape cultivars. On the other hand, 19% of participants disliked all novel cold-hardy table grape cultivars. The majority of participants (61%) had mixed preferences for novel cold-hardy table grape cultivars, indicating varying levels of preference within this group.

We observed distinct bidding patterns among different segment groups. The "like all new grapes" group had overall higher bids for novel cold-hardy table grape cultivars. In this group, Somerset Seedless had the highest average bid of $3.07, followed by MN 1369, MN 1325, MN 1296, and MN 1376. On the other hand, participants in the "dislike all new grapes" group showed considerably lower bids, averaging ~$1; however, Somerset Seedless and MN 1369 still received relatively higher bids compared with the other cultivars. The largest participant group, the "mixed" group, exhibited varying preferences. Within this group, MN 1369 received the highest average bids, followed by Somerset Seedless and one of the warm-climate table grape cultivars—store black table grapes. To examine the differences in bids among the three segment groups further, we conducted an ANOVA analysis. The obtained *P* values indicate statistically significant differences in bids for each cultivar among the three groups. It is noteworthy that the mean bids for MN 1376, MN 1296, and MN 1369 were similar between "like all new grapes" and "mixed" groups, with the main difference driven by the lower mean bids from the "dislike all new grapes" group.

Table 4 presents the results of the WTP estimation of 16 oz of table grapes for all participants and each segment group. The constant term represents the WTP for the reference group, which is the store red table grape cultivar. In comparison with estimated WTP of $2.07 for store red table grape among all participants, the values were $1.18 for participants who like all new grapes, $2.22 for the mixed group, and $2.57 for participants who dislike all new grapes.

Consistent with the findings in Table 3, the "like all new grapes" groups exhibited significantly higher WTP for several novel cold-hardy table grape cultivars. Somerset Seedless had the highest WTP at $2.97, which was $1.79 higher than store red ($1.18). Following closely, WTP estimate for MN 1369 was $2.93, which was $1.75 higher than store red. MN 1325 had a WTP estimate of $2.66, which was $1.48 higher than store red. The WTP estimates for the other two cultivars, MN 1376 and MN 1296, were ~$1 higher than store red.

Table 3. Summary of bids (US$) for 16 oz of table grapes by cultivar and segment group in the second-price auction.

	All participants		Segment groups						*P* value
			Like all new grapes[i]		Mixed[ii]		Dislike all new grapes[iii]		
	M	*SD*	M	*SD*	M	*SD*	M	*SD*	
Novel cold-hardy table grape cultivars									
MN 1376 green	1.96	1.47	2.25	1.16	2.20	1.60	0.91	0.79	<0.01
Somerset seedless red	2.38	1.47	2.96	1.28	2.57	1.46	1.14	1.00	<0.01
MN 1325 black	1.84	1.36	2.66	1.21	1.81	1.37	1.05	0.93	<0.01
MN 1296 red	2.01	1.44	2.24	1.37	2.23	1.44	1.02	1.12	<0.01
MN 1369 green	2.56	1.50	2.92	1.27	2.90	1.44	1.10	0.99	<0.01
Existing warm-climate table grape cultivars									
Store black	2.52	1.33	1.75	1.02	2.63	1.25	3.05	1.56	<0.01
Store green	2.10	1.27	1.17	0.64	2.15	1.21	2.99	1.34	<0.01
Store red	2.07	1.32	1.18	0.75	2.22	1.27	2.56	1.55	<0.01
Percentage of the participants	100		21.21		59.60		19.19		

[i] "Like all new grapes" includes participants whose bids for all five novel cold-hardy table grape cultivars exceeded the average bid for three existing warm-climate cultivars.
[ii] "Mixed" refers to participants who preferred both novel and existing cultivars.
[iii] "Dislike all new grapes" includes those whose bids for all five novel cultivars fell below that average.
Participants were segmented based on their bids for novel cold-hardy table grape cultivars compared with the average bid of three existing warm-climate table grape cultivars. Each column of mean values represents the average bid of participants in that group. *P* value determined by analysis of variance.

Table 4. Willingness to pay (US$) estimation for 16 oz of table grapes by segment group in the second-price auction.

		Segment groups		
	All participants (1)	Like all new grapes (2)	Mixed (3)	Dislike all new grapes (4)
Constant	2.07***	1.18***	2.22***	2.57***
	(0.11)	(0.18)	(0.14)	(0.20)
Novel cold-hardy table grape cultivars				
MN 1376 green	−0.10	1.07***	−0.02	−1.66***
	(0.16)	(0.26)	(0.19)	(0.29)
Somerset seedless red	0.31**	1.79***	0.35*	−1.43***
	(0.16)	(0.26)	(0.19)	(0.29)
MN 1325 black	−0.22	1.48***	−0.41**	−1.52***
	(0.16)	(0.26)	(0.19)	(0.29)
MN 1296 red	−0.06	1.06***	0.02	−1.54***
	(0.16)	(0.26)	(0.19)	(0.29)
MN 1369 green	0.49***	1.75***	0.68***	−1.47***
	(0.16)	(0.26)	(0.19)	(0.29)
Existing warm-climate table grape cultivars				
Store black	0.46***	0.57**	0.41**	0.48*
	(0.16)	(0.26)	(0.19)	(0.29)
Store green	0.04	−0.01	−0.07	0.42
	(0.16)	(0.26)	(0.19)	(0.29)
Observations	792	168	472	152

The base group is "store red" table grape. Statistics show coefficients and standard errors (in parentheses) from our linear regression model, where the dependent variable is the bid (US$) for 16 ounces of table grape. The constant term represents the bid for the store red base group. Standard errors are clustered at the individual level. All regressions control for order effect. *, **, *** indicate significance at 10%, 5%, and 1%, respectively.

Participants in the mixed group showed significantly higher WTP estimates for MN 1369 ($2.90) and Somerset Seedless ($2.57). The WTP estimates for MN 1376 and MN 1296 were comparable to store red. However, the "mixed" group participants had a significantly lower WTP estimate of $1.81 for MN 1325. In comparison, participants who dislike all new grapes had significantly lower WTP estimates for novel cold-hardy table grape cultivars, ranging from $1.43 to $1.66 lower than store red at $2.57.

Participant ratings for table grape attributes by group. Table 5 provides a comprehensive overview of how participants from segment groups rated the various attributes of novel cold-hardy table grape cultivars and existing warm-climate table grape cultivars on a scale of 1 to 7. The ratings cover a wide range of grape attributes, including overall liking, overall appearance, cluster size, cluster compactness, berry size, berry shape, berry color, no cosmetic defects, fresh-looking, overall flavor, sweetness, sourness, texture, firmness, pop energy, maturity, number of seeds, and skin thickness. The table is divided into two panels: panel A shows the ratings for novel cold-hardy table grape cultivars, and panel B shows the ratings for existing warm-climate table grape cultivars. We provide mean and *SD* for each attribute and segmented group.

The ratings for table grape attributes also exhibit distinct patterns among the three segment groups. In panel A for novel cold-hardy table grape cultivars, the "like all new grapes" group generally expressed higher ratings compared with the "mixed" and "dislike all new grapes" groups, whereas the "dislike all new grapes" group tended to provide lower ratings for most attributes. An ANOVA was conducted to assess the statistical differences in ratings across the segment groups, and the results indicate significant differences ($P < 0.01$), as shown in the last column of Table 5. In contrast, in panel B, which represents the ratings of three existing warm-climate grape cultivars, an opposite trend can be observed. The mean ratings were generally lowest in the "like all new grapes" group, indicating that participants in this group found these attributes less favorable compared with the other two groups for three existing warm-climate table grapes. These differences in ratings among the three groups were also statistically significant.

Participant sociodemographics, purchasing behavior, and attitude toward novel foods by segment group. In Table 6, we investigated the sociodemographic characteristics, purchasing behavior, and attitude toward new, different, or innovative foods among participants from different segment groups. In panel A, the mean age of participants in the "like all new grapes" group and "mixed" group were relatively similar, whereas the "dislike all new grapes" group had a higher mean age. This differences between the "dislike all new grapes" groups and the other two groups were found to be statistically significant. The "mixed" groups had the highest percentage of female participants, whereas the "like all new grapes" group had the lowest percentage. The differences in gender distribution between the "mixed" groups and the other two were also statistically significant. Moreover, the "mixed" group had a significantly higher mean household size compared with the "like all new grapes" group. In addition, the "dislike all new grape" groups exhibited a significantly lower percentage of individuals with full-time or part-time employment and a lower percentage of individuals who were members of an environmental group. There were no significant differences observed in other sociodemographic characteristics such as education, marital status, presence of children under 12 years old at home, income, employment status, or environmental group membership among the three groups.

In panel B, participant purchasing behavior, including the frequency of fresh grape consumption, frequency of fresh grape purchasing, and weight of fresh grape when purchased, did not show any significant differences among the three groups. Panel C presents the index for participant attitudes toward new, different, or innovative food, which was constructed as the average of three questions on a 1 to 7 scale, including (1) generally, I am among the first of my circle of friends to buy new, different, or innovative foods; (2) compared with my friends, I purchase more new, different, or innovative foods; and

Table 5. Ratings (mean and *SD*) of sensory and physical attributes for table grapes by consumer segments for both novel cold-hardy and existing warm-climate grape cultivars (on a scale 1 to 7).

	Like all new grapes		Mixed		Dislike all new grapes		
Segment groups	M	*SD*	M	*SD*	M	*SD*	*P* value
Panel A: novel cold-hardy table grape cultivars							
Overall liking	5.23	1.28	4.97	1.53	3.25	1.48	<0.01
Overall appearance	5.46	1.05	5.37	1.36	3.90	1.51	<0.01
Cluster size	5.69	0.88	5.92	1.12	4.64	1.57	<0.01
Cluster compactness	5.66	1.12	5.91	1.21	4.60	1.62	<0.01
Berry size	4.91	1.35	4.74	1.78	2.73	1.32	<0.01
Berry shape	5.63	0.93	5.82	1.22	4.27	1.70	<0.01
Berry color	5.36	1.24	5.55	1.50	4.56	1.69	<0.01
No cosmetic defect	5.23	1.32	5.57	1.48	5.00	1.47	<0.01
Fresh-looking	5.45	1.31	5.67	1.43	4.82	1.59	<0.01
Overall flavor	5.33	1.37	5.03	1.62	3.81	1.59	<0.01
Flavor/aroma	5.44	1.33	5.08	1.61	3.77	1.56	<0.01
Sweetness	5.19	1.32	5.10	1.68	3.71	1.62	<0.01
Sourness	4.91	1.40	4.66	1.83	3.14	1.56	<0.01
Texture	4.96	1.32	4.89	1.46	3.65	1.43	<0.01
Firmness	5.07	1.24	5.10	1.45	4.07	1.50	<0.01
Pop energy	5.38	1.20	5.17	1.48	4.11	1.49	<0.01
Maturity	4.93	1.17	5.24	1.33	4.22	1.43	<0.01
Number of seeds	4.14	1.84	4.19	2.02	3.09	1.97	<0.01
Skin thickness	4.84	1.37	4.89	1.59	3.71	1.84	<0.01
Panel B: existing warm-climate table grape cultivars							
Overall liking	4.30	1.25	5.03	1.46	5.75	1.31	<0.01
Overall appearance	4.67	1.11	5.47	1.24	5.90	1.10	<0.01
Cluster size	4.32	1.24	5.02	1.42	5.57	1.21	<0.01
Cluster compactness	4.14	1.17	4.87	1.38	5.07	1.45	<0.01
Berry size	4.98	1.04	5.59	1.46	6.18	0.93	<0.01
Berry shape	4.93	1.13	5.73	1.25	6.03	1.15	<0.01
Berry color	4.96	1.25	5.62	1.42	5.85	1.21	<0.01
No cosmetic defect	4.65	1.29	5.43	1.50	5.52	1.38	<0.01
Fresh-looking	4.79	1.33	5.62	1.32	5.75	1.31	<0.01
Overall flavor	4.31	1.27	4.84	1.51	5.68	1.37	<0.01
Flavor/aroma	4.25	1.23	4.63	1.55	5.43	1.47	<0.01
Sweetness	4.37	1.43	4.75	1.59	5.37	1.40	<0.01
Sourness	3.84	1.31	4.43	1.57	4.25	1.75	<0.05
Texture	4.61	1.46	5.49	1.51	5.67	1.23	<0.01
Firmness	4.84	1.44	5.81	1.37	5.90	1.26	<0.01
Pop energy	4.39	1.44	5.00	1.70	5.40	1.44	<0.01
Maturity	4.77	1.07	5.44	1.39	5.62	1.30	<0.01
Number of seeds	5.32	1.23	5.89	1.49	5.60	1.88	<0.05
Skin thickness	4.58	1.32	5.56	1.50	5.55	1.32	<0.01

The table reports mean values and standard deviations of participant ratings (on a 1 to 7 scale) of sensory and physical attributes of table grapes. Results are shown for three participant segments. Panel A presents ratings for novel cold-hardy cultivars, and Panel B presents ratings for existing warm-climate cultivars. ANOVA *P* values indicate whether the differences between the three groups are statistically significant ($P < 0.05$ and $P < 0.01$).

(3) if new, different, or Innovative foods are available in shops and supermarkets, I always purchase them. The results indicate that participants in the "like all new grapes" and "mixed" groups generally held more positive attitudes toward new, different, or innovative foods compared with the "dislike all new grapes" group. The Student *t* test revealed that both were significantly higher than the "dislike all new grapes" group, but there was no significant difference between the "like all new grapes" and "mixed" group.

Conclusion and discussion

In this study, we investigated consumer preferences and WTP for novel cold-hardy table grape cultivars. Specifically, we categorized consumers into groups as "like all new grapes," "mixed," and "dislike all new grapes," based on the comparison with their average WTP of existing warm-climate table grape cultivars and estimated consumer WTP for each cultivar. We observed that the majority of participants (81%) fell into the groups of "like all new grapes" and "mixed," indicating that there is a potential market opportunity for cold-hardy table grape cultivars among a significant portion of consumers.

Our findings also revealed that two novel, cold-hardy table grape cultivars, MN 1369 and Somerset Seedless, received consistently highest ratings

Table 6. Participant sociodemographics; table grape purchasing behavior; and attitude toward new, different, or innovative foods by segment.

	Like all new grapes		Mixed		Dislike all new grapes		*t* test (*P* value)		
Segment	M (1)	*SD* (2)	M (3)	*SD* (4)	M (5)	*SD* (6)	H_0: (1) = (3)	H_0: (1) = (5)	H_0: (3) = (5)
Panel A: sociodemographics									
Age	3.42	1.61	3.37	1.47	4.55	1.19	0.94	<0.05	<0.01
Gender	0.58	0.51	0.87	0.34	0.65	0.49	<0.01	0.66	<0.05
Education	0.79	0.42	0.82	0.39	0.9	0.31	0.82	0.35	0.37
Marital status	0.42	0.51	0.62	0.49	0.6	0.5	0.12	0.28	0.83
Household size	1.79	0.85	2.33	1.16	1.9	0.91	<0.05	0.70	0.11
Presence of children under 12 years at home	0.16	0.37	0.15	0.36	0.1	0.31	0.96	0.60	0.56
Household income	2.21	0.79	2.38	0.8	2.25	0.72	0.46	0.87	0.55
Employment status	0.63	0.5	0.73	0.45	0.5	0.51	0.43	0.42	<0.10
Environmental group membership	0.16	0.37	0.25	0.44	0.05	0.22	0.39	0.28	<0.05
Panel B: table grape purchasing behavior									
Frequency of fresh table grape consumption	1.95	0.85	1.93	0.73	1.9	0.64	0.94	0.85	0.86
Frequency of fresh table grape purchasing	2.16	0.9	2.1	0.71	1.95	0.6	0.78	0.40	0.40
Weight of fresh table grape when purchase	1.47	0.51	1.5	0.5	1.35	0.49	0.80	0.45	0.23
Panel C: attitude toward new, different, or innovative foods									
Index for attitude toward new, different, or innovative foods	4.87	1.33	5.02	1.31	4.32	1.51	0.21	<0.01	<0.01

The table presents the mean values and standard deviations for three consumer segments: like all new grapes, mixed, and dislike all new grapes. *t* test *P* values indicate significant differences in the mean values between groups: means in column (1) vs. column (3), column (1) vs. column (5), and column (3) vs. column (5) ($P < 0.10$, $P < 0.05$, $P < 0.01$). The index for attitude toward new, different, or innovative foods is calculated as the average of three questions on a 1 to 7 scale. The three questions are as follows: (1) Generally, I am among the first of my circle of friends to buy new, different, or innovative foods. (2) Compared with my friends, I purchase more new, different, or innovative foods. (3) If new, different, or Innovative foods are available in shops and supermarkets I always purchase them.

from consumers in the "like all new grapes" and "mixed" groups. These cultivars share several consumer desired characteristics shown in previous literature, including being seedless, having smaller clusters, and offering a balanced sweet flavor. For example, Piva et al. (2006) found that Spanish consumers prioritize sweetness, followed by thin skin and few or no seeds. Similarly, Mu et al. (2016) reported a strong preference among Chinese consumers for sweet, seedless grapes. However, other studies highlight different priorities. Wang et al. (2017) found that Chinese favored compact clusters and large, dark red berries over seedlessness. Seccia et al. (2019) also observed that a significant portion of Italian consumers rarely purchase seedless or organic grapes. Moreover, consumers in the "like all new grapes" and "mixed" groups demonstrated a similar WTP for MN 1376, MN 1296. These findings contribute to the literature by providing insights into consumer preferences for cold-hardy table grapes in the U.S. market.

Additionally, we also examined the difference in various measurements, including attributes ratings, attitudes, table grape purchasing behaviors, and sociodemographics among three segment groups, which provide valuable insights into factors that may influence consumer WTP for novel cold-hardy table grapes. We identified a positive association between attributes ratings, consumers' attitudes toward novel food and their WTP. Regarding sociodemographics and table grape purchasing behaviors, the findings suggest that age, gender, household size, employment, and environmental group membership may influence consumer WTP toward novel cold-hardy table grapes. However, there were no significant differences observed in other sociodemographic characteristics, including education, marital status, presence of children under 12 years old at home, household income, or purchasing behaviors among the three groups. These factors did not significantly influence participants' WTP for novel cold-hardy table grapes.

Specifically, the "dislike-all new grapes" group had a higher mean age, indicating that older participants may be less inclined to show interest in new grape cultivars. They also have a lower participation in full-time or part-time employment and a lower membership of environmental groups. These factors suggest that barriers such as cold-hardy table grape attributes, limited interest in novel food, older age, limited employment, and lack of affiliation with environmental organizations may influence their WTP for cold-hardy table grape cultivars. To address these barriers and increase the WTP for cold-hardy table grapes among the "dislike all new grapes" group, targeted marketing strategies should focus on addressing consumers taste preference, advertising and raising awareness, improving market availability, highlighting the unique attributes such as local origin and environmental sustainability to appeal to consumer interest and values, offering competitive pricing to demonstrate that these grapes can be an affordable option for consumers.

On the other hand, the "mixed" group had more percentage of female participants and a slightly larger household size, suggesting that these factors may contribute to a greater acceptance of novel cold-hardy table grape cultivars. Organizing sampling and tastings events can provide opportunities for consumers in the "mixed" group as well as in the "like all new grapes" group to experience the unique flavors

and qualities of cold-hardy table grapes. These events can generate positive word of mouth, increase consumers awareness and interest, and can ultimately help expand the market share of cold-hardy table grapes.

Although the findings contribute to a better understanding of consumer behavior in the context of food innovation and aid in the development of targeted strategies to meet consumer needs and preferences, it is worth noting that this study has certain limitations. The research was conducted within a specific geographic region and may not fully represent the broader population. Additionally, the study focused solely on consumer preferences for cold-hardy table grapes and did not explore other factors such as organic production and availability that could further influence consumer choices. We recommend further research to delve deeper into the underlying motivations and barriers driving consumer preferences and WTP for novel food products. Understanding these factors can help inform product development, marketing strategies, and consumer education initiatives to encourage greater acceptance and adoption of innovative food offerings.

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