

DEMAND FOR DATES FREE OF PESTICIDE RESIDUE IN SAUDI ARABIA

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Abstract. The study estimates the premium price consumers in Saudi Arabia are willing to pay for free pesticide residues (FPR) dates and investigates the factors affecting their willingness to pay. We collected preliminary data and used a double-bounded model. The average premium consumers are willing to pay for FPR dates is SAR 12.96 (3.45 USD) per Kg, representing 86% above the market price of traditional dates. The results pose that education, marital status, shopping contribution, and income influence WTP. So are food safety attitudes, agreeing with the pesticide ban, and preferring buying branded fruits and vegetables. The results will provide insights into designing market strategies and more effective policies to improve the welfare of producers and consumers.

Keywords: *contingent valuation, double-bounded model, food safety, free of pesticide residues*

Introduction

Concern about pesticide residue in agricultural products is increasing among consumers, producers, and policymakers in Saudi Arabia; consumers consider pesticides an undesirable component of food production (Osman et al., 2010; Jalloun, 2022), leaving producers under pressure to meet the food safety standards. Consequently, the government is increasing its efforts to monitor pesticide residues in agricultural products. For example, in early 2018, the Saudi Food and Drug Authority (SFDA) implemented the National Program for Monitoring pesticide residues in legumes, fruits, and vegetables (Saudi Press Agency, 2018).

The free of pesticide residues (FPR) attribute is credence; not identified at purchase unless providing the consumer with information such as certificates (Schroback et al., 2023). In our case, consumers cannot observe pesticide residue contamination if farmers withhold information about pesticide usage. Thus, the information gap between consumers and producers leads to market failures.

On the one hand, when farmers are not forthcoming about pesticide use, consumers do not obtain the desired quality level. On the other hand, farmers are precluded from garnering profits when meeting the required level of quality. It requires testing and certification from a third party to address this failure and improve market outcomes.

Certification transforms the credence goods into a search signal for the desired quality that consumers can see, enabling product differentiation and improving market outcomes (Boccaletti and Nardella, 2000). Eligible producers are rewarded for their commitment to higher quality products, and so are consumers granted the availability of the quality levels they demand. Nonetheless, certification incurs an additional production cost, leading to a higher price for consumers. This fact highlights the importance of assessing the economic value of certified food. The primary objective of

this paper is to determine consumers' willingness to pay (WTP) for FPR food, focusing on dates (a type of fruit). The secondary objective is to determine the effects of consumers' profiles, attitudes, and perceptions of food safety on the WTP for FPR dates. We implemented the Contingent Valuation Method (CVM), to assess the economic value of non-market goods or credence goods (Mitchell and Carson, 1989), employing a stated preference survey. In addition, we implemented a double-bounded elicitation method (Hanemann et al., 1991). The model offers individuals two consecutive bids, an initial bid, and a follow-up, facilitating more information to elicit the true FPR dates value.

Researchers have conducted studies about consumers' WTP for credence food safety attributes and demonstrated the effect of consumers' profiles on WTP in Saudi Arabia (Bashir, 2012; Almarri and Al-Mahish, 2020). So are others addressed the subject worldwide. For instance, Loureiro et al. (2002) in the US; Angulo et al. (2005) in Spain; Xu and Wu (2010), Bai et al. (2013), Yu et al. (2014), and Liu et al. (2023) in China; Delmond et al. (2018) in Russia; Kabir et al. (2023) in Bangladesh; and Sriwaranun et al. (2015) in Thailand. Moreover, studies specifically concerning the attribute of pesticide residues include Boccaletti and Nardella (2000) in Italy, Krishna and Qaim (2008) in India, Mergenthaler et al. (2009) in Vietnam, and Khan et al. (2021) in Pakistan.

Boccaletti and Nardella (2000) estimated the WTP for free-of-pesticide fresh fruits and vegetables among consumers in Italy. They used a payment card for the elicitation method and employed an order logit model. The results indicated a positive correlation between WTP for pesticide-free products and income and pesticide concerns. However, the opposite effects on WTP were found regarding males and education. Mergenthaler et al. (2009) estimated the Vietnamese consumers' WTP for Chinese mustard using a double-bounded model. They confronted half of their sample with a hypothetical scenario regarding FPR Chinese mustard and the other half with a hypothetical scenario regarding a partial reduction of pesticide residues. Even though this variation in the valuation scenario did not affect WTP, the mean WTP to avoid pesticide residues was 60% above the market price. The researchers found that general food safety concerns exerted the highest impact on WTP. Among consumers in urban India, Krishna and Qaim (2008) found that the mean WTP for FPR vegetables is 56.6% above market price. Consumers with increased awareness about pesticide residue and risk perception exert a higher WTP. Living with a child under 14, income, and education positively affect WTP.

The limitation of the abovementioned research is that it may not assess consumers' preferences in the country regarding FPR dates to provide insights to marketers and policymakers. In Saudi Arabia, dates are beyond fruits, demonstrating religious and social values. It is usually eaten during the fasting month of Ramadan (the ninth month in the Islamic calendar). Additionally, dates are often present during social gatherings with friends and family, and are traditionally offered as sweets with Saudi coffee. Still, to the best of our knowledge, previous research has yet to use the CVM to estimate consumers' WTP for FPR dates in Saudi Arabia. Thus, this paper contributes to the literature by eliciting consumers' preferences for FPR dates in Saudi Arabia. The results will provide information to set market strategies and design better and more effective policies to benefit consumers and producers.

The remainder of this paper comprises three sections. The first section introduces the theoretical setting, the data used, and the empirical model to elicit consumers' WTP for FPR dates. The second section presents the results, and the last section discusses the results and conclusion.

Materials and methods

Given the different economic valuation methods used in the field, we apply the CVM. The CVM is a standard approach employing a stated preference survey to estimate consumers' WTP for non-market credence goods. The survey introduces a new product and asks the participants, through different elicitation methods, about the amount they are willing to pay for that product (Mitchell and Carson, 1989; Hanemann et al., 1991; Li et al., 2004). The CVM also costs less than other methods of replicating actual purchasing transactions (Boccaletti and Nardella, 2000).

The CVM is appropriate for eliciting consumers' WTP for FPR dates and determining factors influencing their WTP. On the one hand, the unavailability of actual transactional data prevents assessing the premium consumers are willing to pay for quality improvement. On the other hand, the CVM is the holistic valuation of the candidate product because we are not valuing the individual attributes of the product (He et al., 2017).

The CVM allows the establishment of a hypothetical market by introducing the survey respondents with a hypothetical certified dates as FPR to assess their WTP for better food quality (Sriwaranun et al., 2015). Therefore, hypothetical bias can arise when applying the CVM. Such bias is more pronounced when valuing public goods and is less critical when consumers are familiar with the candidate object being investigated, thereby generating reliable results (Krishna and Qaim, 2008; Mergenthaler et al., 2009).

Drawn from the random utility model (McFadden, 1974), we let $V(p_i, x_i, y)$ be the consumer's indirect utility function, x is the candidate good (dates), p is the price, and y is income. The subscripts, i , are equal to 0 and 1 for the conventional and FPR dates, respectively. Dates certified as FPR incur a premium, c . The WTP, an additional amount for FPR dates, is contingent on a positive net benefit from consuming the new product. Mathematically, it is written as:

$$V(p_0, x_0, y) \leq V(p_1, x_1, y - c) \quad (\text{Eq.1})$$

We incorporate the error term, u , to the utility function in *Equation 1* to include the effect of unobservable random consumers' preferences (Hanemann and Kanninen, 2001; Carlsson, 2011), where u is assumed to be independent and identically distributed.

$$V(p_0, x_0, y) + u_0 \leq V(p_1, x_1, y - c) + u_1 \quad (\text{Eq.2})$$

To express the model in a probability term, we write

$$Pr(WTP \geq c) = Pr(V_0 + u_0 \leq V_1 + u_1) = Pr(u_0 - u_1 \leq V_1 - V_0). \quad (\text{Eq.3})$$

This theoretical framework establishes the foundation for choosing a specific empirical model to estimate consumers' WTP for FPR dates.

The empirical model

We used a double-bounded elicitation model to estimate the model in *Equation 3*. Even though the above setup was formulated for a single-bounded model, it was also valid for a double-bounded model (Mostafa, 2016). The participant presented with one bid to state their preferences in a signal-bounded model, whereas the double-bounded

model offered two consecutive bids. The initial bid is equivalent to that in the single-bounded model. However, the second bid is contingent on the first bid's response. For example, if the response to the first bid is "Yes," the second bid increases. In contrast, the consecutive bid decreases after the "No" response to the initial bid, leading to four possible outcomes: (Yes, Yes), (Yes, No), (No, Yes), and (No, No).

The double-bounded model provides additional information for the actual WTP and generates asymptotically more efficient estimates than a single-bounded model, thus translating into higher *t*-test and *R*² values (Hanemann et al., 1991). The informational gain would require the second bid not to be sufficiently large (small) if the response to the initial bid were "Yes" ("No") (Hanemann et al., 1991).

Consider that *N* participants are present; *t*¹ is the first bid, *t*² is the follow-up bid, and *WTP*_{*i*} denotes the premium for FPR dates paid by the *i*'s individual, *i* = 1, 2, ..., *N*. Then the four outcome cases of the double-bounded model are written as:

$$D_i = \begin{cases} t^2 \leq WTP_i < \infty & , \text{ If the answer is Yes, Yes.} \\ t^1 \leq WTP_i < t^2 & , \text{ If the answer is Yes, No.} \\ t^2 \leq WTP_i < t^1 & , \text{ If the answer is No, Yes.} \\ WTP_i < t^2 & , \text{ If the answer is No, No.} \end{cases} \quad (\text{Eq.4})$$

The individual *i*'s WTP function is:

$$WTP_i = z'\beta + \varepsilon_i \quad (\text{Eq.5})$$

where *z* is a vector of explanatory variables, *β* is a vector of the parameters to be estimated, and *ε*_{*i*} is the random error that is normally distributed with a mean of zero and variance *σ*², *ε*_{*i*} ~ *N*(0, *σ*²).

The probability of each of the four outcome cases is characterized as:

$$\begin{aligned} \Pr(y, y) &= \Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right), \\ \Pr(y, n) &= \Phi\left(\frac{z_i'\beta - t^1}{\sigma}\right) - \Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right), \\ \Pr(n, y) &= \Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right) - \Phi\left(\frac{z_i'\beta - t^1}{\sigma}\right), \text{ and} \\ \Pr(n, n) &= 1 - \Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right) \end{aligned} \quad (\text{Eq.6})$$

where *y* denotes a "Yes" response, *n* denotes a "No" response, and *Φ* is the standard normal cumulative distribution function. The log-likelihood function is written as follows:

$$\begin{aligned} L = \sum_{i=1}^N [& I_i^{y,y} \ln\left(\Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right)\right) + I_i^{y,n} \ln\left(\Phi\left(\frac{z_i'\beta - t^1}{\sigma}\right) - \Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right)\right) + \\ & I_i^{n,y} \ln\left(\Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right) - \Phi\left(\frac{z_i'\beta - t^1}{\sigma}\right)\right) + I_i^{n,n} \ln\left(1 - \Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right)\right)] \end{aligned} \quad (\text{Eq.7})$$

where *I*^{*y,y*}, *I*^{*y,n*}, *I*^{*n,y*}, and *I*^{*n,n*} are indicator variables taking the value of 1 or 0 based on individual *i*'s response to the two bids offered. The estimated coefficients are

interpreted as the marginal effects for the independent variables, and the mean WTP for FPR dates are calculated as $E(WTP_i) = \beta'z$.

Sampling and data collection

We used a snowballing method to collect primary data through an online survey from December 2020 to January 2021 and recruited participants through different social media platforms, primarily WhatsApp and Twitter, as the most commonly used in Saudi Arabia (The Communication, Space, and Technology Commission, 2020).

The survey occurred amid health recommendations to prevent the disease (Covid-19) by social distancing, wearing a mask, and avoiding gathering in crowded, closed areas and unnecessary interactions with others (The Saudi Ministry of Health, 2020). However, given our resources, an online survey would ensure more participation than other survey methods. Furthermore, the online survey enables extensive data collection promptly. A drawback of the snowball survey is that it does not utilize a representative sample but is still applicable in many exploratory consumer behavior studies (Testa et al., 2019; Palmieri et al., 2020; Alagsam et al., 2023).

Our population comprises date consumers in Saudi Arabia. The survey questionnaires were pretested and approved by the Research Ethics Committee of the Deanship of Scientific Research at King Saud University in Saudi Arabia. The survey includes four sections. *Table 1* shows all the explanatory variables, summary statistics of the variables, and their expected directions.

We first asked participants about their attitudes toward food safety through a tradeoff scenario, having them place themselves on a scale from 1–7, where 1 means the price is all-important regardless of food safety, and 7 means food safety is all-important regardless of price. From an estimation perspective, such tradeoffs ensure variations in consumers' attitudes toward measures (Loureiro et al., 2002). We found a lack of variations in attitudes toward food safety and price during the survey pretest. Loureiro et al. (2002) argue that omitting a frame of reference causes a lack of variation. However, food safety considerations are expected to positively affect WTP for FPR dates.

With the gathered information, we asked the participants to rate their perceptions concerning pesticides using a five-Likert scale whether they: 1) think that all pesticides should be banned, 2) have previously stopped buying some fruits or vegetables due to negative food safety information in the media, 3) think that regulators are doing a good job monitoring pesticide residues, 4) and prefer to buy branded types of fruits and vegetables. We expect consumers that favor banning pesticides or react to negative media information about food safety to pay a higher premium for FPR dates. Furthermore, given that food labels signal a better quality, for those trusting the government to monitor pesticide residues or prefer consuming branded fruits and vegetables we are thereby anticipating a positive effect on WTP.

The second section collects data on date consumption habits. Our study tests the hypothesis that individuals eating dates all year long are willing to pay a higher premium for FPR dates than those only consuming dates during social or religious events.

The place where frequent date consumption occurs is expected to influence WTP. We hypothesize that consumers often eating dates at home will exert higher WTP than those primarily eating dates away from home, including the workplace, restaurants/cafés, and other places. Participants were also asked about the primary source for dates, such as specialized date stores, supermarkets, and date auctions. Buying from a supermarket is expected to affect WTP positively, but negatively regarding buying from an auction. Date

auctions are English-type auctions that sell dates in relevantly large quantities. Because dates are way less perishable than other fruits and vegetables, consumers can bid for enormous amounts for household consumption throughout the year.

Table 1. Variables definition and summary statistics for estimating WTP for FPR dates

Variable	Definition	Expected sign
Male	1 if the responder is male and 0 if the responder is female	Undetermined
Age	1 if the age range is 26–40, 2 if the age range is 41–60, and 3 if the age range is > 60	+
Education	1 if the education level is less than high school, 2 if it is high school, 3 if it is a college degree, 4 is for an education level of bachelor's degree, and 5 is for an education level of postgraduate	+
Social status	1 if married and 0 otherwise	+
Employee	1 if "employee" and 0 otherwise	+
Main shopper	1 if "the main shopper" and 0 otherwise	+
Shopping contributor	1 if a shopping contributor, and 0 otherwise	+
Has children under 18 years old	1 if "Yes" and 0 for "No"	+
Has chronic disease?	1 if "Yes" and 0 for "No"	+
Place of residence	1 if from Riyadh and 0 otherwise	Undetermined
Income	Group 1 if less than SAR 6,000 (USD 1,600), Group 2 if between SAR 6,000 (USD 1,600)–12,000 (USD 3,200), Group 3 if between 12,000 (USD 3,200)–18,000 (USD 4,800), and Group 4 if more than 18,000 (USD 4,800)	+
Price vs. food safety	A tradeoff between price and food safety, where 1 is preferring price, and 7 is preferring food safety	+
Ban	The government should ban all pesticides. 1 = strongly disagree to 5 = strongly agree	+
Brand	Respondent prefers to buy branded types of fruits and vegetables, 1 = strongly disagree to 5 = strongly agree	+
Reacting	In the past, respondents stopped buying certain fruits and vegetables due to some negative food safety information in the media, 1 = strongly disagree to 5 = strongly agree	+
Government censorship	Respondent trusts the government in monitoring pesticide residues, 1 = strongly disagree to 5 = strongly agree	+
Frequency	Frequency of eating dates, 1 = all year long, 0 = during religious or social events	+
Place	Place where often consuming dates, 1 = at home, 0 = other	+
Supermarket	1 = if often buying dates from a supermarket, 0 = otherwise	+
Date-Store	1 = if often buying dates from a specialized date store, 0 = otherwise	-
Auction	1 = if often buying dates from a date auction, 0 = Otherwise	-
Fruits and vegetables shop	1 if often buying dates from a fruit and vegetables shop, and 0 otherwise	-

The third section asks questions contingent on testing and certifying for FPR. Before presenting these questions, we wanted participants to read a hypothetical scenario of an existing approved certifying third body, which would test for pesticide residues potentially harming human health and certifies non-contaminated dates as FPR dates. Then we asked the participants about their choices among conventional and certified dates when both types are offered for the same price per Kilogram (Kg). Those choosing to buy certified dates were offered a random bid expressed as an additional price paid to avoid pesticide residues. If the response to the first bid were “Yes,” the participant would be offered a higher follow-up bid. Otherwise, the respondent would be offered a lower bid if he or she rejected the initial bid by saying “No.” *Table 2* represents the initial bids offered and the amounts of the higher and lower follow-up bids.

Table 2. *The amount of initial and follow-up bids*

First bid	If (Yes) to the first bid	If (No) to the first bid
SAR 3	SAR 5	SAR 2
SAR 6	SAR 9	SAR 3
SAR 9	SAR 13	SAR 5
SAR 10	SAR 14	SAR 6

USD 1 = SAR 3.75 (The Saudi Central Bank, 2022)

Because previous research has not addressed the elicitation of consumers’ WTP for FPR dates, we initially set the first and second bids within the difference between the date price/Kg Maknoz Khilas SAR 15 (USD 4) (The Saudi General Authority for Statistics, 2020) and the average price/Kg of the same organic type 30 SAR (8 USD). Furthermore, we assumed the price for Maknoz Khilas to be SAR 15 (USD 4) the average price for traditional dates.

The last section of our questionnaire contains demographic and personal questions. We ask each individual to indicate if he or she is the main/participant in food shopping, expecting the main/participant of food shopping to paying more for certified dates. Moreover, consumers with chronic diseases are hypothesized to pay more for certified dates. We also hypothesized that consumers with children under 18 would have a higher WTP for food safety.

Results

The study relied on achieving its objectives on the initial data collected by an electronic questionnaire published through different social media platforms. Because the questionnaire was divided into four parts, the study’s results were presented as follows: socio-economic characteristics, respondents’ attitudes toward food safety, the consumption habits of consuming dates, and then exploring the explanatory variable and estimating the willingness to pay for FPR dates in Saudi Arabia. The responses totaled 765, but 112 observations were excluded for various reasons, including incomplete responses. Thus, the total number of the sample used in the study was 653.

Respondents overview

Demographic characteristics

Table 3 summarizes the demographic characteristics; the proportion of male respondents was 69.7%, higher than that of female respondents representing 30.3%. When comparing respondents per nationality, we find that non-Saudis represent 3.1%, while Saudis represent 96.9%. Moreover, the results showed that the percentage of participants from Riyadh represents 56%.

Table 3. Distribution of socio-economic variables

Variable	Frequency	Ratio %
Gender		
Male	456	67.7
Female	198	30.3
Age		
18–25	17	2.6
26–40	255	39.0
41–60	333	50.9
> 60	48	7.3
Education		
Less than high school	11	1.7
High school	71	10.9
College diploma	51	7.8
Bachelor's degree	316	48.3
Advanced education, such as a Master's or Ph.D.	206	31.2
Marital status		
Married	560	85.6
Single	94	14.4
Occupation		
Employee	484	74
Student	19	2.9
Unemployed or looking for a job	61	9.3
Retired	89	13.6
Participation in shopping		
The main shopper	427	56.3
Shopping contributor	201	30.7
Not contributed to shopping	25	3.8
Nationality		
Saudi	634	96.9
Non-Saudi	20	3.1
Do you live with children under 18 years old?		
Yes	531	81.2
No	123	18.8
Do you suffer from chronic diseases?		
Yes	171	26.1
No	483	73.9
Place of residence		
Riyadh City	366	56
Outside Riyadh City	288	44
Income (monthly household income)		
Less than 6,000	60	9.2
6,000-12,000	192	29.4
12,000-18,000	183	28.1
More than 18,000	217	33.2

Regarding marital status, 85.6% were married. When asked whether participants lived with children under 18, 81.2% responded affirmatively. Nevertheless, when asked about the age group of respondents, the number of young people between 18 and 25 was low; this group was found on social media platforms such as Twitter and WhatsApp. The low participation of this group could be attributed to the unimportance of date products among them, which has led them to refrain from participating. The second age group representing 26–40 years of age, demonstrated 39% participation, while the third group, aged between 41 and 60, represented 50.9%. The high participation of the second and third age groups indicates the importance of this product to them. Most participants had at least a college education, with the sample comprising 48.3% with undergraduate degrees and 31.2% with postgraduate degrees. Regarding employment status, 74% of respondents were employed, 13.6% were retirees, and the remaining were students and unemployed. The high proportion of employees in the sample explains the high participation from the second and third age groups.

Table 3 also depicts the proportions of observations within our sample based on health conditions, participation in food shopping, and income categories. The sample included 26.1% of respondents with chronic diseases. Fifty-six percent of respondents were primary shoppers, and 30.7% only participating in food shopping. The monthly household income was divided into four categories: 9.2% of individuals within the income group of less than SAR 6,000 (USD 1,600) per month and 29.4% between SAR 6,000 (USD 1,600) and SAR 12,000 (USD 3,200). Respondents from the last two categories accounted for 28.1% of those with monthly household incomes of between SAR 12,000 (USD 3,200) and SAR 18,000 (USD 4,800) and 33.2% of those with monthly households exceeding SAR 18,000 (USD 4,800).

Responses on food safety

Table 4 summarizes the average of the sample views concerning food safety questions. The first question measures attitudes toward food safety, asking a tradeoff question between price and food safety, providing the respondent the freedom to set a number on a scale from 1 to 7. Number 1 indicates that the consumer is interested in paying a lower price regardless of food safety, while 7 means that the consumer is interested in food safety irrespective of the cost. The average sample view is 5.9 out of 7, meaning respondents are generally interested in food safety.

Additionally, the respondents provided an opinion on preventing chemical pesticide use once and for all; the result was that the average sample opinion tended to approve of the prohibition of chemical pesticides, with 75.5%. When asked if the respondents prefer to buy fruits and vegetables from a particular brand, 72.1% indicated an interest in the brand. In addition, the questionnaire asked whether the media impacted consumer reluctance to buy certain fruits and vegetables because of negative information related to food safety. The majority agreed that they were affected by the media when posting negative news related to food safety. Therefore, multiple media outlets have a positive awareness effect. However, the result indicated that the sample opinion was neutral when asked whether the government is doing its duty toward pesticide residues. This result may suggest that the community does not have sufficient information about government measures to control food safety and reduce pesticide residues in foods.

Table 4. Distribution of variables of attitudes and perceptions toward food safety

Variables	Average sample opinion	Percentage %	Sample direction
Price vs. food safety	5.9 out of 7	84.2	Positive food safety attitudes
Ban	3.8 out of 5	75.5	Agree
Brand	3.6 out of 5	72.1	Agree
Reacting	3.7 out of 5	74.8	Agree
Government censorship	2.9 out of 5	57.2	Neutral

Dietary habits for the consumption of dates

This section summarizes whether respondents consume dates throughout the year or only during social or religious events, the occasions where dates are primarily consumed, and the primary source of obtaining dates. *Figure 1* shows that 81% of the research sample consumes dates year-round, while only 19% is concerned with dates during social or religious events. This result shows the importance of dates to consumers in Saudi Arabia. *Figure 2* illustrates that 91% primarily consume dates in their homes, while 9% in other places. Regarding the source of dates, *Figure 3* depicts that the specialized date shops are the primary source (40.7%).

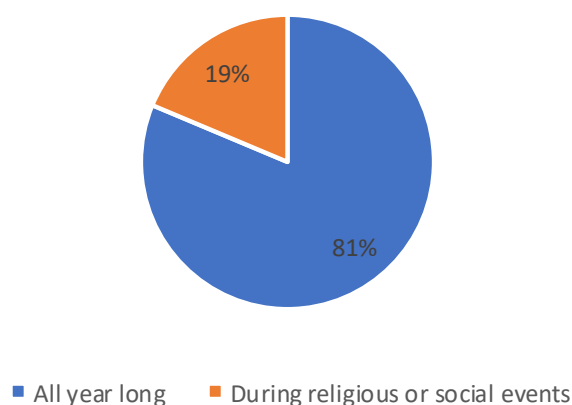


Figure 1. Distribution of responses to consuming dates during the year

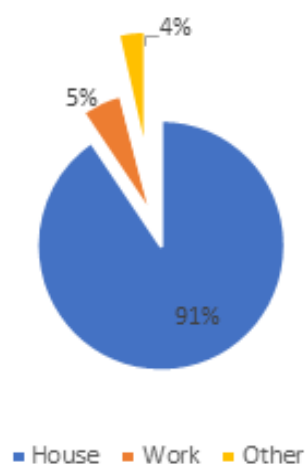


Figure 2. Distribution of responses for places to consume dates

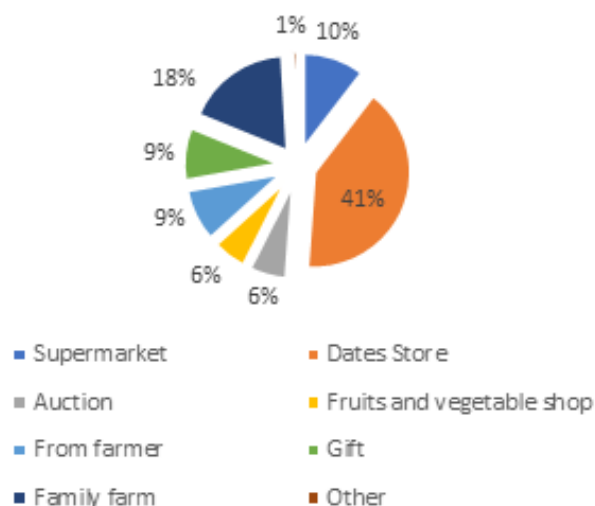


Figure 3. Distribution of responses to obtain dates

Estimate willingness to pay

Overview to estimate the willingness to pay for pesticide-free dates

The study used the double-bounded elicitation model to estimate consumers' WTP, representing the difference between the price of ordinary dates and FPR dates. Moreover, the study assumed that the price of a Kg of FPR dates increased by the initial bid of SAR 3, 6, 9, or 10 (USD 0.80, 1.60, 2.40, or 2.67). The study adopted four scenarios regarding whether the consumer is willing to pay that amount, with the answer yes or no. If the answer was "yes," the respondent was presented with a greater amount SAR 5, 9, 13, or 14 (USD 1.33, 2.40, 3.47, and 3.73), respectively. If the answer to the first question was "no," the next question determined what the respondent would do if the price dropped to SAR 2, 3, 5, or 6 (USD 0.53, 0.80, 1.33, or 1.60). Therefore, the expected results suggest that the participant rejects the initial bid and the lower bid (NN), rejects the initial bid and accepts the lower bid (NY), accepts the initial bid and rejects the higher bid (YN), or accepts both the initial bid and higher bid (YY).

Table 5 shows how the sample was divided between the four scenarios. The distribution of the research sample to the expected answers needed to obtain the product of FPR dates and refusal to pay any amount for it represented 9.8% of the sample. Those willing to pay below the initial bid were 6.3%, and those not agreeing to pay higher than the initial bid represented 23.3%, while those willing to pay higher than the initial bid represented 60.8%. For smaller bidding prices, the probabon of those related to the (YY) outcome is higher, aligning with the theory, but unexpectedly, the same pattern continues as prices increase from 6 to 10. A possible justification is that the positive attitude toward food safety, as measured by trading off between price vs. food safety, could contribute to such pattern.

Estimate willingness to pay without explanatory variables

This study uses the Stata 13 SE program and the "doubleb" command (Lopez-Feldman, 2012). From Table 6, the research sample indicates that, on average, the consumer is willing to pay an additional difference of SAR 12.95 (3.45 USD) per Kg to

obtain FPR dates. Therefore, the estimated total price is SAR 27.95 (USD 7.45), as the study assumed that the average traditional date is SAR 15 (4 USD) per Kg. However, the question is as follows: what are the factors affecting willingness to pay, and what is the average value that the consumer is willing to pay for the existence of these influencing factors?

Table 5. Distribution of responses to initial, higher, and lower bid offers

First bid	Higher bid	Lower bid	NN		NY		YN		YY	
			Freq.	Ratio %	Freq.	Ratio %	Freq.	Ratio %	Freq.	Ratio %
3	5	2	10	6.0	2	1.2	35	20.8	121	72.0
6	9	3	5	3.0	20	12	47	28.1	95	56.9
9	13	5	22	14.8	14	9.4	31	20.8	82	55.0
10	14	6	26	15.4	5	3	39	23.1	99	58.5
Total overall			63	9.8	41	6.3	152	23.3	397	60.8

Table 6. Estimating the WTP model with no control variables

Dependent variable: WTP	Coefficient	SE	Z	p-value
Constant	12.950	0.415	31.200	0.000

N = size of sample = 653

Estimated willingness to pay with explanatory variables

This section presents a statistical model to identify explanatory variables and explores a significant statistical impact on WTP for FPR dates, eliciting the mean WTP. The explanatory variables comprise economic and social variables, factors related to food safety and the effect of habits, and the source of dates. The economic and social variables include male, age, education, marital status, employee status, primary shopper, shopping contributor, children under 18, chronic disease, place of residence, and income. The second explanatory variables are price vs. food safety, ban, brand, reacting, and government censorship. The last explanatory variable group includes frequency, place, supermarket, date store, auction, and fruits and vegetables shop. This comprehensive model contains the most assumed variables that could impact the dependent variable.

Table 7 depicts the results revealing statistically significant variables. Education, marital status, shopping contributor, and income variables are significant at the 5%, rejecting the null hypothesis of no effect on WTP. Education negatively impacts WTP, while income poses a positive impact. Compared to unmarried individuals, being married is negatively associated with WTP.

The second group of variables explores the impact of variables related to food safety. The results indicate that the price vs. food safety, ban, and brand are statistically significant at 1%, exerting positive impacts. The results for the mean elicited WTP are robust among different specifications. *Table 7* shows that the main WTP is SAR 12.96 (USD 3.46), similar to the model outcome in *Table 6*, without controlling for consumer characteristics.

Table 7. Variables affecting respondents' WTP and estimating the average WTP

Variable	Coefficient	SE	Z	p-value
Male	-0.88	0.83	-1.05	0.293
Age	0.54	0.58	0.92	0.357
Education	-0.71	0.40	-1.77	0.076
Marital status	-2.89	1.15	-2.51	0.012
Employee	0.91	0.84	1.09	0.277
Main shopper	-2.42	1.99	-1.22	0.223
Shopping contributor	-3.75	1.96	-1.92	0.055
Having children under 18 years old	-0.23	0.96	-0.24	0.808
Having chronic disease	0.25	0.81	0.31	0.757
Place of residence	-0.31	0.71	-0.43	0.668
Income	0.99	0.41	2.44	0.015
Price vs. food safety	1.18	0.23	5.01	> 0.001
Ban	0.94	0.29	3.21	0.001
Brand	0.84	0.32	2.66	0.008
Reacting	-0.38	0.33	-1.15	0.250
Government censorship	0.42	0.31	1.36	0.175
Frequency	0.94	0.89	1.07	0.286
Place	0.52	1.17	0.45	0.654
Supermarket	1.85	1.20	1.54	0.123
Date-store	1.21	0.76	1.61	0.108
Auction	0.74	1.50	0.49	0.621
Fruit and vegetables shop	-1.02	1.42	-0.72	0.470
Constant	1.74	3.53	0.49	0.622
Mean of WTP	12.96	0.39	32.90	> 0.001

N = size of sample = 653

Discussion and conclusion

In this study, we aim to estimate the WTP for FPR dates in Saudi Arabia and assess the impact of the most critical variables influencing the WTP for FPR dates. Consumers are willing to pay 12.96 SAR (3.46 USD) above the average price per Kg of uncertified dates, indicating an increase of 86%. To the best of our knowledge, no previous research has elicited WTP for FPR dates among consumers in Saudi Arabia, creating a challenge to cross-validate our findings for the additional percentage the consumers are willing to pay for the FPR dates. Other studies using a double-bound model have varied in their estimates of the premium for the FPR products. Vietnamese consumers are willing to pay 60% above the market price for Chinese mustard to avoid pesticide residues (Mergenthaler et al., 2009). Consumers in urban India are willing to pay 56.6% higher to obtain FPR vegetables. Nevertheless, the total price consumers are willing to pay for FPR dates is still below the average price of organic dates. The 86% could be deemed the upper bound premium for FPR dates.

Higher education is negatively associated with lower WTP for food safety. A possible explanation is that FPR certificates might resonate less with highly educated consumers as a signal for better quality because they maybe already have a prior perception of the accepted level. This negative association between education and WTP

for food safety attributes is common (Misra et al., 1991; Boccaletti and Nardella, 2000). Sriwaranun et al. (2015) cited that education exerted conflicting results among studies they reviewed in their work estimating WTP for organic products.

Surprisingly, married individuals and shopping contributors were less likely to pay a higher premium for FPR dates in Saudi Arabia; however, as expected, income was positively associated with WTP for FPR dates.

The government's policy implies increasing awareness campaigns to help shift consumer attitudes toward food safety. Attitudes toward food safety positively affected consumers' WTP, as measured by a tradeoff variable between price and food safety. This result aligns with Misra et al. (1991) and Mergenthaler et al. (2009), who found that food safety concerns positively impacted WTP.

Consumers agreeing to ban pesticides would pay higher prices for FPR dates, and so are those preferring to buy branded fruits and vegetables. Branded products can be traceable, which could identify a marking opportunity for certified and traceable produce.

Given the above insights, our study is exploratory due to the applied snowball sampling method and not accounting for potential biases such as starting point bias (Britwum and Yiannaka, 2019). Even with a representative sample and addressing all sorts of potential biases, still be cautious about extrapolating, given the inability to cross-validate with other studies addressing similar research objectives within Saudi Arabia. Another limitation is omitting environmental attitudes in estimating consumers' WTP for FPR products. Future research should overcome such limitations.

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Data availability. The datasets generated during the current study are available from the corresponding author on reasonable request.

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