

## ECONOMIC VALUATION OF STEVIA SWEETENER: DOUBLE-BOUNDED DICHOTOMOUS CHOICE STUDY IN EAST JAVA

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### Abstract

**Background:** Sugar consumption in Indonesia reaches 160 grams per day, six times the WHO recommendation, contributing to 20.4 million diabetes cases (ranked 2nd globally). Stevia rebaudiana Bertoni offers a promising natural, zero-calorie sweetener alternative; however, its market adoption in Indonesia remains hindered by high prices, consumer perceptions, and a lack of empirical economic valuation data.

**Purpose:** This study aimed to analyze consumer willingness to pay (WTP) for stevia-based sweetener products in East Java and examine the factors influencing this decision.

**Design/methodology/approach:** The study employed the Contingent Valuation Method with Double-Bounded Dichotomous Choice format on 200 respondents in East Java. Factor analysis utilized ordered logit regression with independent variables that included sociodemographic characteristics, diabetes status, knowledge of stevia, perceptions of price and quality, and health consciousness.

**Findings/Result:** Consumers in East Java demonstrated a strong premium WTP for stevia sweeteners, exceeding current market prices by more than 50%. Product knowledge and health consciousness emerged as the most influential determinants, indicating that health-related motivations substantially shape consumer valuation.

**Conclusion:** East Java consumers demonstrated substantial premium WTP for stevia sweeteners, with product knowledge and health consciousness as primary determinants, indicating the importance of health education strategies and product value communication to increase stevia sweetener product adoption in Indonesia.

**Originality/value (State of the art):** This study contributes to the limited literature on the economic valuation of healthy sweetener products in developing countries with high sugar consumption, using the CVM-DBDC approach to identify specific determinants of consumer decisions in adopting natural sweeteners as substitutes for conventional sugar.

**Keywords:** contingent valuation method, double-bounded dichotomous choice, health consciousness, stevia sweetener, willingness to pay

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## INTRODUCTION

Excessive sugar consumption has become a serious public health challenge in Indonesia. In 2024, the country recorded 20.4 million diabetes mellitus cases, ranking second globally, and the number is projected to increase by 40.19% by 2050 (International Diabetes Federation, 2025). This alarming trend is closely associated with prevailing dietary patterns, where cane sugar (*Saccharum officinarum*) remains the dominant sweetener and is consumed at an average of 160 grams per day, which is six times higher than the 25-gram daily recommendation of the World Health Organization (Badan Pangan Nasional, 2024; World Health Organization, 2015). Excessive sugar intake is particularly concerning because it provides 4 calories per gram and has a high glycemic index (65), contributing to blood glucose spikes and increasing the risk of diabetes (Atkinson et al. 2021; Choi et al. 2026). These conditions underscore the urgent need to promote healthier sweetener alternatives as part of preventive health strategies.

Along with increasing awareness of sugar-related health risks, consumer preferences have gradually shifted toward healthier sweetener options globally (Nugraha et al. 2025; Pielak et al. 2019; Ren et al. 2025). This change reflects the growing concern regarding diet-related diseases and the long-term health effects of excessive sugar consumption. As a result, consumers are increasingly seeking alternative sweeteners that provide sweetness while minimizing negative health impacts. This behavioral transition is reflected in the steady expansion of the natural sweetener market, which has grown at a Compound Annual Growth Rate (CAGR) of 4.9% during 2021–2028 and is projected to reach USD 20.9 billion (Fortune Business Insight, 2022). However, while global demand trends indicate increasing interest in sugar substitutes, the extent to which Indonesian consumers are willing to adopt and financially support such alternatives remains unclear.

Among natural sweeteners, *Stevia rebaudiana* Bertoni has emerged as a prominent alternative because of its high-intensity sweetness (200–400 times sweeter than sucrose), zero-calorie content, negligible glycemic effect, and thermal stability (Jiang et al. 2026; Khilar et al. 2022; Peteliuk et al. 2021). Its main components, steviol glycosides (stevioside and rebaudioside A), have received Generally Recognized as Safe (GRAS) status from the U.S. Food and Drug Administration and are approved by Indonesia's food authority, BPOM (Perrier et al. 2018).

In addition, stevia leaves contain various bioactive compounds, such as phenolics and flavonoids, which are associated with potential health benefits (Myint et al. 2020; Nuryandani et al. 2024; Papaefthimiou et al. 2024). These functional attributes position stevia as a promising preventive dietary substitute for diabetes. Consequently, stevia has attracted increasing attention from researchers and policymakers as a potential strategy for reducing excessive sugar consumption.

Despite these advantages, the market adoption of stevia sweeteners in Indonesia remains limited. One of the main barriers is its consistently higher price compared to conventional sugar, creating a trade-off between perceived health benefits and affordability (Kamarulzaman et al. 2014; Navanukraw et al. 2025). Although the Indonesian stevia market is projected to grow from USD 19.19 million in 2024 to USD 33.43 million by 2032, with a CAGR of 6.7% (DataBridge Market Research, 2024), the actual product penetration remains relatively low. Previous studies have indicated that consumer acceptance of Stevia is influenced by taste perception, product knowledge, and communication of health benefits (Goodman et al. 2021; Samuel et al. 2018; Williams et al. 2023). However, acceptance does not necessarily translate into willingness to pay (WTP) a premium price.

Previous studies have widely applied the Contingent Valuation Method (CVM), particularly the Double-Bounded Dichotomous Choice (DBDC) approach, to estimate consumers' willingness to pay (WTP) for food products, environmental goods, and public services that provide additional health, safety, or environmental benefits. For example, Kamarulzaman et al. (2014) examined consumer acceptance of Stevia as a sugar substitute in Malaysia and found that health benefits, promotion, and product availability significantly influenced consumer acceptance. Similarly, studies on alternative food products, such as cultured meat and plant-based milk, have shown that consumer awareness, education, and perceived health benefits play important roles in shaping consumer acceptance and willingness to pay (Su et al. 2024; Zhang et al. 2020).

Several studies have applied the DBDC-CVM framework to estimate WTP for food and agricultural products. Brago et al. (2022) found that consumers in Ghana were willing to pay a substantial premium for quail products, with knowledge, education, and income significantly influencing their WTP. Likewise, Kabir et al. (2023)

reported that consumers in Bangladesh were willing to pay additional premiums for traceable vegetables, particularly when their income and quality perception were high. Similar findings have been reported for organic or pesticide-free food products, where health awareness, perceived food safety, and environmental concerns positively affect consumers' WTP (Ha et al. 2019; Nohara, 2023). Beyond food products, the CVM–DBDC approach has been widely used to estimate the economic value of environmental programs and public services, such as reusable food container systems, green roofing programs, and improved waste management services (Ji et al. 2022; Schuermann & Woo, 2022; Tassie et al. 2024). These studies demonstrate that consumers often assign positive economic value to products and services that improve sustainability, safety, and environmental quality.

Despite the growing literature on WTP for healthier and sustainable products, empirical evidence on the economic valuation of natural sweeteners, such as stevia, remains limited, particularly in developing countries. Most existing studies focus on consumer acceptance or attitudes rather than estimating consumers' monetary valuations using structured valuation methods. In addition, limited research has examined how health-related factors, such as diabetes exposure and health consciousness, influence consumers' willingness to pay for alternative sweeteners. Therefore, this study contributes to the literature by estimating consumers' willingness to pay for stevia sweeteners using the DBDC contingent valuation approach in Indonesia, a country characterized by high sugar consumption and increasing diabetes prevalence. By incorporating sociodemographic, health-related, and perception-based variables into the WTP model, this study provides new empirical evidence on how consumer awareness, health concerns, and product perceptions influence the economic valuation of healthier sweetener alternatives in the Philippines.

Based on the theoretical discussion, this study expects that consumers in East Java will demonstrate a positive premium WTP for the stevia sweetener relative to conventional sugar. Health-related behavioral factors, particularly health consciousness and product knowledge, are anticipated to exert a stronger influence on WTP than purely demographic characteristics. Furthermore, consumers with diabetes exposure are expected to assign higher valuations due to increased perceived health risks.

To address these gaps, this study applies the Contingent Valuation Method (CVM) using the Double-Bounded Dichotomous Choice (DBDC) format to estimate consumer WTP for stevia sweetener products in East Java, Indonesia. The DBDC approach improves statistical efficiency by extracting more information from each respondent through two sequential bid questions (Hanemann et al. 1991). In addition, an ordered logit regression model was employed to analyze the determinants of WTP, integrating sociodemographic characteristics with health-related behavioral factors. This analytical framework allows us to examine both economic valuation and behavioral determinants simultaneously.

This study aims to estimate consumers' willingness to pay (WTP) for stevia sweeteners and identify the factors influencing this valuation. Specifically, this study applies the Contingent Valuation Method (CVM) with a Double-Bounded Dichotomous Choice (DBDC) format to estimate the economic value that consumers assign to the stevia sweetener. In addition, this study examines how sociodemographic characteristics, product knowledge and perception, and health-related psychological factors influence consumers' willingness to pay. The findings are expected to provide insights into consumer valuation of stevia sweeteners and offer implications for pricing strategies and marketing approaches in the development of healthier sweetener products.

## METHODS

This study was conducted in East Java Province from October to November 2025. East Java was selected because it has a relatively high diabetes mellitus prevalence (2.2%) and a population of 41.8 million people, making it a relevant setting for examining food consumer behavior in Indonesia. A total of 200 adult respondents ( $\geq 18$  years) who were the primary decision-makers in household food purchases, including sweeteners, were selected using purposive sampling. This non-probability sampling approach was employed to ensure that the respondents met specific eligibility criteria and possessed sufficient relevance to the valuation scenario. Given that stevia remains a niche product in Indonesia, probability-based sampling could yield a high proportion of respondents with limited awareness or relevance to purchasing. Therefore, purposive sampling was considered appropriate to capture informed consumer valuation within the targeted

market segment while acknowledging potential limitations in representativeness.

The sample size of 200 respondents is consistent with common practice in Contingent Valuation Method (CVM) studies employing Double-Bounded Dichotomous Choice (DBDC) formats, which typically involve between 120 and 300 observations to achieve statistically efficient WTP estimates (Brago et al. 2022; Su et al. 2024). The chosen sample size also accounts for potential non-response or incomplete questionnaire rates estimated at approximately 10%, ensuring an adequate number of usable observations for the analysis. Furthermore, a sample of this size satisfies the general maximum likelihood estimation requirements and aligns with previous empirical applications of CVM in food product valuation studies. In addition, this sample size provides sufficient variability in responses to estimate the influence of sociodemographic and

behavioral variables on the WTP. Therefore, the final sample was considered adequate for both the valuation estimation and regression analysis.

All variables included in the empirical analysis were operationalized based on the prior literature and the structure of the survey instrument. Sociodemographic characteristics, economic variables, health-related indicators, and perception-based constructs were measured using categorical, binary, and Likert scale formats, as appropriate. Composite indices were constructed for multi-item constructs by averaging the item responses. Likert-scale variables and composite indices were treated as continuous predictors in the ordered logit estimation. Detailed definitions and coding procedures are presented in Table 1 to ensure the transparency and replicability of the empirical analysis.

Table 1. Definitions and measurement indicators of variables used in the willingness to pay model for Stevia Sweetener

Variable	Scale Treatment	Measurement/Coding	Reference
Gender	Dummy variable	0= Female, 1= Male	Brago et al. (2022); Ha et al. (2019); Zhang et al. (2020)
Age	Ordered categorical	1= 18-28 years; 2= 29-44 years; 3= 45-60 years; 4= 61-79 years	Brago et al. (2022); Ha et al. (2019); Zhang et al. (2020)
Marital Status	Dummy variable	0=Unmarried (including single/divorced/widowed), 1=Married	Brago et al. (2022); Ha et al. (2019)
Education Level	Ordered categorical	1= Elementary, 2= Junior High, 3= Senior High, 4= Diploma/Bachelor (D3/S1), 5= Postgraduate (S2/S3)	Brago et al. (2022); Ha et al. (2019); Zhang et al. (2020)
Occupation	Dummy coding	1= Student, 2= Housewife, 3= Private Sector Employee, 4= Government Employee (ASN/PNS/ BUMN), 5= Self-employed/Entrepreneur, 6= Others	Brago et al. (2022); Zhang et al. (2020)
Number of Family Members	Continuous	Number of household members	Brago et al. (2022); Ha et al. (2019); Zhang et al. (2020)
Income	Ordered categorical	1 = <IDR2.500.000, 2 = IDR2.500.001 – IDR5.000.000, 3 = IDR5.000.001 – IDR10.000.000, 4 = >IDR10.000.001	Brago et al. (2022); Ha et al. (2019); Zhang et al. (2020)
Food Expenditure	Ordered categorical	1 = <IDR1.000.000, 2 = IDR1.000.001 – IDR2.500.000, 3 = IDR2.500.000 – IDR4.000.000, 4 = >IDR4.000.001	Brago et al. (2022); Ji et al. (2022)
Diabetes Status	Dummy variable	Binary (0= No, 1= Yes)	Zhang et al. (2020)
Knowledge of Stevia	Dummy variable	Binary (0= No, 1= Yes)	Tan et al. (2022)
Price Perception	Likert (1-5)	1 (Very unimportant) to 5 (Very important)	Kabir et al. (2023)
Quality Perception	Likert (1-5)	1 (Very unimportant) to 5 (Very important)	Kabir et al. (2023)
Health Consciousness (HC)	Likert (1-5)	Mean of Likert items (1–5) (1 = strongly disagree to 5 = strongly agree)	Su et al. (2024)

Note: Composite indices were calculated as the means of the respective Likert-scale items. Higher scores indicate a stronger agreement or greater perceived intensity. Ordinal variables preserved natural ranking and were entered into the regression model accordingly.

Data were collected through an online survey using Google Forms. Each respondent received standardized information about Stevia sweetener products, including nutritional content, potential health benefits, BPOM approval status, and examples of products available in the market. Information was presented through product images and written descriptions to ensure informed valuation in accordance with CVM principles (Mitchell & Carson, 1989). The research questionnaire consisted of four sections: (1) sociodemographic characteristics, (2) health status and sweetener consumption experience, (3) psychometric scales measuring health consciousness, price perception, and quality perception, and (4) WTP questions using the DBDC format. This structured questionnaire design ensured that respondents clearly understood the valuation scenario before providing their WTP responses.

### Pilot Study and Bid Design

A pilot study involving 40 respondents was conducted to assess the feasibility of the data collection procedure, identify potential technical issues, and determine appropriate bid levels for the valuation scenario (Arrow et al. 1993; Bateman et al. 2002). Based on the pilot study results and market price surveys of stevia-based healthy sweetener products ranging from IDR29,009–IDR92,120 with an average of IDR56,714 per 15 ml, four starting bid values were determined: IDR 40,000, IDR60,000, IDR80,000, and IDR100,000. These bid levels were selected to reflect realistic market conditions while capturing variations around the prevailing price range. In the DBDC framework, respondents are first presented with a starting bid . The follow-up bid was then determined using the following formula:

$$B_{\text{higher}} = B_0 \times (1+r)$$

for respondents answering “Yes” to the initial bid, and

$$B_{\text{lower}} = B_0 \times (1+r)$$

for respondents answering “No,” where  $r$  represents the adjustment ratio.

In this study, the adjustment ratio was set at (50%), which falls within the range recommended by Cooper (1993), between 0.5 and 1.0. The choice of a 50% adjustment was based on several factors. First, it creates a sufficiently distinct price difference between the initial and follow-up bids, enabling respondents to reassess their valuation meaningfully without producing excessively wide intervals that could increase the response variability. Second, pilot study findings indicated that a 50% adjustment remained within a realistic price range and generated adequate variation in acceptance. Finally, applying a consistent ratio across all starting bids enhances the comparability and statistical efficiency of the DBDC estimation.

To minimize anchoring effects and starting-point bias, respondents were randomly assigned to one of the four starting bid values (Herriges & Shogren, 1996). Random assignment ensures that no specific bid level systematically influences the respondents’ valuation responses. This procedure helps to improve the internal validity of the contingent valuation scenario. The complete structure of the starting and follow-up bids applied in this study is presented in Table 2.

Table 2. Starting bid and follow-up bid levels used in the Double-Bounded Dichotomous Choice (DBDC) method based on pilot study

Starting Bid ( $B^i$ )	Higher Follow-up Bid ( $B_i^H$ )	Lower Follow-up Bid ( $B_i^L$ )
	Accepting the Starting Bid	Rejecting the Starting Bid
IDR40,000	IDR60,000	IDR20,000
IDR60,000	IDR90,000	IDR30,000
IDR80,000	IDR120,000	IDR40,000
IDR100,000	IDR150,000	IDR50,000

### Contingent Valuation Method: Double -Bounded Dichotomous Choice (DBDC)

This study uses the Contingent Valuation Method (CVM) with a Double-Bounded Dichotomous Choice (DBDC) format to estimate consumer WTP (Hanemann et al. 1991; Mitchell & Carson, 1989). The DBDC format is an improvement over the simple dichotomous choice, offering higher statistical efficiency by reducing the estimation variance by 30-50% compared to the single-bounded format (Hanemann et al. 1991). Respondents were first asked whether they were WTP an initial bid amount,  $B_i$ . If the response was “Yes,” a higher follow-up bid  $B_i^H$  was offered. If the response was “No,” a lower follow-up bid  $B_i^L$  was presented. This sequential design produces four possible response combinations: yes–yes (YY), yes–no (YN), no–yes (NY), and no–no (NN). The willingness to pay (WTP) elicitation in this study employed the Double-Bounded Dichotomous Choice (DBDC) format. The sequence of the bid questions presented to the respondents is illustrated in Figure 1.

The DBDC framework generates interval-censored WTP information rather than exact monetary value. Let denote a respondent’s latent WTP. The observed outcomes can be categorized into five ordered groups:

- $y_0 = 0$  if  $y_i^* \leq 0$  = Zero WTP
- $y_1 = 1$  if  $0 < WTP \leq B_i^L$  (NN WTP)
- $y_2 = 2$  if  $B_i^L < WTP \leq B_i$  (NY WTP)
- $y_3 = 3$  if  $B_i < WTP \leq B_i^H$  (YN WTP)
- $y_4 = 4$  if  $WTP > B_i^H$  (YY WTP)

Because respondents provide bounded responses rather than continuous values, WTP is naturally represented as an ordered categorical variable reflecting increasing valuation intensity.

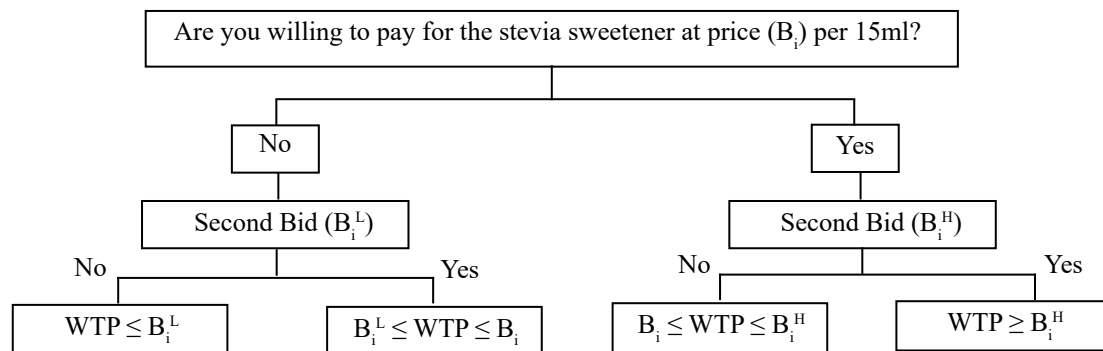


Figure 1. Double-Bounded Dichotomous Choice (DBDC) elicitation format for measuring consumer willingness to pay for stevia sweetener

Under the logistic distribution assumption, the probability of each response category is defined as

$$\pi_1 = P(NN) = \Lambda(B_i^L - x'\beta) - \Lambda(0 - x'\beta)$$

$$\pi_2 = P(NY) = \Lambda(B_i - x'\beta) - \Lambda(B_i^L - x'\beta)$$

$$\pi_3 = P(YN) = \Lambda(B_i^H - x'\beta) - \Lambda(B_i - x'\beta)$$

$$\pi_4 = P(YY) = 1 - \Lambda(B_i^H - x'\beta)$$

where  $\Lambda(t) = 1/(1+e^{-t})$  represents the cumulative logistic distribution function.

Parameter estimation was conducted using Maximum Likelihood Estimation (MLE). The log-likelihood function is constructed by summing the logarithm of the probability corresponding to each observed response outcome across all the respondents.

$$\ln L = \sum_{i=1}^n \{d^{yy} \ln \pi^{yy}(\lambda_i, \lambda_{SH}) + d^{yn} \ln \pi^{yn}(\lambda_i, \lambda_{SH}) + d^{ny} \ln \pi^{ny}(\lambda_i, \lambda_{SL}) + d^{nn} \ln \pi^{nn}(\lambda_i, \lambda_{SL})\}$$

where  $d^{yy}$ ,  $d^{yn}$ ,  $d^{ny}$ , and  $d^{nn}$  are dummy variables that take the value 1 if the statement is true, and 0 otherwise. In the DBDC framework, respondents do not directly state a continuous monetary amount; instead, they provide sequential yes/no responses to the bid levels, generating interval-censored valuation data. Consequently, treating WTP as an ordinal variable is consistent with the structure of DBDC responses, where the exact monetary value remains unobserved but is bounded within known price intervals. Therefore, the ordered logit model is employed to capture the ordered nature of the WTP categories while preserving the ranking information embedded in the response patterns.

## Ordered Logit Regression Model

Factors influencing WTP were analyzed using the ordered logit regression model, which is suitable for ordinal multi-category dependent variables such as WTP categories in CVM studies (Liu et al. 2023; Marcillo-yepez et al. 2024). The latent WTP variable is specified as a linear function of the independent variables:

$$y_i^* = \beta_1 x_{1i} + \beta_2 x_{2i} + \dots + \beta_k x_{ki} + \varepsilon_i = x_i' \beta + \varepsilon_i$$

where  $x_{1i}, x_{2i}, \dots, x_{ki}$  are independent variables,  $\beta_1, \beta_2, \dots, \beta_k$  are regression coefficients, and  $\varepsilon_i$  is a random error term with a logistic distribution. The observed dependent variable ( $y_i$ ) is ordinal with five categories (0 = Zero WTP, 1 = NN WTP, 2 = NY WTP, 3 = YN WTP, 4 = YY WTP) and can be expressed through the threshold parameter ( $\lambda$ ) as follows:

$$y_i = j \leftrightarrow \lambda_{j-1} - 1 < y_i^* \leq \lambda_j$$

The probability of the respondent being in category  $j$ :

$$P = (y_i = j | x_i) = \Lambda(\lambda_{j-1} - x' \beta) - \Lambda(\lambda_j - x' \beta)$$

where  $\Lambda(\cdot)$  is the cumulative logistic distribution function.

The coefficient represents the change in the log-odds of being in a higher WTP category. Odds ratios (OR) are obtained by exponentiating the coefficients,  $OR = e^\beta$ , while marginal effects are computed to illustrate changes in predicted probabilities.

To validate the ordered logit specification, the proportional odds (parallel lines) assumption was evaluated using the nominal test within the cumulative link modeling framework. This test examines whether the estimated coefficients remain constant across the cumulative thresholds of the ordinal dependent variable. The results indicate that most of the explanatory variables satisfy the proportional odds assumption. Minor deviations were detected for the variables Diabetes and Knowledge; however, given that the violation was limited and did not affect the majority of predictors, the ordered logit model was retained for interpretability and consistency with prior empirical valuation studies. Parameter estimation was conducted using maximum likelihood estimation with R software (version 4.5.2).

## Hypothesis

Drawing upon information asymmetry theory, health behavior theory, and consumer demand theory, this study formulates the following hypotheses regarding the determinants of WTP for stevia sweetener:

- H1 : Gender significantly influences consumers' WTP for stevia sweetener.
- H2 : Age significantly influences consumers' WTP for stevia sweetener.
- H3 : Marital status significantly influences consumers' WTP for stevia sweetener.
- H4 : Education level positively influences consumers' WTP for stevia sweetener.
- H5 : Occupation significantly influences consumers' WTP for stevia sweetener.
- H6 : Number of family members significantly influences consumers' WTP for stevia sweetener.
- H7 : Income positively influences consumers' WTP for stevia sweetener.
- H8 : Food expenditure positively influences consumers' WTP for stevia sweetener.
- H9 : Diabetes status positively influences consumers' WTP for stevia sweetener.
- H10 : Knowledge of stevia sweetener positively influences consumers' WTP.
- H11 : Positive price perception significantly influences consumers' WTP for stevia sweetener.
- H12 : Positive quality perception significantly influences consumers' WTP for stevia sweetener.
- H13 : Health consciousness positively influences consumers' WTP for stevia sweetener.

These hypotheses are empirically tested using an ordered logit model within the DBDC contingent valuation framework. Figure 2 illustrates the study's conceptual framework. Consumers' willingness to pay (WTP) for the stevia sweetener was estimated using the Contingent Valuation Method (CVM) with a Double-Bounded Dichotomous Choice (DBDC) format. The framework also highlights that WTP is influenced by several groups of factors related to consumer characteristics and product perception. These factors were analyzed to identify the determinants influencing consumers' valuation of stevia sweeteners. The results of the analysis provide insights that can support the development of managerial and marketing strategies for stevia products.

## RESULTS

### Respondent Characteristic

This study involved 200 respondents from East Java. The majority were women, reflecting their dominant role in household food purchasing and family health management in Indonesia (Fatchiya et al. 2024). Most respondents were aged 18–28 years, indicating a strong representation of Generation Z, a demographic group reported to have a growing interest in healthy food products (Ulita et al. 2024). The dominance of younger consumers may also reflect higher participation rates in online surveys for this age group. The detailed socio-demographic characteristics of the respondents are presented in Table 3.

The educational attainment was relatively high, with most respondents holding at least a diploma or bachelor’s degree. Education is considered an important component of human capital that influences the ability to process health information and make informed

purchasing decisions (Brago et al. 2022; Zhang et al. 2020). A substantial proportion of respondents reported a personal or family history of diabetes, consistent with the high prevalence of diabetes in East Java. Although awareness of stevia was high, the actual product trial remained limited. Similar awareness–trial gaps have been documented in Malaysia, where consumer knowledge does not automatically translate into product adoption (Kamarulzaman et al. 2014). This pattern suggests that information alone may not be sufficient to drive consumers’ adoption of alternative sweeteners.

### Distribution of WTP Responses

The DBDC responses indicate that most respondents fall into the higher WTP categories. No respondents reported zero WTP, indicating that all respondents were willing to pay at least the minimum offered. Table 4 summarizes the distribution of WTP responses among consumers.

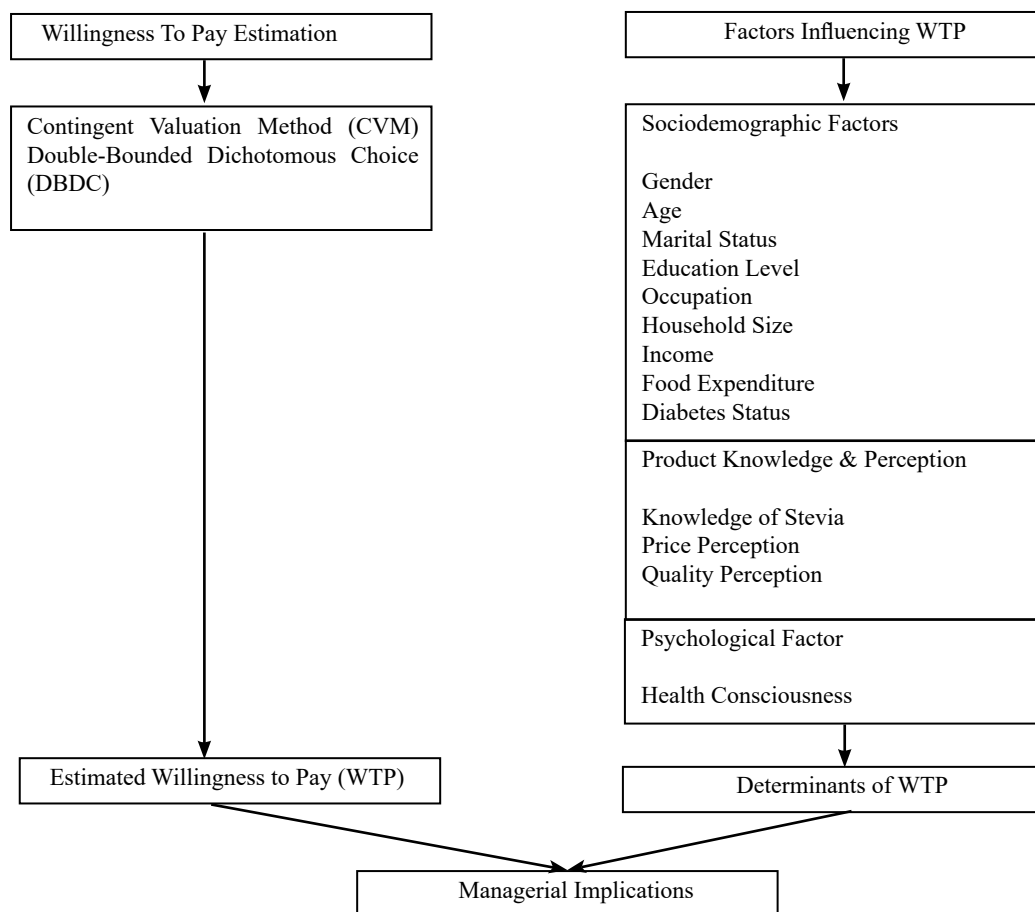


Figure 2. Conceptual framework of willingness to pay for stevia sweetener

Table 3. Socio-demographic characteristics of respondents in the stevia sweetener consumer survey in East Java

Variable	Frequency	Percentage	Mean	St. Dev.
<b>Gender</b>				
Female	138	69.0		
Male	62	31.0		
<b>Age</b>				
18-28 years	123	61.5	28.59	6.70
29-44 years	69	34.5		
45-60 years	6	3.0		
61-79 years	2	1.0		
<b>Marital Status</b>				
Unmarried	110	55.0		
Married	90	45.0		
<b>Education Level</b>				
Senior high school/equivalent	44	22.0		
Diploma/Bachelor's degree	124	62.0		
Postgraduate degree (Master/Doctoral)	32	16.0		
<b>Occupation</b>				
Student	20	10.0		
Housewife	47	23.0		
Private sector employee	80	40.0		
Government employee	31	15.5		
Self-employed/Entrepreneur	22	11.0		
<b>Number of Family Members</b>			2.73	1.29
<b>Income (IDR/month)</b>			4,935,000	2,281,843
<IDR2,500,000	26	13.0		
IDR2,500,001 – IDR5,000,000	60	30.0		
IDR5,000,001 – IDR10,000,000	109	54.5		
> IDR10,000,001	5	2.5		
<b>Food Expenditure (IDR/month)</b>			1,684,500	848,238
< IDR1,000,000	40	20.0		
IDR1,000,001 – IDR2,500,000	129	64.5		
IDR2,500,001 – IDR4,000,000	27	13.5		
> IDR4,000,000	4	2.0		
<b>Diabetes Status</b>				
Yes	128	64.0		
No	72	36.0		
<b>Stevia Product Experience</b>				
Have tried	28	14.0		
Never tried	172	86.0		

Table 4. Distribution of Consumer Willingness to Pay (WTP) responses for Stevia Sweetener

Response Category	Frequency	Percentage (%)	Cumulative (%)
No-No (NN)	11	5.5	5.5
No-Yes (NY)	62	31.0	36.5
Yes-No (YN)	52	26.0	62.5
Yes-Yes (YY)	75	37.5	100.0

The distribution pattern suggests a broad acceptance of the stevia sweetener within the sampled population. Compared to the findings from Malaysia, where a notable proportion of consumers were unwilling to pay a premium (Kamarulzaman et al. 2014), the absence of zero WTP in this study indicates a stronger baseline valuation. This result may reflect increasing consumer awareness of the health risks associated with excessive sugar consumption. This also suggests that the perceived health benefits of stevia may justify a higher valuation among consumers. These findings highlight the potential market opportunities for healthier sweetener alternatives in Indonesia. Table 5 presents the detailed distribution of WTP responses across different starting bid categories.

Acceptance rates declined as the starting bid levels increased, reflecting price responsiveness. However, a segment of respondents continued to accept higher bids, suggesting the presence of relatively price-insensitive consumers in the market. This pattern is consistent with the value-based market segmentation theory, which proposes that purchasing decisions are driven by perceived value rather than absolute price (Zeithaml, 1988). The implied price elasticity indicates a relatively inelastic demand compared to conventional food products, which typically exhibit higher price sensitivity (Brago et al. 2022). Similar findings have been observed in studies of healthy food products, where consumers with stronger health motivations demonstrate lower price sensitivity (Alsubhi et al. 2023; Parashar et al. 2023).

### Mean WTP Estimation

The estimated mean WTP exceeds the prevailing average market price, indicating that consumers assign a substantial economic value to the stevia sweetener. The parameter estimation results and calculated WTP values are shown in Table 6. This finding suggests that consumers are willing to pay a premium for healthier alternatives to sweeteners. The positive price premium may reflect the perceived functional and health-related benefits associated with stevia consumption. The premium magnitude is positioned within the upper range reported in global systematic reviews of WTP for healthy food products (Alsubhi et al. 2023) and is higher than the typical organic food premiums documented in previous studies (Hu et al. 2024). This finding suggests that stevia sweetener is perceived not merely as a substitute product but as a health-enhancing alternative with added functionality. Therefore, consumers may view stevia as a preventive dietary choice rather than a simple sweetening agent. This perception strengthens the economic justification for promoting stevia in health-oriented food market.

### Determinants of Willingness to Pay (WTP)

The ordered logit results show that knowledge of stevia, health consciousness, and diabetes status have significant positive effects on the WTP. The education level is positively associated with WTP at a lower significance level. The complete regression results of the factors influencing WTP are reported in Table 7. These results indicate that both cognitive and health-related factors influence consumers' valuation of the stevia sweetener.

Table 5. Distribution of Willingness to Pay (WTP) responses across different starting bid categories

Starting Bid (B <sub>i</sub> )	N	No-No	No-Yes	Yes-No	Yes-Yes
IDR 40.000	50	4%	12%	18%	66%
IDR 60.000	50	2%	20%	16%	62%
IDR 80.000	50	2%	28%	56%	14%
IDR 100.000	50	14%	64%	14%	8%

Table 6. Estimated economic value of consumer willingness to pay for stevia sweetener using the double-bounded dichotomous choice model

Parameter	Value
MLE Estimation	
Mean WTP	IDR87,046
95% CI Lower	IDR81,685
95% CI Upper	IDR 92,592

Table 7. Ordered logit regression results of factors influencing consumer willingness to pay for stevia sweetener

Variable	Coefficient	Std. Error	z-value	p-value	OR
Gender	0.223	0.3330	0.670	0.503	1.250
Age	-0.011	0.025	-0.430	0.667	0.989
Marital Status	0.049	0.465	0.105	0.917	1.050
Education Level .	0.452	0.253	1.786	0.074	1.571
Occupation	0.154	0.142	1.086	0.277	1.166
Number of Family	0.040	0.187	0.213	0.831	1.041
Income	0.019	0.147	0.131	0.896	1.019
Food Expenditure	-0.322	0.416	-0.774	0.439	0.725
Diabetes Status ***	1.679	0.342	4.914	<0.001	5.359
Knowledge of Stevia ***	2.893	0.512	5.654	<0.001	18.038
Price Perception	-0.286	0.195	-1.463	0.144	0.752
Quality Perception	-0.321	0.246	-1.308	0.191	0.725
Health Consciousness (HC) ***	2.453	0.379	6.467	<0.001	11.102
Model Fit: McFadden's Pseudo R <sup>2</sup> = 0,335; LR $\chi^2$ = 166,3 (p<0,001); AIC = 361,9					

Note: \*\*\* p<0.001; \*\* p<0.01; \* p<0.05; p<0.1

Stevia knowledge had the strongest influence. This result aligns with evidence that consumer knowledge reduces uncertainty and increases the acceptance of healthier or novel food products (Tan et al. 2022). In line with the Information Asymmetry Theory (Stiglitz, Joseph, 2002), improved information mitigates perceived risk and enhances economic valuation. Health consciousness also showed a strong positive association with WTP. This finding is consistent with research on plant-based and healthy food products in Asia, where health-oriented attitudes significantly increase premium WTP (Shah et al. 2025; Su et al. 2024). Diabetes status showed a significant positive relationship with WTP, indicating that individuals with higher perceived health risks exhibit a stronger valuation of preventive food products. Similar patterns have been identified in studies on functional foods and risk-related consumption behaviors (Chen et al. 2024). In contrast, income and several demographic variables were not statistically significant predictors. This suggests that health-related motivations play a more central role than purchasing power in shaping the valuation of stevia sweeteners.

The findings demonstrate that consumers in East Java assign a meaningful economic value to stevia sweeteners. The premium over the market price indicates perceived benefits that extend beyond basic sweetness substitution. The strong influence of knowledge and health consciousness suggests that consumers' valuation of stevia is closely linked to awareness of health attributes and preventive health orientation. These results reinforce the relevance

of behavioral health frameworks in explaining the demand for healthier food alternatives. The positive effect of diabetes exposure indicates that perceived health vulnerability significantly shapes economic valuations. This supports the risk perception theory, which argues that individuals facing higher perceived health threats are more likely to adopt protective consumption behaviors. The limited role of income in explaining WTP suggests that the demand for preventive food products may not follow traditional income-driven demand patterns. Instead, informational and health-related variables appear to provide stronger explanatory power in high-risk health contexts than sociodemographic variables.

This study expands the literature on the economic valuation of healthy food products by applying the DBDC approach to natural sweeteners in a developing country characterized by high sugar consumption and diabetes prevalence. However, empirical evidence on stevia valuation in such contexts remains scarce. The findings indicate that health consciousness and product knowledge exert a stronger influence on WTP than conventional socioeconomic variables. This highlights the importance of integrating health behavior theory and information economics into consumer valuation models of preventive food products. The significant role of diabetes exposure further demonstrates that perceived health risks are a critical component of economic valuation. This suggests that models of WTP for functional or preventive foods should incorporate health vulnerability and awareness as the central explanatory factors.

## Managerial Implications

The findings of this study have several implications for food producers, marketers, and policymakers involved in developing and promoting healthier sweetener alternatives. The strong influence of consumer knowledge on willingness to pay suggests that educational strategies play an important role in increasing the market acceptance of stevia sweeteners. Therefore, producers and marketers should emphasize consumer education through clear product information, labeling, and marketing communication that highlights the health benefits of stevia over conventional sugar. Health consciousness is also a key factor influencing consumer valuation. This indicates that marketing strategies should target health-oriented consumer segments that are more receptive to healthier food alternatives. Promotional messages that emphasize reduced sugar intake, natural ingredients, and preventive health benefits may strengthen consumer interest and increase product adoption.

Furthermore, the significant role of diabetes exposure suggests that consumers with higher perceived health risks are more willing to pay for healthier sweeteners. This finding implies potential opportunities for collaboration between the food industry and public health institutions to promote healthier dietary choices. Public health campaigns addressing excessive sugar consumption should incorporate information about alternative sweeteners, such as stevia, as part of broader strategies to reduce diabetes risk. Finally, the positive premium observed in the willingness to pay indicates potential market opportunities for value-based pricing strategies. Producers may position stevia sweeteners as premium health-oriented products while maintaining affordability to reach a broader consumer base. Such strategies may help expand the market for natural sweeteners while supporting efforts to encourage healthier consumption patterns among consumers.

## CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

This study aimed to estimate consumer WTP for stevia sweeteners in East Java and identify the determinants influencing this valuation. Using the DBDC contingent valuation method, the mean WTP was estimated at IDR 87,046 per 15 ml, representing a 53.5% premium

over the prevailing market price. This premium reflects favorable market potential and indicates the economic feasibility of broader stevia adoption. The ordered logit results show that the WTP is primarily influenced by product knowledge, health consciousness, diabetes exposure, and education level. Informational and health-related factors exerted a substantially stronger effect than conventional socioeconomic characteristics such as income. These findings indicate that consumer valuation of stevia is driven predominantly by health-oriented motivations rather than purchasing power alone, underscoring the importance of education-based and risk-awareness strategies for promoting healthier sweetener substitution.

This study further contributes to the theoretical advancement of WTP models by demonstrating that health consciousness, perceived health risk, and product knowledge function as central determinants in the valuation of preventive food products. The findings suggest that economic valuation frameworks for functional foods should integrate health-centered behavioral determinants with traditional socioeconomic variables, particularly in high-risk public health contexts.

### Recommendations

Government and health organizations need to integrate the promotion of natural sweeteners, such as stevia, into national diabetes prevention programs through evidence-based education campaigns and policies supporting healthy sweetener product accessibility. Given the still-wide gap between awareness and trials, structured public education programs and incentives to increase product availability in health facilities can accelerate the adoption of healthy sweeteners among the public, particularly in populations with a high risk of diabetes. Future research should adopt longitudinal designs to analyze changes in consumption behavior over time, expand geographically to find generalization, and explore additional factors, such as sensory attributes and cultural beliefs, that influence consumer decisions in transitioning to healthy sweeteners.

This study had several limitations. First, the use of purposive sampling limits the generalizability of the findings beyond the sampled population. Although appropriate for the valuation of niche products, the sample may not fully represent all consumer segments in East Java. Second, the cross-sectional design

captures stated preferences at one point in time and does not reflect long-term purchasing behaviors. The hypothetical bias inherent in contingent valuation methods may lead to an overestimation of actual WTP. Third, the relatively young and highly educated sample may influence the magnitude of the estimated WTP. Future research should incorporate probability-based sampling and experimental or revealed preference approaches to enhance the external validity.

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#### **DECLARATION OF GENERATIVE AI USE:**

During the preparation of this manuscript, the authors used Claude AI to assist in checking the grammar and improving the clarity of the language. After using this tool, the authors carefully reviewed and edited the content as needed and took full responsibility for the final content of the manuscript.

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