Economia agro-alimentare /
Food Economy

An International Journal on Agricultural and Food Systems

Vol. 27, Iss. 3, Art. 7, pp. 121-143 - ISSNe 1972-4802
DOI: 10.3280/ecag2025oa20762

Non-nutritive sweeteners: Factors influencing the choice of university students in Vietnam

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Abstract

This study explores the factors that influence Vietnamese university students' food choices when it comes to products containing non-nutritive sweeteners (NNSs). Drawing on consumer behavior theory and insights from focus group discussions, a conceptual model was developed with five independent variables – Health Perception, Acceptance, Product Properties, Beliefs, and Availability – and one dependent variable – Food Choice. A survey was then conducted both online and offline with 1,849 responses and further reduced to 936 valid responses after two rounds of data cleaning. Data from the survey were analyzed for reliability, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and structural equation modeling (SEM). The results confirmed a good model fit with strong convergent and discriminant validity. Three factors significantly influenced food choices were: Acceptance (β = 0.463), Health Perception (β = 0.235), and Availability (β = 0.141), with Acceptance being the most influential. These findings offer valuable insights for businesses and organizations aiming to promote NNS-containing products more effectively. Understanding the key drivers behind students' food choices can help stakeholders tailor their products and communication strategies to better meet consumer needs and encourage healthier dietary habits.

Article info

Type:
Article
Submitted:
31/07/2025
Accepted:
03/10/2025
Available online:
20/11/2025

JEL codes:
A13, B23, I18

Keywords:
Healthy diets
Consumer behavior
Food
Additives
Spice-sugar

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Introduction

Sugar is a crystallized, water-soluble organic molecule that has the general formula $(CH_2O)n$, having essential role in food manufacturing, such as flavor enhancement, energy production, preservation, structure and aesthetic application, processing facilitation. However, there is evidence that the excess consumption of sugar can be prone to some diseases and disorders such as oral illness, non-communicable diseases, disorder of the biliary system, risk in cognitive function and some issues during pregnancy (Arshad *et al.*, 2022). In purpose of limiting those risks, WHO has released the guidance for adults and children that state crucial recommendations on reducing free sugar intake to less than 10% of total energy intake and throughout the life course (*Sugars Intake for Adults and Children*, n.d.). In Vietnam, to reduce the excess of sugar in sugar-sweetened beverages SSBs, the National Assembly has passed the amended Law on Special Consumption Tax for 10% on sugary drinks with sugar content over 5g/100ml (*Sugary Drinks, Alcohol, and Cigarettes to Face Higher Taxes in Vietnam*, n.d.). Under the pressure from regulatory bodies, health organizations, and the increased interest of consumers in health, businesses have to figure out strategies to reduce the impact of sugar on their products. One popular idea is to use substituting sweeteners to replace the sweet taste in the product, leading to a reduction in sugar content. In general, sweeteners are food additives (coded with an E-number), which are used to mimic the sweet taste of sugar in the product. Based on commercial purposes, there are some criteria for sweeteners to be fulfilled, including adequate sweetening capability, satisfactory aftertaste, non-carcinogenic and non-mutagenic, appropriate price, thermostable and produce minimal to no calories (Gupta, 2018).

Although non-nutritive sweeteners have been widely used in the food industry, many consumers remain concerned about this additive. Young consumers, who are impacted by the media and market trends, are among the demographics that should be worried about. Their awareness, perceptions and behavior in choosing products containing NNS can be influenced by many factors: psychology, nutritional knowledge, taste sensation, brand image, or perceptions of "food safety". To remove customers' psychological barriers, businesses need to determine appropriate promotional strategies based on previous academic evidence. Furthermore, governments and international organizations are also interested in understanding young population decision-making on foods containing NNSs, to create suitable policies on a broad basis.

In Vietnam, in-depth studies on consumer behavior for products containing non-nutritive sweeteners are quite limited. Therefore, research on factors affecting the behavior of choosing these products is not only essential

in terms of academics but also highly practical, contributing to support businesses, legislators and health organizations in building development strategies, nutrition communication and raising public awareness. Accordingly, the topic "Research on factors that influence the choice of non-nutritive sweeteners among university students" is a significant field of study that is appropriate for the current practical context and has high application value in the area of food technology and public health.

1. Background

1.1. *Non-nutritive sweeteners*

Non-nutritive sweeteners (NNSs) are high-intensity sweeteners (can be thousands of times sweeter than sucrose – a table-top sugar) and have non-caloric value. This term does not include sugar alcohol, or polyols (e.g., sorbitol, maltitol, xylitol), a category of sweeteners that can also be used to mimic the sweet taste of sugar in foods and beverages. In some research, there is a misconception that NNSs refers to artificial sweeteners. Artificial sweeteners are the subset of NNSs, which refer to synthetic, non-caloric sweeteners created through chemical processes in laboratories. NNSs are also included of natural sources, for instance, Stevia is derived from plants.

Although sugars, polyols and NNSs all contribute to sweetness, their mechanisms are slightly different. Sweet taste perception begins with chemosensory cells in the tongue and gastrointestinal tract. In taste bud, there is an aggregate of 50–100 neuroepithelial cells, include type II cells that responsible for sweet, umami and bitter taste detection through G protein-coupled receptors (GPCRs). Taste 1 receptor family member 2 (T1R2) and taste 1 receptor family member 3 (T1R3) are two different GPCRs that make up the receptor that facilitate the detection of sweetness. Furthermore, the formation of T1R3/T1R3 homodimer can detect monosaccharides and disaccharides at high concentrations (Lee & Owyang, 2017). The difference is that while sugars bind selectively to the venus flytrap domain of the T1R2 subunit, exhibit partial agonism of the T1R2/T1R3 receptor, primarily interacting with the transmembrane domain of T1R3. On the other hand, various types of NNSs result in different binding sites. For example, NNSs with artificial sources are similar to sugar (but higher affinity), but for natural NNSs, they interact with T1R3 transmembrane domain (Servant *et al.*, 2010).

1.2. *Regulation approval and implementation*

Regulatory approval of NNSs varies globally, with bodies such as the Joint FAO/WHO Expert Committee on Food Additives (JECFA) or Food and Drug Administration (FDA). Since Aspartame is approved by FDA or recognized as Generally Recognized as Safe (GRAS), JECFA has yet to publish a formal safety evaluation. In Vietnam, regulations on the use of food additives and its Accepted Daily Intake (ADI), which include NNSs, are referred to JECFA, Fragrance and Extract Manufacturers Association of the United States and European Parliament and Council European Parliament and Council. According to the circular 24/2019/TT-BYT of the Ministry of Health, there are total of 8 substances that are approved to use in Vietnam, namely Acesulfame potassium (E950), Aspartame (E951), Cyclamate (E952), Saccharin (E954), Sucralose (E955), Alitame (E956), Steviol glycoside (E960), Neotame (E961).

NNSs have been more preference in the wide range of food industry as a sugar substitute, such as beverage, dairy products, chewing gum or confectionary. It is noticeable that different substances are used for their own specific product types. For instance, while Acesulfame potassium and Aspartame are commonly used in beverages, Sucralose is often added in baked goods. The market of foods containing NNSs is various in different regions and continents. The research assesses across 4 countries show that Mexico is leading in percentage of product with NNSs components (11%) compared to the US (4%), New Zealand (1%) and Australia (< 1%) (Dunford *et al.*, 2018). It is also noticeable that the US and Mexico had larger proportions of products containing NNSs and higher levels of total sugar concentrations compared to Australia and New Zealand. Another research in Brazil indicates that NNSs were found in 7.7% in total sample of 11,434 packaged product (Fagundes Grilo *et al.*, 2022). Beyond food manufacturing, NNSs also have crucial implementation in the pharmaceutical industry, including medicated lozenges, functional foods and vitamin/mineral chewable.

1.3. *Awareness, perception and behavior of consumers*

Food choices and the acceptance of NNSs are significantly influenced by consumer perception and awareness. When studying consumer knowledge, awareness and behavior, the research subjects are often low-calorie sweeteners or artificial sweeteners. Those studies often have confusion when combining sugar alcohol (polyols) and NNSs, but they are generally useful as a resource for consumer psychology. Products using NNSs as a partial sugar

substitute (or complete sugar substitute) are becoming increasingly popular, especially in sugar-sweetened beverages or confectionery products (Naveed *et al.*, 2024; Alharthi *et al.*, 2023; (Jurcevic Zidar *et al.*, 2025). Consumers may consider the taste of products containing NNSs before consuming them. Some products have a bitter aftertaste when used, making customers feel unsatisfied (Naveed *et al.*, 2024; Daher *et al.*, 2022; Jaruga-Sękowska *et al.*, 2022). Consumers tend to be concerned about the use of artificial sweeteners and often consider stevia to be safe and consume it frequently (because stevia is naturally derived) (Naveed *et al.*, 2024; Alharthi *et al.*, 2023; Laja García *et al.*, 2022). In addition, aspartame or acesulfame K are also widely available on the market (Naicker *et al.*, 2024; Jurcevic Zidar *et al.*, 2025).

Intention to use products containing NNSs may change if consumers have more knowledge related to this substance. It can be motivation for consumers, since NNSs is commonly being marketing as healthy ingredients (Naveed *et al.*, 2024; Alharthi *et al.*, 2023; Jurcevic Zidar *et al.*, 2025). Furthermore, public knowledge of NNS's types, purposes, and safety features is still limited across a range of demographics, despite the increasing prevalence of NNS and food containing them worldwide. 2 items that are significantly correlated to consumers' behavior are age and gender. Some demographic disparities, including major of study, weight status or dietary can be involved in some research, but there is still much controversy and remain undefined due to different results for each topic.

While children and adolescents exhibit limited awareness about types of NNSs or health implications, because the use of these products is determined primarily by their parent; young population (18-35 years) demonstrate higher awareness and consumption of NNSs and foods containing products, driven by weight management goals and perceptions of modernity (Jurcevic Zidar *et al.*, 2025); Apergi *et al.*, 2024). Nonetheless, it is evident that this group shows conflicting beliefs, with some putting a higher priority on the benefit of energy reduction and others being caution on "artificial" sources. Middle-aged and older adults (45 years old and above) are more aware of the link between NNSs and chronic disease management (e.g., diabetes), but they are also more skeptical about their long-term safety and frequently prefer natural sweeteners (Alharthi *et al.*, 2023; Laja García *et al.*, 2022).

Women report higher awareness of NNS types (e.g., aspartame, sucralose) and greater consumption of food containing NNSs with motivation of weight control, even though they show greater concerns about safety, pointing to worries about "artificiality", metabolic consequences, and carcinogenicity (Alharthi *et al.*, 2023; Farhat *et al.*, 2021). In contrast, men prioritize performance and practicality about NNSs and food containing them. Even though they are less likely to associate NNS with health risks, they are more inclined to reject NNSs because of its aftertaste (Jurcevic Zidar *et al.*, 2025).

1.4. *Consumer behavior*

Consumers behaviour can be defined in numerous ways, but in general, it can be said that "consumer behavior is a marketing discipline that studies the behavior of individuals, groups or organizations and the processes they use to select, secure, use and dispose of products and services, experiences or ideas to satisfy needs and the impacts that these processes have on the consumers and society" (Adis, 2012). Kotler define consumer behavior as "the study of how individuals, groups, and organizations select, purchase, use, and dispose of goods, services, ideas, and experiences to satisfy their needs and wants" The strength of Kotler's model is combining buyer characteristics (cultural, social, personal, and psychological aspects) with marketing stimuli (the 4Ps: product, price, place, and promotion). For that reason, it clarifies the "black box" of buyer psychology and provides useful insights into how outside efforts influence consumer behavior. The term "black box" is referred to cognitive process mediating between external marketing stimuli and observable behavioral responses.

The Theory of Planned Behavior (TPB) was the expansion of the Theory of Reasoned Action model (TRA) of Fishbein and Ajzen (1975), in which volitional behavior was described and predicted. It was defined as "the causal links from beliefs, through attitudes and intentions, to actual behavior; to understand the psychological determinants of volitional behaviors". The basic assumption of this model is that people usually consider the information at their disposal and think through the consequences of their choices either directly or implicitly. There are 2 fundamental components: (1) attitudes toward the behavior, reflecting an individual's positive or negative evaluation of performing a specific action based on expected outcomes and their desirability; and (2) subjective norms, capturing perceived social pressure from significant referents weighted by the individual's motivation to comply with those expectations. The strength of the TRA theory is about providing mechanistic clarity, with attitudes derived from salient behavioral beliefs multiplied by outcome evaluations, while subjective norms emerge from normative beliefs multiplied by motivation to comply.

The use of non-nutritive sweeteners (NNS) as substitutes for traditional sugars remains a subject of ongoing debate, particularly concerning the appropriate dosage for safe and effective food consumption. Although the World Health Organization (WHO) has issued guidelines regarding their application, these recommendations appear to have limited reach and influence among younger consumer demographics. This research aims to understand young consumers by investigating the factors influencing attitude and the choice of food products containng NNS among university students in Vietnam. The study is guided by three specific objectives: (i) To develop

a model of factors influencing the choice of NNS containing products, (ii) To validate the hypotheses within the proposed model and (iii) To assess the impact of these factors on attitudes towards NNS-containing products among the target group.

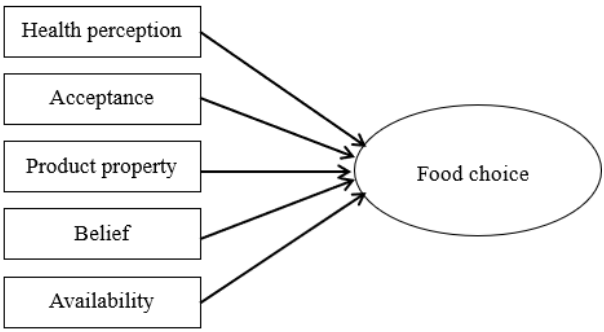
2. Materials and methods

2.1. *Questionnaire design*

The proposed research model is developed based on previous theoretical frameworks and model of consumers behavior (Figure 1). In developing the research model for this study, we have anchored our approach in the Theory of Planned Behavior (TPB), which assumes that people usually consider the information at their disposal and think through the consequences of their choices either directly or implicitly. This model includes three components: "Attitude" (an individual's evaluative judgment of performing a specific action), "Subjective norms" (belief in other referent subjective to engage or refrain from a behavior) and "Perceived behavior control" (facilitators or obstacle that may lead to decision-making). The reference materials are prior to studies about factor impact on the selection of consumers. However, to ensure the selected factors within these constructs were contextually relevant to young Vietnamese consumers, the theoretical model was refined and validated through an inductive, qualitative phase. Prior to survey distribution, two focus group discussions were conducted with students aged 18-35 possessing background knowledge in nutrition, food science, and public health. After two sessions, we had identified 5 key factors and 21 items that influence attitude and subjective norms through a comprehensive literature review. These factors encompass personal concerns, product-related information, and external influences, precisely health perception, acceptance, property of products, belief, availability. Each item was measured on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree), which allows respondents to indicate the degree of their agreement and provides a reliable means of **quantifying** attitudes and perceptions related to food choice. According to Hair *et al*., the minimum sample can be calculated by the ratio 5:1 of an observed variable plus 50, which is a total of 155 respondents.

Health perception forms a core component of attitude, encompassing the consumer's evaluation of the health benefits that associated with NNSs, which directly impacts their consumption behavior. Acceptance relates to the consumer's willingness to use products containing NNSs, whether intentionally or unintentionally, without being deterred by their presence, reflecting a behavioral intention that may not be driven by strong prior

Figure 1 - Proposed theoretical research model



Based on the proposed theoretical model, 5 hypotheses were developed as following:
H1: Health perception of NNSs is positively related to the consumers' choice of NNSs and foods product containing them*
H2: Acceptance of NNSs is positively related to the consumers' choice of NNSs and foods product containing them*
H3: Property of products contain with NNSs are positively related to the consumers' choice of NNSs and foods product containing them*
H4: Belief in NNSs is positively related to the consumers' choice of NNSs and foods product containing them*
H5: Availability of NNSs is positively related to the consumers' choice of NNSs and foods product containing them*

* At offline survey, tasting with sweet drink ginger flavored under form of spice-sugar to assess NNS health perception in a culturally familiar context provided by T2022-PC-095.

beliefs. The property of products, including price, origin, and sensory qualities, represents a central consideration in the formation of attitudes, as consumers assess these tangible attributes against their needs and preferences. Within the subjective norms construct of the TPB, belief captures the external impact of institutional, social, and cultural information on the consumer's trust and assessment of NNS products. Finally, availability serves as a critical dimension of perceived behavioral control, determining the physical and economic accessibility of these products and thus facilitating or constraining the translation of intention into actual purchase behavior. Together, these factors provide a comprehensive framework for understanding the variables behind food choices related to food containing NNSs.

2.2. *Participants*

The research is focused on youth participants taking universities' degrees aged 18-35 years old, who are voluntarily answering the survey. Although the

respondents were studying at universities in Hanoi and Ho Chi Minh City, they originally came from many different provinces across Vietnam, which strengthens the representativeness of the sample. Those with specialized knowledge in food, nutrition, medicine, chemistry, etc., as well as those who studied other majors, made up a diverse group of survey respondents. This target demographic was chosen because they have ready access to information, are vulnerable to new consumer trends, and tend to be more aware of concerns related to weight control and product nutrition. In addition, young consumers are also a potential customer group for products using non-nutritive sweeteners. After conducting the survey, the sample consists of 1867 respondents over 1934 distributed survey, showing a response rate of 96.5%, reflecting the prominent level of interest of the participants. After cleaning data, there are 935 observations, including 627 female and 303 males (5 nonbinary).

2.3. *Data analysis*

Reliability analysis and Exploratory Factor Analysis (EFA) were involved in SPSS 26.0. A scale is considered reliable if its observed variables have a Corrected Item-Total Correlation greater than 0.3; Cronbach's Alpha coefficient greater than 0.7. Also, the Cronbach's Alpha when item deletes can be lower than basic coefficient of its factor. For EFA, some indexes to consider are Kaiser-Meyer-Olkin (KMO) ≥ 0.5, the significance (Sig.) coefficient of Bartlett test ≤ 0.05, Eigenvalue ≥ 1.0, and total variance explained $\geq 50\%$. Additionally, factor loadings of all observed variables must be ≥ 0.40, and the difference between the cross-loadings factors must be > 0.2.

AMOS 24.0 was used to conduct Confirmatory Factor Analysis (CFA) and Structure Equation Modelling (SEM). Model fit was examined in CFA, which include Chi-square/df (CMIN/df) ≤ 5, Comparative Fit Index (CFI) ≥ 0.9, Goodness-of-Fit Index (GFI) ≥ 0.9, Tucker-Lewis Index (TLI) ≥ 0.9, Root Mean Square Error of Approximation (RMSEA) ≤ 0.06. In addition, reliability, convergence and discrimination can be guaranteed, with composite reliability (CR) ≥ 0.70, Average variance extract (AVE) ≥ 0.50, Maximum Shared Variance (MSV) $<$ AVE and $\sqrt{\text{AVE}} >$ Inter – construct Correlation. SEM examines the relationships between factors representing factors influencing young consumers' choice of products containing non-nutritive sweeteners. While the p-value of Unstandardized Regression Weights is a crucial component of null hypothesis significance testing, its standardized estimate represents the strong or weak impact of independent factors on a dependent factor. The coefficient of determination R squared is calculated to predict the proportion of how dependent factors can be explained.

3. Results

3.1. *Descriptive analysis*

After conducting the survey in both online and offline formats, the total number of distributed surveys was 1934 and the total number of questionnaires collected was 1867 respondents, showing a response rate of 96.5% reflecting the prominent level of interest of the participants. The number of results collected is higher than the minimum sample size that is previously calculated in the above section (2.1). The data underwent a two-stage cleaning process before the final analysis. In the first stage, questionnaires were considered valid only if fully completed, which resulted in the removal of 18 incomplete responses and resulted in 1,849 valid cases. Most survey participants were university students aged 18-22 years old and females were overrepresented (64.5%). Over half of the participants reported having a normal weight (53.9%), while 8.5% were overweight and 2.5% obese. Table 1 shows descriptive analysis. In the second stage, additional exclusions were applied based on specific criteria, including respondents who reported no prior awareness of NNSs and those who provided identical responses across all survey items. Following this two-step procedure, the final data set consisted of 935 valid observations. Reliability test and Exploratory Factor Analysis (EFA).

Table 1 - Sample description

Socio-demographic characteristic		Frequency	Percentage
Gender	Male	303	32.4%
	Female	627	67.1%
	No answer	5	0.5%
Major of education*	Food & Nutrition	689	
	Medicine & Pharmacy	6	
	Others	249	
BMI status	Underweight	189	20%
	Normal	515	55%
	Pre-obesity	73	8%
	Obesity	12	1%
	No answer	146	16%

Independent variances: Table 2 shows the pattern matrix of exploratory factor analysis EFA of independent factors. The supplementary Table (in the appendix) provides detailed information of variables for each independant factors. Cronbach's Alpha coefficients of all factors ranged from 0.832 to 0.944, which implies that the factors have good internal consistency. The Corrected Item-Total Correlation of the items in the factor group are all greater than 0.3. Therefore, 21 items were conducted for EFA, with The Principal Component method for extraction and Varimax rotation were applied. The 1st EFA test revealed 3 cross-loading factors that have been

Table 2 - Pattern matrix of EFA of independent factors

Factor	Item	Component					Cronbach's alpha		CITC[b]
		1	2	3	4	5	General	IID[a]	
AV	AV2	0.900					0.934	0.907	0.867
	AV3	0.890						0.909	0.863
	AV4	0.887						0.909	0.861
	AV1	0.812						0.931	0.791
HP	HP2		0.874				0.898	0.859	0.802
	HP4		0.845					0.861	0.796
	HP3		0.831					0.879	0.748
	HP1		0.809					0.876	0.756
RI	RI2			0.908			0.926	0.876	0.868
	RI1			0.902				0.889	0.853
	RI3			0.879				0.912	0.824
AC	AC2				0.815		0.832	0.756	0.729
	AC1				0.791			0.797	0.651
	AC4				0.784			0.765	0.713
	AC3				0.690			0.827	0.571
ST	ST2					0.846	0.869	0.801	0.775
	ST1					0.816		0.826	0.745
	ST3					0.807		0.816	0.749
Bartlett's test of Sphericity		Approx. Chi-square			2146.095		Eigenvalues		1.186
		Freedom degree (df)			231				
		Significance level (Sig.)			0.000		KMO		0.887

Note: [a] Cronbach's alpha if item deleted; [b] Corrected Item-total correlation.

eliminated to ensure discrimination. Also, items of BE were extracted into 2 new groups, suggesting that 2 new factors were formed: "Reputable information" (RI) and "Social trust" (ST). For the 2nd EFA, the contruct was validated, with the Kaiser-Meyer-Olkin was 0.887, and the Sig. value of Barlett's test was 0.000. The lowest Eigenvalue was 1.186 at the 5th factor, and 79.478% of the data is explained through 5 factors.

Dependent variance: Reliability analysis shows strong internal consistency, with Cronbach's Alpha coefficients exceeding 0.7, and Corrected Item-Total Correlations greater than 0.3. Therefore, no observed variables were removed from the analysis. The criteria for sampling adequacy in EFA test are accepted, with KMO = 0.909 > 0.5 and Sig. = 0.000 < 0.005. It indicates that the items are correlated with each other. A single factor is extracted, with 81.621% of the data is explained by 1 factor, and Eigenvalue is 4.081.

Table 3 - Pattern matrix of EFA of dependent factors

Factor	**Item**	**Component**	**Cronbach's alpha**		**CITC**[b]	**KMO**	**0.909**
		1	**General**	**IID**[a]			
FC	FC3	0.917	0.944	0.927	0.866	**Eigenvalue**	4.081
	FC4	0.917		0.927	0.866		
	FC5	0.914		0.928	0.862	**Sig. of Bartlett test**	0.000
	FC2	0.901		0.931	0.844		
	FC1	0.867		0.939	0.796		

3.2. *Confirmatory Factor Analysis (CFA)*

After conducting CFA, all of the structural criteria of model fit were fulfilled, with the result show acceptable to very good value (CMIN/df = 4.388; GFI = 0.911; CFI = 0.957; TLI = 0.949; RMSEA = 0.060; PCLOSE = 0.000) (Table 4). In addition, the scale also reveals a good evaluation on both reliability, convergent and discriminant validity (Table 5). The results of Table 5 show that: CR of each factor is greater than 0.7, so the scales ensure good reliability. AVE of each factor is greater than 0.5, indicating that convergence is guaranteed. MSV of each factor is lower than AVE, indicating that discrimination is guaranteed. In addition, (Font is displayed in bold format and grey theme) is greater than the correlation between that variable and other variables (Font is displayed in italic format and grey theme) in the model. To sum up, discrimination is guaranteed.

Table 4 - Model Fit Measures

Index	Criteria	Result	Rating
CMIN/df	≤ 5	4.388	Acceptable
GFI	≥ 0.9	0.911	Good
CFI	≥ 0.95	0.957	Very good
TLI	≥ 0.9	0.949	Good
RMSEA	≤ 0.06	0.060	Good
PLOSE		0.000	

Table 5 - Model Validity Measures

	CR	AVE	MSV	AV	HP	RI	AC	ST	FC
AV	0.935	0.783	0.206	**0.885**					
HP	0.900	0.692	0.285	*0.298***	**0.832**				
RI	0.926	0.807	0.206	*0.454***	*0.235***	**0.898**			
AC	0.836	0.562	0.440	*0.359***	*0.477***	*0.081**	**0.749**		
ST	0.873	0.696	0.324	*0.361***	*0.495***	*0.263***	*0.569***	**0.834**	
FC	0.944	0.771	0.440	*0.409***	*0.534***	*0.191***	*0.663***	*0.499***	**0.878**

p-value < 0.001 is denoted by ***, p-value < 0.050 is denoted by *

3.3. *Structural Equation Modeling (SEM)*

The results of the SEM analysis, following the CFA, provide insights into the effects of the five factors on Attitude and Willingness to Try (Figure 2). The standardized parameters of the SEM model all meet the necessary criteria for SEM, indicating that the proposed model is a good fit for the actual data. The results of the SEM model, as shown in Table 6. After conducting confirmatory factor analysis (CFA) to test the fit of the scale to market data, data is analyzing structural equation modeling (SEM) to examine the relationships between factors representing factors influencing young consumers' choice of products containing non-nutritive sweeteners.

The unstandardized p-value of RI and ST is higher than 0.05, rejecting the hypothesis that "Reputable information" and "Social trust" are positively impact on the selection of NNSs and foods containing it. The estimate value of standardize regression weight demonstrate that factor "Acceptance" has largest impact on food choice (0.463), follow by "Health perception" (0.235) and "Availability". The coefficient of determination R squared is 0.525, which means that the predictors of FC explain 52.5% of its variance.

Figure 2 - Standardized SEM model

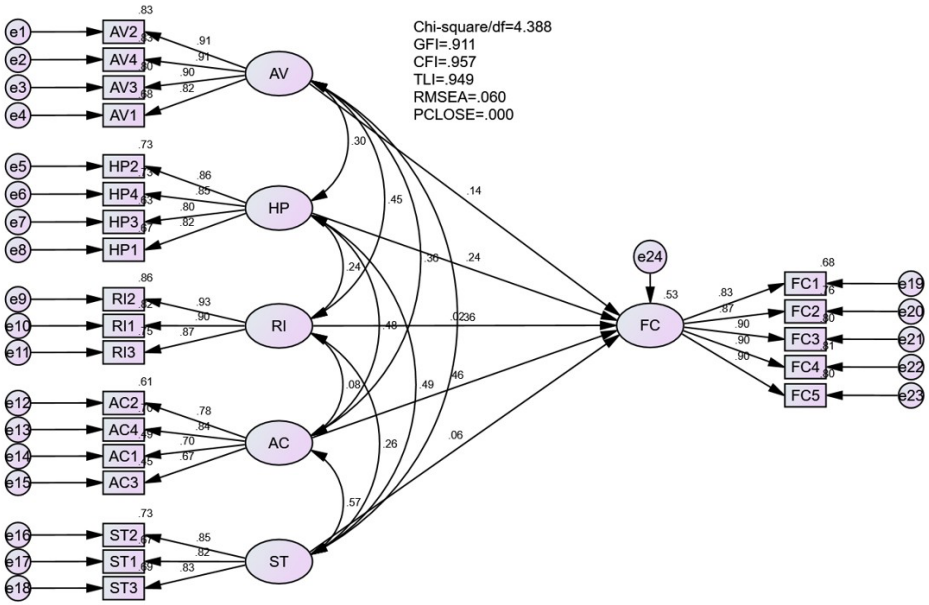


Table 6 - Regression Weights and Standardized Regression Weights

Relationships			Unstandardize p-value	Standardize Estimate
FC	←	**AV**	***	0.141
FC	←	**HP**	***	0.235
FC	←	**RI**	0.569	0.018
FC	←	**AC**	***	0.463
FC	←	**ST**	0.090	0.064

3.4. *Discussion*

During the focus group, information related to NNS was exchanged by the participants in a positive and constructive manner. Opinions on factors influencing the choice of NNS were discussed. Some interesting perspective mentioned by the participants may include: “when using sweets, I do not pay much attention to the ingredients that produce this taste”, “the taste is quite fake” or “products with big brands give me more trust”. This is similar to previous qualitative research in the UK (Tang *et al.*, 2021). However,

although the session can achieve consensus from various people, it remains limitation that lack of exploit the in-depth thoughts of everyone (Guest *et al.*, 2017). Therefore, it is possible to conduct focus group and individual interviews in parallel to better understand the knowledge and attitude toward NNSs. At the same time, the processes in the focus group discussion can be further developed according to the 6-step thematic analysis.

After conducting EFA, "Product property" factor was omitted from the model. When proposing the theoretical model, this factor included many variables surrounding the criteria of product quality. However, according to previous studies (Luru *et al.*, 2024; T Ha *et al.*, n.d.), these variables were separated into each individual factor (e.g., price, safety). Therefore, grouping them together may cause these items to be cross-loaded and eliminated.

According to SEM analysis, "Official information" and "Social trust" have no impact on choice in the model, showing that young people today are less interested or do not rely much on these sources of information in the consumer decision-making process. However, some studies have evident that factors such as the law will reinforce customers' consumption decisions, or consumers often look for nutritional information on social media (Naveed *et al.*, 2024; Alharthi *et al.*, 2023; Jurcevic Zidar *et al.*, 2025). There are several explanations for this situation as follows: First, young people often prioritize personal experiences and real feelings over recommendations from official organizations such as WHO, FDA or nutrition experts. They tend to trust their intuition and consumption habits rather than learn about scientific information. Second, when conduct the survey, there was various conflicting information in Vietnam related to unhealthy and unsafe food. This resulted in the decline in consumers' beliefs, which significantly affects their answer in the survey. Last but not least, lack of information verification and clarity of marketing on social networks, consequence in university students reduce their trust in sources from KOLs, online newspapers or celebrities. Although they are often exposed to digital media, they still have a certain level of caution. However, it should be noted that the effects of social trust and reputable information may vary depending on the country, food type, and information source used. For example, the research of traceable fresh food in Taiwan found that trust in the government had no direct impact on perceived healthiness and repurchase intention, while trust in the producer or certification had a significant impact (Wang *et al.*, 2021). Similarly, a UK study on the influence of social media influencers also found that trust in influencers sometimes did not increase but even decreased purchase intention (Adaba, 2025). This evidence suggests that the lack of impact found in the current study is not unusual but reflects the complexity and context-dependent nature of food consumption behavior among college students. Furthermore, according to a review on consumer trust in food and the food system,

consumers often rely on multiple trust signals, such as labeling, certifications, traceability, and assurances from relevant stakeholders, to assess food quality, especially when quality attributes cannot be directly observed (Hobbs, 2021).

Three factors "Acceptance", "Health perception" and "Availability" were retained after data processing, demonstrating that they contribute to university students' decisions to consume NNSs and foods containing them. Among them, "Acceptance" is the factor that has the greatest influence on consumer choice. This shows that part of the consumers think that their choice is obvious and willing to accept the presence, leading to them not paying attention to the ingredients on the packaging when choosing food. This is consistent with a previous study in Africa (Naicker *et al.*, 2024). In this regard, reputable organizations need to publish appropriate policies to raise consumer awareness of NNSs, as their use is becoming more and more popular. At the same time, "Health perception" and "Availability" are also related to customer choice, reflecting the trend of healthy eating and calorie control is increasingly, and the popularity and accessibility of NNSs and food containing in the market (e.g., supermarkets, stores, and e-commerce platforms).

The study provides a useful basis for future research with both practical and scientific implications. First, the findings can be applied to design and evaluate interventions or communication programs that aim to change awareness and consumption behavior among young people. In addition, longitudinal studies could be conducted to examine how attitudes and behaviors change when living conditions, social environments, and personal experiences shift, thereby clarifying the stability or variability of influencing factors. Furthermore, extending the research to other countries would allow comparisons of cultural and policy differences in food consumption decisions. Experimental studies could also be implemented to test the impact of warning labels, safety certifications, or recommendations from international organizations on consumer choices. Finally, linking consumer perceptions and behaviors with health indicators would provide stronger evidence on the relationship between trust, consumption decisions, and health outcomes.

In addition to the results achieved, this research topic still has certain limitations. Specifically, it focuses on the university students instead of young consumer group in Vietnam. The trend of consuming healthy foods is not only emphasized by the younger generation but also of interest to other age groups, particularly middle-aged and older adults. Broadening the scope to include different age groups and exploring these drivers more thoroughly would provide policymakers and food producers with a more comprehensive understanding of non nutrition sweeteners consumption in Vietnam.

Conclusions

This study developed a comprehensive model to understand the factors influencing food choice towards non-nutritive sweeteners containing products amongst students in Vietnam. The model includes 21 observed variables categorized into five factors influencing attitudes and three factors influencing food choice among universities students. The findings indicate that 3 factor "Acceptance", "Health perception" and "Availability" were retained after data processing, demonstrating that they contribute to university students' decisions to consume NNSs and foods containing them. Among them, "Acceptance" is the factor that has the greatest influence on consumer choice. This shows that part of the consumers think that their choice is obvious. These insights can guide local manufacturers and policymakers in developing strategies to enhance consumer acceptance and drive the transition towards sustainable dietary practices.

Future research should consider expanding the sample beyond university students to include diverse demographic groups for broader generalizability. Longitudinal studies could provide deeper insights into how consumer attitudes toward non-nutritive sweeteners (NNSs) evolve over time. Additionally, incorporating variables such as cultural influences, marketing exposure, and peer dynamics may offer a more comprehensive understanding of food choice behavior. Qualitative methods, such as in-depth interviews, could also complement survey findings by capturing nuanced consumer perceptions and motivations.

Acknowledgements

This work was supported in part by Hanoi University of Science and Technology under Grant T2024-PC-081 and T2022-PC-095 and the collaboration of Ho Chi Minh University of Industry and Trade. The authors would like to acknowledge these supports.

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Supplementary table

Description of factor-item

Factor	Code	Item
Health perception	HP1	The consumption of non-nutritive sweeteners or the intake of foods containing them could improve the quality of your diet
	HP2	The consumption of non-nutritive sweeteners or the intake of foods containing them could help improve body weight control
	HP3	The consumption of non-nutritive sweeteners or the intake of foods containing them could help you reduce the risk for diabetes
	HP4	The consumption of non-nutritive sweeteners or the intake of foods containing them could help you improve dental health
Acceptance	AC1	I think it is unimportant to check on the packaging whether a food contains non-nutritive sweeteners or not
	AC2	I have more important things to do than worry about non-nutritive sweeteners
	AC3	I can accept that certain foods contain non-nutritive sweeteners
	AC4	Non-nutritive sweeteners cannot be harmful; otherwise, they would not be contained in so many foods
Reputable information	RI1	Regulatory authorities and governmental agencies effectively evaluate and authorize foods containing non-nutritive sweeteners to ensure consumer safety
	RI2	I have confidence in the assessments and guidance of international organizations (e.g., FDA, WHO, EFSA, JECFA) and professional scientific associations regarding the use of non-nutritive sweeteners
	RI3	I trust the recommendations of nutritionists, medical practitioners, and public health experts about non-nutritive sweeteners and food containing them
Social trust	ST1	I consider information about non-nutritive sweeteners published in reputable nutrition and health blogs, mainstream media outlets, and professional social-media channels to be reliable
	ST2	I assume that endorsements of non-nutritive sweetener products by key opinion leaders (KOLs), influencers, and public figures reflect careful selection of safe, high-quality formulations

	ST3	When my friends or family members consume or recommend the use of foods containing non-nutritive sweeteners, I feel more assured about trying them myself
Availability	AV1	I can easily buy non-nutritive sweeteners and products containing them on e-commerce platforms
	AV2	I am able to find non-nutritive sweeteners and food containing them in my local area
	AV3	Non-nutritive sweeteners and food containing them are often available in supermarkets and retail store
	AV4	Non-nutritive sweeteners and food containing them are typically placed in easy-to-locate sections
Food choice	FC1	I intend to use foods containing non-nutritive sweeteners in the near future
	FC2	I will prioritize choosing food containing non-nutritive sweeteners over those with table sugar
	FC3	I am willing to purchase foods that contain non-nutritive sweeteners
	FC4	I will recommend foods containing non-nutritive sweeteners to my family and friends
	LC5	I plan to use non-nutritive sweeteners and foods containing them over the long term

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