


## Drivers behind consumers' intent to purchase deodorized soy milk

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### Abstract

Soy milk, rich in vitamin D and calcium, is a common alternative to dairy milk. However, its distinct 'beany off-flavor' has limited its acceptance, particularly in Western countries. A new technique employing preformed 'empty' V-type starch has been introduced to scavenge this off-flavor, aiming to promote soy milk consumption. The purpose of this study was to identify predictors of consumers' purchase intention of 'empty' V-type starch deodorized soy milk, particularly among college students. In this cross-sectional study, 105 college students were surveyed by a validated survey instrument that measures their perceptions of sensory quality, healthiness, price, environmental friendliness, food safety, and purchase intention of a novel product – 'empty' V-type starch deodorized soy milk. Additionally, demographic data were gathered to understand any correlations between these factors and the students' willingness-to-purchase of the deodorized soy milk. From the results, more than 80% of the participants expressed a positive attitude toward the 'empty' V-type starch-deodorized soy milk. The two dominant drivers behind their purchasing decision were Sensory Quality and Environmental Concern. Accordingly, it is crucial to highlight the improved sensory profile and the environmental friendliness of this soy milk product in order to achieve marketing success.

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### Introduction

Osteoporosis is a prevalent skeletal disease, marked by reduced bone mass and strength, and deterioration of bone tissue structure<sup>[1,2]</sup>. It significantly heightens the risk of fractures and currently impacts nearly 200 million individuals globally<sup>[3]</sup>. Vitamin D plays a pivotal role in bone health, enhancing calcium absorption in the intestines and regulating serum calcium and phosphate levels<sup>[4]</sup>. In the United States, most pasteurized cow's milk is fortified with vitamin D, making it an excellent source of vitamin D<sup>[5,6]</sup>, and thus its inclusion in diets is highly recommended to meet nutrition needs and support bone health<sup>[7]</sup>.

However, cow's milk is not always the best choice, as lactose intolerance is a widespread issue in the United States, which affects nearly all Asian Americans, 70% of both Native Americans and African Americans, 50% of Mexican Americans, and 15% of Caucasians, leading to symptoms like an upset stomach, diarrhea, flatulence and bloating<sup>[8]</sup>. Additionally, a comprehensive review encompassing over 25 observational studies and clinical trials have linked milk consumption to an increased prevalence and severity of acne<sup>[9]</sup>.

Given these concerns, cow's milk alternatives like soy milk emerge as a favorable option<sup>[5]</sup>. Soy milk provides essential nutrients including vitamin D, potassium, phosphorus, and B vitamins. When compared to cow's milk, soy milk offers an excellent calcium source and high-quality protein, all while being devoid of saturated fat and cholesterol<sup>[10]</sup>. Previous research has indicated that soy milk consumption has comparable benefits to cow's milk in reducing osteoporosis risk<sup>[11]</sup>. Furthermore, the U.S. Food and Drug Administration (FDA) has approved the health claim that daily consumption of 25 g of soy protein could reduce the risk of coronary heart disease,

especially when paired with a diet low in saturated fat and cholesterol<sup>[12]</sup>.

Despite its nutritional benefits, the acceptance of soy milk, particularly in Western countries, is hampered by its strong characteristic soy odor, which is commonly referred to as 'beany off-flavor'<sup>[13–15]</sup>. To date, several methods have been employed to mitigate the 'beany off-flavor' in soy milk. One of the widely used approaches is the vacuum method, which uses high temperatures to remove volatile compounds such as short-chain fatty acids, sterols, and sulfur compounds<sup>[16]</sup>. Another method is the Cornell hot grinding technique. In this method, soaked soybeans are ground at a high temperature (80 °C) using boiling water or steam to create a slurry. This slurry is maintained at the same temperature for an additional 10 min<sup>[15]</sup>, in order to inactivate lipoxygenase. Lipoxygenase, naturally present in soybeans, can lead to 'beany off-flavors' as it catalyzes the oxidation of polyunsaturated fatty acids into hydroperoxides<sup>[17]</sup>. Alternatively, the Illinois pre-blanching method blanches soaked soybeans in boiling water, also aiming to inactivate lipoxygenase<sup>[18]</sup>. These high-temperature treatments (vacuum, Cornell hot grinding, and Illinois pre-blanching) can adversely affect soy protein, causing dissociation, denaturation, and aggregation, which in turn reduces protein solubility<sup>[19]</sup>. To address this, the pulsed electric field method was developed<sup>[20]</sup>, which is a non-thermal technology to deodorize soy milk, but it can alter the milk's rheological properties. Other strategies, such as alkaline soaking, and the use of defatted flour, soy protein isolates, or concentrates, have been employed to curtail the 'beany off-flavor', but with limited success<sup>[21]</sup>. Given that the characteristic beany off-flavor remains a barrier to the consumption of soy milk and related products in many Western countries, there is still a demand for

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methods that can mitigate this flavor without adversely affecting soy protein solubility or the physical properties of soy milk.

Recently, a novel method of scavenging 'beany off-flavor' compounds from the gas phase using the 'empty' V-type starch have been demonstrated by our research group<sup>[22]</sup>. It relies on the ability of starch in complexing flavor compounds through various mechanisms, including surface adsorption, physical entrapment, interhelical entrapment, and inclusion complexation. The 'empty' V-type starch contains a porous structure and empty helical spaces that facilitate these complexation mechanism<sup>[23]</sup>. The 'empty' V-type method does not require elevated temperature to form an inclusion complex with guest molecules, making it an ideal solution for encapsulating heat-sensitive compounds like aroma compounds. Before the odor elimination process, 'empty' V-type starch will be prepared and utilized as an odor sequester. This prepared starch will then be placed atop the container that holds the food product in need of deodorization, remaining there for a duration tailored to the specific needs of the process. This gas phase complexation approach has been demonstrated by our group and other researchers<sup>[22,24–28]</sup>, offering a potentially efficient and versatile deodorization method for food applications.

## Literature review

Considering the health benefits of soy milk and the potential of the 'empty' V-type starch to deodorize it, this study seeks to gauge consumer perceptions of soy milk treated with this method and their purchasing intentions. Food choice is a complicated behavior, influenced by numerous factors and their interplay<sup>[29,30]</sup>. According to the theory of planned behavior (TPB), the intention to perform a certain behavior precedes the actual behavior<sup>[31]</sup>. Previous studies have shown that consumers' attitudes towards beverages significantly impact their purchasing and consumption intentions<sup>[32]</sup>. Attitude is defined as 'a latent disposition or tendency to respond with some degree of favorableness or unfavorableness to a psychological object'<sup>[33]</sup>, which involves several related factors, such as sensory quality, health, price, sustainability, and food safety.

### Sensory quality

Sensory qualities, including taste, aroma, and texture of foods could strongly influence food choices<sup>[34,35]</sup>, and consumers are typically willing to prioritize taste over health benefits<sup>[36]</sup>. Inman<sup>[37]</sup> has found that within a product category, consumers' purchase choice is highly based on sensory attributes rather than non-sensory attributes. Taste is particularly impactful; a previous study observed that taste played a key role and strongly affected the consumers' willingness-to-use of both beverages and frozen soups<sup>[29]</sup>. In addition, Glanz et al.<sup>[38]</sup> indicated that among around three thousand adults, taste is recognized as the most important factor when making food choices using two self-administered cross-sectional surveys. Additionally, taste is also found to be positively associated with willingness-to-consume milk products<sup>[39]</sup>. Beyond taste, flavor, and texture could also influence consumption decisions, as evidenced in yogurt product preferences<sup>[40]</sup>.

### Healthiness

Healthiness, an intrinsic product attribute<sup>[32]</sup>, has been reported as a significant predictor of individuals' food choice and purchase intention<sup>[41]</sup>. For example, empirical research has

shown that consumers' perceptions of food healthiness contributes to various types of food product consumption, including functional foods<sup>[42,43]</sup>, processed vegetables, and packaged fruits<sup>[44]</sup>. Also, healthiness is found to be an important attribute when purchasing milk products<sup>[32]</sup>. The same is evidenced in milk products, with their health and nutritional aspects weighing heavily on consumption choices<sup>[39]</sup>. Another large-scale cross-cultural study conducted by Johansen et al.<sup>[45]</sup> noted that young consumers in Europe and North America prioritize healthiness, alongside taste and price, when choosing dairy products.

### Price

Price consciousness is pivotal in consumers' purchase willingness of food products. As Glanz and colleagues<sup>[38]</sup> found, the cost is a significant determinant in food choices. Another survey carried out by de Graaf et al.<sup>[32]</sup> in Belgium noted the importance of price when buying milk products, adding that a higher emphasis on price might deter milk product purchases. Besides, Zhao et al.<sup>[46]</sup> found that in a sample of university student, the willingness-to-purchase of milk products is primarily affected by price. Additionally, based on Rizzo et al.'s findings, price was one of the most important attributes of milk product consumers and they tended to purchase milk products with lower price<sup>[47]</sup>.

### Environmental concern

Environmental and sustainability considerations are becoming important in food choices. For example, a web-based survey found that for Canadian consumers, positive views on agriculture and the environment influenced their purchasing behaviors<sup>[48]</sup>. Previous research carried out in Malaysia has shown that environmental concern exerts significant positive effect on consumers' organic food purchase intention<sup>[49]</sup>. Angulo et al.<sup>[50]</sup> also found that, perceptions and worries about the negative impact of agricultural products on the environment is one of the main factors affecting consumer purchasing decisions of food products. In addition, a study examined the consumers' acceptability and perceptions toward the willingness-to-buy of a food product found that consumers' perceived benefits, which include the environmental sustainability, is significantly associated with food consumption<sup>[51]</sup>. Furthermore, other research also highlighted the importance of environmental sustainability concerns in influencing consumers' food choices<sup>[52–54]</sup>.

### Food safety

Food safety remains crucial in making purchasing decisions. Previous research has shown it is the psychological interpretation of safety rather than the actual product properties that steer choices<sup>[55]</sup>. There's an inverse relationship between risk perception and purchasing<sup>[55]</sup>, with heightened safety incidents leading to reduced purchases, as also seen in Spain<sup>[50]</sup>. In addition, a study carried out by Xu & Wu<sup>[56]</sup> demonstrated that, beyond demographic features, such as gender, age, educational level, and income, consumers' overall satisfaction with food safety is also the main determinant of Chinese consumers' willingness to purchase food products. Similarly, in Belgium, food safety perceptions significantly shape the buying intentions of milk products<sup>[32]</sup>.

### Demographics

Demographic variables, such as gender, age, and ethnicity, can influence consumers' willingness-to-purchase of food

products. In the study by Lyly et al.<sup>[29]</sup>, age was found to be a significant factor in participants' purchasing behavior. Specifically, the youngest consumers were least likely to purchase, while older consumers showed a greater inclination towards functional foods. Bower et al.<sup>[57]</sup> found that demographic characteristics, including gender and age, interact with consumers' health concerns and nutritional knowledge to affect purchasing intention. Specifically, older women with many health concerns had a higher intention to purchase food products labeled with health benefits. Additionally, food consumption patterns vary among races and ethnicities. For instance, Mexican Americans showed higher consumption of soy protein compared to black or white individuals<sup>[58]</sup>.

### Study group

University students, who are often open to new trends and inclined toward sustainable options, constitute a large group of potential consumers of soy-based foods<sup>[46]</sup>. Given the cultural and ethnic diversity of colleges<sup>[59]</sup>, research participants from this group can provide a broader representation of various backgrounds. Therefore, findings based on college students can be more generalizable and offer valuable directions for future research<sup>[60]</sup>. This young generation is increasingly health-conscious, emphasizing food quality and nutrition. Yadav & Pathak<sup>[61]</sup> noted the emerging trend of healthful eating patterns among young consumers, probably driven by their education from families and schools. Moreover, several studies emphasized the importance of young consumers in eco-friendly purchasing decisions. Being more educated about environmental issues and sustainability<sup>[62–66]</sup>, they tend to prefer eco-friendly products<sup>[67]</sup>. Research also indicated that younger consumers were more willing to accept plant-based foods compared to other age groups<sup>[68,69]</sup>. In particular, the Millennials, born approximately between 1980 and 2000, are at the forefront of driving demand for more plant-based foods. As such, young consumers represent a key segment for research focus.

As aforementioned, food choice is a complicated behavior influenced by many factors and their interactions<sup>[29,30]</sup>. According to TPB, the intention of performing a certain behavior precedes the actual behavior<sup>[31]</sup>. Accordingly, several factors, including sensory quality, healthiness, price, environmental concern, food safety, as well as demographic characteristics, were examined. To examine how consumers respond to a soy milk product that is deodorized by a new technique, 'empty' V-type starch, the objectives of the study were threefold: (1) to understand consumers' perceptions towards the 'empty' V-type starch deodorized soy milk; (2) to determine the purchase intention of university students towards the 'empty' V-type starch deodorized soy milk; and (3) to identify the determinants of consumers' purchase intention. Hypotheses are as follows.

H1: Sensory quality is positively related to purchase intention.

H2: Healthiness is positively related to purchase intention.

H3: Price is positively related to purchase intention.

H4: Environmental concern is positively related to purchase intention.

H5: Food safety is positively related to purchase intention.

H6: Age is significantly associated with purchase intention.

H7: Gender is significantly associated with purchase intention.

H8: Ethnicity is significantly associated with purchase intention.

## Methods

### Survey development

Healthiness, price, environmental concern, food safety, and sensory quality were measured using multi-item scales. The measurement items for these constructs were adapted from previous studies and the language was changed accordingly. All these constructs were measured on a five-point Likert scale, ranging from strongly disagree (1) to strongly agree (5), and higher values indicated stronger agreement towards the statement listed in each construct. The detailed information is as follows:

#### Sensory quality

A three-item scale adapted from Pohjanheimo & Sandell<sup>[40]</sup> was employed to measure sensory quality, with an alpha reliability of 0.68. The measuring scale included the following items:

1. After 'empty' V-type starch deodorization, the product will smell nice.

2. After 'empty' V-type starch deodorization, the product will have a pleasant texture.

3. After 'empty' V-type starch deodorization, the product will taste good.

#### Healthiness

Three items developed by Roininen et al.<sup>[70]</sup> was used to measure consumers' attitudes towards the health characteristics of food (Cronbach's  $\alpha = 0.89$ ), which included: 'The healthiness of food has little impact on my food choices', 'I am very particular about the healthiness of the food I eat', and 'I eat what I like and I do not worry much about the healthiness of food'.

#### Price

Another three-item scale with a Cronbach's  $\alpha$  value of 0.70 developed by Campbell et al.<sup>[71]</sup> was employed to measure consumers' price consciousness when purchasing food. The measuring items included: 'When it comes to choosing food items, I rely heavily on price', 'I am a price-conscious shopper' and 'I buy the lowest-priced items that will suit my needs'.

#### Environmental concern

Environmental concern was measured by the five-item scale adapted from Shin et al.<sup>[72]</sup>, including: 'It is important to me that the products I use don't harm the environment', 'I consider the potential environmental impact of my actions when making many of my consumption decisions', 'I am concerned about wasting the resources of our planet', 'I would describe myself as environmentally responsible' and 'I am willing to be inconvenienced to take environmentally sustainable actions'. The scale validity and reliability were validated with standard factor loadings ranging between 0.84 and 0.90, and construct reliability of being 0.94.

#### Food safety

Food safety scale was adapted from Unklesbay et al.<sup>[73]</sup> with an alpha reliability of 0.75, and the adapted measuring items were: 'Food safety is an important issue to me', 'I think more classes and seminars about food safety should be available for consumers', and 'I believe that my decisions and actions impact my risk for foodborne illness'.

### Purchase intention

Consumers' purchase intention of 'empty' V-type starch deodorized soy milk was also measured on a five-point Likert-scale from strongly disagree (1) to strongly agree (5) using the following questions: 'I am willing to purchase deodorized soy milk from now on, instead of the soy milk I usually purchase'<sup>[32]</sup>, 'I expect to purchase this soy milk deodorized by 'empty' V-type starch'<sup>[74]</sup>, 'I want to purchase this soy milk deodorized by 'empty' V-type starch'<sup>[74]</sup>, and 'I intend to purchase this soy milk deodorized by 'empty' V-type starch'<sup>[74]</sup>. The adapted questions all showed a Cronbach's alpha value of being higher than 0.70 in the referred studies, which indicated an acceptable reliability for the construct.

Besides the constructs, an open-ended question: 'Please tell me how did you feel when you heard the technology of 'empty' V-type starch deodorization' was also asked to the study participants to determine students' overall attitude toward the 'empty' V-type starch deodorization technique.

### Study participants and data collection

This study was approved by the Institutional Review Board (IRB) of the researcher's institution (IRB # 21-10-5102). Using a convenience sample technique, surveys were distributed to students in classrooms. Inclusion criteria were 18 years of age or older, involved in food purchasing to some extent, and have sufficient English language skills. Students who are allergic to soy and have never tasted soy milk before were excluded from the study. Individuals who were eligible for the study and were willing to participate in the study were informed and enrolled. Individuals who were ineligible and decided not to participate in the study were also given the informed consent to finish, which asked them not to disclose the study to the public. The objectives of the study were informed to the participants and a folder that contains the consent form and study details was provided. To help participants better understand 'empty' V-type starch deodorized soy milk, a presentation covers the concept of the novel technique, and the product processing procedure was delivered to those who met the inclusion criteria. After the brief presentation, the enrolled participants were asked to complete the survey that assess consumers' intention to purchase 'empty' V-types starch deodorized soy milk, purchasing/eating habits, socio-demographics (gender, age, education, ethnicity, and household spending), and attitudes towards 'empty' V-type starch deodorization technology. As a result, a total of 105 usable responses were obtained and the data were used for further analysis.

A pilot study was performed before conducting the full-scale survey study, which included 49 eligible participants. Cronbach's analyses were conducted on five subscales, including Healthiness, Price, Environmental Concern, Food Safety, and Purchase Intention, of the survey. It was found that all the subscales' alpha levels were above 0.70. To be specific, for Healthiness and Food Safety, the alpha values were 0.72, indicating these two subscales have adequate levels of inter-item reliability. For Price and Environmental Concern, the alpha values greater than 0.80 indicate good reliability. For Purchase Intention, the alpha value greater than 0.90 shows an excellent inter-item reliability.

### Statistical analysis

The Statistical Package for the Social Science (SPSS) 25 (Chicago, IL) was used to conduct data analyses. Descriptive

data of the study participants were used to describe the general characteristics of the study participants, including means  $\pm$  standard deviation (SD) for continuous variables and frequencies (including percentages) for categorical variables. Regression analysis was used to examine the relationships between consumers' purchase intention and five independent variables. In addition, Pearson correlation test was employed to analyze the correlation among latent variables for the survey study. A  $p$ -value of  $\leq 0.05$  was considered statistically significant.

## Results

### Descriptive information of sampling

Table 1 presents the demographic profile of the study participants. Out of 105 usable survey responses, 10 were from males (9.5%) and 95 from females (90.5%). In terms of age, the majority of the participants (73.3%) were between 18 and 20 years old. Regarding ethnicity, White/Caucasian accounted for 81% of the study participants and Sophomore and Junior were the most represented, together making up almost 71% of the study participants. Furthermore, regarding weekly grocery expenses, 56.2% reported spending between USD\$50 and USD\$100, while 12.4% spent less than USD\$50.

### Mean values and measurement model

All survey items utilized a five-point scale. The average score for sensory quality was at 3.78 out of 5.00, which suggests that participants anticipate the soy milk to exhibit a better texture, taste, and aroma after being deodorized by the 'empty' V-type starch. The healthiness average score was 3.69 out of 5.00, underscoring health consciousness as a significant factor in food purchasing decisions. Participants also emphasized food safety with a mean score of 4.11 out of 5.00. Yet, the intent to buy the 'empty' V-type starch deodorized soy milk yielded a neutral score of 3.50. Comprehensive results for all predictors

**Table 1.** Demographic characteristics of respondents (N = 105).

Characteristics		Frequency	Percent
Gender	Male	10	9.5%
	Female	95	90.5%
Age (years)	18–20	77	73.3%
	21–23	26	24.8%
	24–26	1	1.0%
	30 or older	1	1.0%
Ethnicity	White/Caucasian	85	81.0%
	African American	6	5.7%
	Hispanic	6	5.7%
	Asian	2	1.9%
	Native American	1	1.0%
	Other	5	4.8%
Class	Freshman	9	8.6%
	Sophomore	38	36.2%
	Junior	36	34.3%
	Senior	20	19.0%
	Graduate	2	1.9%
Household spending (USD)	<\$50	13	12.4%
	\$50–\$100	59	56.2%
	\$101–\$150	12	11.4%
	\$151–\$200	11	10.5%
	\$201–\$250	5	4.8%
	>\$250	5	4.8%



and purchase intention can be found in Table 2.

The Cronbach's alpha values of all variables, including Sensory Quality, Healthiness, Price, Environmental Concern, Food Safety, and Purchase Intention were listed in Table 2, which exceeded the minimum threshold of 0.70<sup>[75]</sup>, confirming their reliability. Convergent validity within each construct was significant, with correlations ranging between 0.39 and 0.81, as seen in Table 3. Additionally, as suggested by Fornell & Larcker<sup>[76]</sup>, both the average variance extracted (AVE) and the composite reliability (CR) for each variable exceeded the respective minimum criterion of 0.50 and 0.70, respectively (Table 4). Altogether, the results indicated solid inter-item reliability and confirmed the convergent and discriminant validity.

Attitudes toward 'empty' V-type starch technology

After presenting the concept of the 'empty' V-type starch deodorized soy milk, participants' attitude toward this technology was evaluated using an open-ended question: 'Please tell me how did you feel when you heard the technology of 'empty' V-type starch deodorization'. The results revealed that none of the participants had prior knowledge of this 'empty' V-type starch technology. This unfamiliarity is expected, as the 'empty' V-type starch is an emerging, non-conventional technology still in the research phase. Out of 105 participants, 102 responses were considered valid. The major attitudes could be classified into three categories, including confusing, interested and intrigued, and not necessary.

Though unfamiliar with the technology, only a small

segment (11, 10.8%) conveyed confusion post-introduction, with remarks such as 'Sounded confusing and unsure about it...', 'It sounds really cool, but I still don't fully understand...', 'I feel like it was a little odd...', 'Confused, ..., it's too professional to me'. Such results suggest that the initial presentation effectively conveyed the essence of the 'empty' V-type starch process to the majority.

A significant majority (85, 83.3%) expressed interest and curiosity, anticipating the product's release. They shared thoughts such as, 'I thought it was cool, ..., want to try some', 'Interested, ..., want to see the outcome', 'Good!... It is amazing that ... more options to people', 'It's very interesting, ..., a solution for people who drink soy milk', 'Very interesting and a cool concept, ..., would consider purchasing'. This underscores a general willingness to embrace the innovative approach and try the improved soy milk.

While, only six of the study participants (5.9%), regular soy milk consumers felt the technology might be superfluous, with comments such as 'Interested, ..., but I honestly wasn't aware odor was an issue with soy milk', 'I do not taste 'beany' when I drink soy milk..., do not understand the need for this technology'.

Overall, the majority of the participants showed positive attitudes towards the 'empty' V-type starch technology and the deodorized soy milk. This positivity aligns with questionnaire data, which indicated a belief that the 'empty' V-type starch soy milk would possess an improved aroma and flavor, and that purchase intentions were neutral.

Table 2. Descriptive statistics.

Variable	Item	Min.	Max.	Mean	Cronbach's alpha
Sensory quality	After 'empty' V-type starch deodorization, the product will smell nice.	2.00	5.00	3.74	0.765
	After 'empty' V-type starch deodorization, the product will have a pleasant texture.	2.00	5.00	3.77	
	After 'empty' V-type starch deodorization, the product will taste good.	2.00	5.00	3.84	
	Overall mean		3.78		
Healthiness	The healthiness of food has little impact on my food choices (Recoded).	1.00	5.00	4.03	0.737
	I am very particular about the healthiness of the food I eat.	2.00	5.00	3.56	
	I eat what I like and I do not worry much about the healthiness of food (Recoded).	1.00	5.00	3.49	
	Overall mean		3.69		
Price	When it comes to choosing food items, I rely heavily on price.	1.00	5.00	3.25	0.834
	I am a price-conscious shopper.	1.00	5.00	3.68	
	I buy the lowest priced items that will suit my needs.	1.00	5.00	3.06	
	Overall mean		3.33		
Environmental concern	It is important to me that the products I use don't harm the environment.	1.00	5.00	3.44	0.897
	I consider the potential environmental impact of my actions when making many of my consumption decisions.	1.00	5.00	3.11	
	I am concerned about wasting the resources of our planet.	1.00	5.00	3.75	
	I would describe myself as environmentally responsible.	1.00	5.00	3.36	
	I am willing to be inconvenienced in order to take environmentally sustainable actions.	1.00	5.00	3.27	
Food safety	Overall mean		3.39		0.773
	Food safety is an important issue to me.	2.00	5.00	4.18	
	I think more classes and seminars about food safety should be available for consumers.	1.00	5.00	4.05	
	I believe that my decisions and actions impact my risk for foodborne illness.	2.00	5.00	4.09	
Purchase intention	Overall mean		4.11		0.896
	I am willing to purchase deodorized soy milk from now on, instead of the soy milk I usually purchase.	1.00	5.00	3.66	
	I expect to purchase this soy milk deodorized by 'empty' V-type starch.	1.00	5.00	3.31	
	I want to purchase this soy milk deodorized by 'empty' V-type starch.	1.00	5.00	3.60	
	I intend to purchase this soy milk deodorized by 'empty' V-type starch.	1.00	5.00	3.41	
	Overall mean		3.50		

**Table 3.** Convergent validity.

	Correlations																
	SQ1	SQ2	SQ3	HS4	HS5	HS6	Price7	Price8	Price9	EC10	EC11	EC12	EC13	EC14	FS15	FS16	FS17
SQ1	1	0.515**	0.526**	-0.055	0.186*	0.019	0.042	0.116	0.183*	0.190*	0.247**	0.103	0.230**	0.225*	0.265**	0.250**	0.236**
SQ2	0.515**	1	0.529**	-0.054	0.039	-0.116	0.029	0.049	0.186*	0.100	0.121	0.078	0.166*	0.148	0.199*	0.158	0.160
SQ3	0.526**	0.529**	1	0.037	0.182*	0.076	-0.078	0.132	0.035	0.202*	0.213*	0.096	0.065	0.137	0.370**	0.298**	0.298**
HS4	-0.055	-0.054	0.037	1	0.390**	0.603**	0.003	0.059	0.019	0.008	0.033	0.009	0.026	-0.080	0.058	0.059	-0.129
HS5	0.186*	0.039	0.182*	0.390**	1	0.455**	-0.201*	-0.139	-0.143	0.073	0.111	0.019	0.127	0.044	0.120	0.063	0.030
HS6	0.019	-0.116	0.076	0.603**	0.455**	1	-0.053	0.123	0.050	0.008	0.062	0.067	0.020	-0.143	0.094	0.053	0.040
Price7	0.042	0.029	-0.078	0.003	-0.201*	-0.053	1	0.673**	0.618**	0.150	0.135	0.128	0.032	0.128	-0.041	-0.101	-0.089
Price8	0.116	0.049	0.132	0.059	-0.139	0.123	0.673**	1	0.610**	0.146	0.114	0.156	0.067	0.131	0.050	-0.005	0.057
Price9	0.183*	0.186*	0.035	0.019	-0.143	0.050	0.618**	0.610**	1	0.128	0.042	0.082	0.030	0.126	0.039	0.033	0.056
EC10	0.190*	0.100	0.202*	0.008	0.073	0.008	0.150	0.146	0.128	1	0.809**	0.708**	0.590**	0.651**	0.311**	0.228**	0.045
EC11	0.247**	0.121	0.213*	0.033	0.111	0.062	0.135	0.114	0.042	0.809**	1	0.693**	0.631**	0.584**	0.352**	0.271**	0.135
EC12	0.103	0.078	0.096	0.009	0.019	0.067	0.128	0.156	0.082	0.708**	0.693**	1	0.663**	0.490**	0.268**	0.266**	0.063
EC13	0.230**	0.166*	0.065	0.026	0.127	0.020	0.032	0.067	0.030	0.590**	0.631**	0.663**	1	0.495**	0.267**	0.245**	0.045
EC14	0.225*	0.148	0.137	-0.080	0.044	-0.143	0.128	0.131	0.126	0.651**	0.584**	0.490**	0.495**	1	0.217*	0.127	-0.058
FS15	0.265**	0.199*	0.370**	0.058	0.120	0.094	-0.041	0.050	0.039	0.311**	0.352**	0.268**	0.267**	0.217*	1	0.683**	0.397**
FS16	0.250**	0.158	0.298**	0.059	0.063	0.053	-0.101	-0.005	0.033	0.228**	0.271**	0.266**	0.245**	0.127	0.683**	1	0.516**
FS17	0.236**	0.160	0.298**	-0.129	0.030	0.040	-0.089	0.057	0.056	0.045	0.135	0.063	0.045	-0.058	0.397**	0.516**	1

SQ: Sensory Quality; HS: Healthiness; EC: Environmental Concern; FS: Food Safety. \* $p < 0.05$ , \*\* $p < 0.01$ .

**Table 4.** Discriminant validity and reliability.

	Average Variance Extracted (AVE)	Composite Reliability (CR)
Sensory quality	0.682	0.866
Healthiness	0.657	0.851
Price	0.756	0.903
Environmental concern	0.708	0.923
Food safety	0.691	0.870
Purchase intention	0.763	0.928

### Correlation among latent variables and between factors and purchase intention

The correlation coefficients for all latent variables and coefficients between factors and purchase intention are presented in Table 5. Significant positive relationships were observed between Sensory Quality and Environmental Concern ( $p < 0.05$ ), Sensory Quality and Food Safety ( $p < 0.01$ ), and Environmental Concern and Food Safety ( $p < 0.01$ ). On the other hand, other latent variables did not show any significant relationships. The Variance Inflation Factor (VIF) values for Sensory Quality, Healthiness, Price, Environmental Concern, and Food Safety was 1.188, 1.008, 1.118, 1.035, and 1.211 respectively. These values suggest a moderate correlation among the independent variables. Hence, even though certain constructs are significantly related, this will not influence the interpretation of the regression analysis results.

Moreover, Sensory Quality, Environmental Concern, and Food Safety exhibited significant positive correlations with Purchase Intention. This suggests individuals with pronounced environmental and food safety concerns are more inclined to buy the "empty" V-type starch-deodorized soy milk. Previous studies have also demonstrated that food safety<sup>[77–79]</sup> and environmental concern<sup>[48–50]</sup> were the two factors that could contribute to consumers' purchasing habits. Furthermore, the participants who believed that 'empty' V-type starch deodorization process would improve the sensory profile tended to have higher purchase intention than those who did not. The result was consistent with previous research, which also showed that

**Table 5.** Correlations among variables.

Variable	1	2	3	4	5	6
1. Sensory quality	1.000					
2. Healthiness	0.055	1.000				
3. Price	0.108	-0.045	1.000			
4. Environmental concern	0.220*	0.040	0.145	1.000		
5. Food safety	0.364**	0.063	0.001	0.266**	1.000	
6. Purchase intention	0.486**	0.055	0.170	0.329**	0.308**	1.000

Pearson correlation test, \* $p < 0.05$ , \*\* $p < 0.01$ .

sensory quality, including taste, aroma, and texture, was the key determinant that influenced consumers' purchase intention of food products<sup>[29,39,80]</sup>.

### Relationships between purchase intention and demographic characteristics

In the univariate analysis, a notable difference in purchase intention based on gender was observed ( $p = 0.027$ ). However, age, school year, ethnicity, and household spending did not exhibit significant variations in purchase intention. A more comprehensive assessment of the relationship between purchase intention and demographic variables was undertaken using multiple regression analysis, as detailed in Table 6. This model accounted for 28.3% of the variance in participants purchase intention, suggesting that demographic factors like gender, age, school year, race/ethnicity, and household spending explain 28.3% of the variation in purchase intent. However, the relatively low  $R^2$  value of 0.283 implies the model is not particularly robust in predicting college students' intent to purchase the 'empty' V-type starch deodorized soy milk, especially when contrasted with findings from previous studies<sup>[81–83]</sup>.

In the full model, only gender significantly influenced the purchase intent for the 'empty' V-type starch deodorized soy milk ( $p = 0.02$ ). The findings indicate that females were more inclined to buy this product than males. However, other demographic factors, including age, school year, ethnicity, and household spending, did not significantly impact the purchase intent related to the soy milk processed with the novel 'empty' V-type starch approach.

**Table 6.** Relationships between purchase intention and demographic characteristics.

Variable	$\beta$ -Coefficient	$p$ -value
Gender	0.585	0.020*
Age	0.050	0.759
School year	-0.063	0.540
Ethnicity	0.077	0.196
Household spending	-0.052	0.391
Constant	2.498	<0.001**

Regression analysis, \*  $p < 0.05$ , \*\*  $p < 0.01$ .

**Relationships between purchase intention and factors**

From the multiple regression analysis, it is evident that the proposed model accounted for 55.4% of the variation in consumers' purchase intentions. This implies that factors like Sensory Quality, Healthiness, Price, Environmental Concern, and Food Safety collectively influence 55.4% of the Purchase Intention outcomes ( $R^2 = 0.554$ ). In addition, the proposed model showed an F value of 8.785 ( $p < 0.01$ ), indicating the significance of certain variables in shaping Purchase Intention. In the full model, both Sensory Quality and Environmental Concern were significantly associated with participants' purchase intention of 'empty' V-type starch deodorized soy milk ( $p < 0.01$  and  $= 0.027$ , respectively) (Table 7). This suggests that participants valuing the enhanced sensory attributes of soy milk through the 'empty' V-type starch process were more likely to buy the product. Specifically, for every unit increase in Sensory Quality, Purchase Intention scores would rise by 0.511. Additionally, there was a positive correlation between Environmental Concern and Purchase Intention. This indicates that participants with a heightened awareness of environmental matters were more inclined to buy the innovative deodorized soy milk. A unit rise in Environmental Concern corresponded to a 0.204 increase in Purchase Intention scores. In contrast, while factors such as health, price, and food safety did not emerge as significant predictors in the model, their positive relationships suggest that participants valuing these aspects were still more predisposed to consider a purchase.

**Discussion and implications**

Prior research has established that a high intake of soy protein and isoflavones can decrease low-density lipoprotein (LDL) cholesterol levels and increase antioxidant properties<sup>[84–87]</sup>. There is a growing body of evidence suggesting that soy consumption, inclusive of soy milk, correlates with reduced risks of noncommunicable diseases<sup>[88–90]</sup>. The numerous benefits of soy diets have been widely studied, revealing that soy proteins, particularly those rich in isoflavones, can impede cholesterol absorption in the small intestine, diminish saponin-mediated bile salt absorption rates, curb lipid oxidation, and elevate high-density lipoprotein (HDL) cholesterol levels<sup>[86,91–93]</sup>. Additionally, a previous double-blind, randomized, crossover study conducted by Bricarello et al.<sup>[94]</sup> revealed that compared to non-fat cow's milk, six weeks of soy milk consumption significantly lowered LDL cholesterol and raised HDL levels in patients with primary hypercholesterolemia. Besides, soy milk also considerably reduced plasma thiobarbituric reactive substances (TBARS), an indicator of lipid peroxidation. Even though soy products offer significant health

**Table 7.** Relationships between purchase intention and examined factors.

Variable	$\beta$ -Coefficient	$p$ -value
Sensory quality	0.511	<0.01**
Healthiness	0.025	0.781
Price	0.088	0.242
Environmental concern	0.204	0.027*
Food safety	0.145	0.228
Constant	-0.106	0.871

Regression analysis, \*  $p < 0.05$ , \*\*  $p < 0.01$ .

advantages, including protection against cardiovascular diseases, diabetes, and cancer, annual per capita soy consumption in the U.S. (0.11 kg) lags behind Asian countries including Japan (7.94 kg) and China (3.61 kg), and even some European nations (average 0.28 kg), according to Food and Agriculture Organization of the United Nations<sup>[95]</sup>. Liquid soy milk is the dominant soy food product, but its inherent soy scent can deter consumers. The 'empty' V-type starch has shown promise in effectively encapsulating undesirable aromas<sup>[22,24–26]</sup>, and was also used in a chewing gum variant which exhibited a pronounced citrus flavor when compared to counterparts made without this starch<sup>[96]</sup>. This research, therefore, aimed to pinpoint factors influencing consumer intentions to buy soy milk treated with 'empty' V-type starch.

Key findings spotlighted gender, Sensory Quality, and Environmental Concern as pivotal determinants for purchasing this product. These outcomes align with previous studies focusing on consumer tendencies in beverage and milk product purchases. Lyly et al.<sup>[29]</sup> examined the factors that affect consumers' willingness to use beverages and soups that contain  $\beta$ -glucan, a soluble fiber that could enhance heart health. The study consisted of over 1100 participants from Finland, France, and Sweden. Food samples were provided to the consumer and questions about liking and willingness to use were asked. The results indicated that the taste of the samples could strongly influence consumers' purchase intention. Another study conducted in the United States utilized TPB to predict soy milk consumption in two Illinois counties, with a total participation number of 380 from Women Infant and Children program. In the cross-sectional survey, factors including soy food intake, behavioral beliefs, subjective norms, and motivation were tested. Based on the findings, environmental belief was a significant factor that could influence participants' intention to consume soy milk<sup>[10]</sup>. Similar findings were noticed in another study that determined consumers' intention to purchase animal-friendly milk products. The survey was conducted online and approximately half of the participants were willing to purchase animal-friendly milk products, indicating the importance of environmental consciousness among consumers when they are making purchase choice<sup>[32]</sup>. These findings highlight the importance of sensory profile and environmental friendliness of a milk beverage product. With 'empty' V-type starch, the undesirable soy odors will be encapsulated, hence improving soy milk's sensory profile. Together with the environmentally friendly nature of soy milk, the consumers' purchase intention toward the 'empty' V-type starch deodorized soy milk could be largely enhanced.

Previous research investigating consumer acceptance toward food products found that gender also had a significant

## Consumers' intent to purchase deodorized soy milk

effect on purchase intent and perceptions<sup>[57,97]</sup>. According to Bower et al.<sup>[57]</sup>, among 70 participants, older women displayed a stronger inclination to pay more for health-beneficial spreads relative to other demographics. Another study carried out in Argentina examined the factors that could influence consumers' purchase intention toward food products. Among 256 responses, gender-based differences in purchase attitudes was also noticed<sup>[97]</sup>. Furthermore, recent research by Chekima et al.<sup>[98]</sup> consisted of 405 valid questionnaires highlighted gender's pronounced effect on green product purchasing and consumption. The current study echoes these findings, underscoring gender's pivotal role in shaping purchase intentions. Nevertheless, the predominance of female participants in the study (> 90%), attributed to the survey's academic setting and subject matter introduces potential sample bias, warranting caution in interpreting the gender-specific findings. Future research could be conducted under a more diverse context to verify the current findings.

The results of this study also showed a significant positive relationship between sensory quality and purchase intention of 'empty' V-type starch-deodorized soy milk. Previous study suggests that consumers are reluctant to sacrifice flavor even for the health benefits a product might offer<sup>[36]</sup>. A recent study by Palmieri et al.<sup>[39]</sup> emphasized taste as a primary motive for milk product consumption among over 330 Italian consumers. Multiple studies have highlighted the importance of taste in shaping consumers' willingness-to-purchase food products. Specifically, Imtiyaz et al.<sup>[80]</sup> determined that sensory appeal, encompassing aspects like taste, appearance, smell, and texture, significantly influenced purchase intention, consumption, and satisfaction among around 500 participants. Moreover, research by Pinsuwan et al.<sup>[99]</sup> and Haddad et al.<sup>[100]</sup> both underscored the significant role of sensory attributes, such as flavor, aroma, and texture, in influencing consumer decisions to buy beverages or milk-related products. Given these insights, emphasizing the superior sensory quality of "empty" V-type starch deodorized soy milk is paramount for its successful market positioning.

Furthermore, the current study found a positive association between environmental concern and the intention to buy soy milk treated with 'empty' V-type starch. This aligns with prior research, including a study by Ahmed et al.<sup>[101]</sup>, which demonstrated a strong positive relationship between environmental concerns and the purchasing intentions for food products among young Chinese consumers. Another multi-country study assessed factors affecting food product purchasing intentions in Pakistan (271 responses), Turkey (245 responses), and Iran (220 responses). While results varied by country, environmental concern consistently emerged as a significant influencing factor<sup>[102]</sup>. Additionally, a study from India highlighted a positive correlation between environmental concerns and young adult consumers' intentions to buy organic food<sup>[61]</sup>. The data suggest that college students, who often lean towards sustainable lifestyles and show higher environmental concern compared to older generations, are influenced by these concerns in their purchasing decisions. This leads to a heightened interest in the innovative soy milk processing approach. As a result, to effectively market this new soy milk product, emphasizing its sustainability attributes is essential. Such observations indicated that college students are open to accepting the

novel technique of deodorized soy milk products, with the product sensory profile and the suitability being the primary considerations influencing their purchasing decisions.

## Conclusions

The findings of this study suggested that more than half of the consumers presented a positive attitude towards the soy milk deodorized by the 'empty' V-type starch and were willing to try or purchase the product. Nonetheless, there are limitations to this research. First, the study participants were comprised of students from only one university in the United States and the sample size comprised primarily of females (90.5%), college students between the ages of 18 and 20 years (73.3%), and Caucasians (81%). Accordingly, the outcomes of this study might not represent the broader population. To ensure more comprehensive results, future research could benefit from a more diverse sample. Additionally, due to COVID-19 restrictions, participants weren't provided with samples of the 'empty' V-type starch deodorized soy milk, preventing any direct sensory evaluation. Subsequent studies that delve into the sensory aspects of this product will improve the research's validity and offer more insights into the 'empty' V-type starch's efficacy in masking undesired odors.

Overall, sensory quality is a critical factor in promoting such a positive attitude and could significantly influence the intention to purchase the 'empty' V-type starch-deodorized soy milk. Sensory characteristics, including taste, smell, and texture, should not be underestimated and ought to be emphasized during the product marketing stage for marketing success. Furthermore, the soy milk deodorized by 'empty' V-type starch may appeal to consumers who have higher environmental consciousness. To the best of our knowledge, this was the first study to investigate the factors that could influence consumers' intention to purchase soy milk that has been post-production treated, specifically by the 'empty' V-type starch that has been shown potential in masking off-flavor.

## Author contributions

The authors confirm contribution to the paper as follows: investigation, data collection: Zhou J; methodology: Zhou J, Shin YH, Jung SE; formal analysis: Zhou J, Shin YH, Jung SE; conceptualization: Jung SE, Kong L; supervision: Shin YH, Jung SE, Kong L; visualization, project administration, funding acquisition: Kong L; writing - original draft: Zhou J; writing - review & editing: Zhou J, Shin YH, Jung SE, Kong L. All authors reviewed the results and approved the final version of the manuscript.

## Data availability

The data that has been used is confidential.

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## Conflict of interest

The authors declare that they have no conflict of interest. Lingyan Kong is the Editorial Board member of *Food Innovation and Advances* who was blinded from reviewing or making decisions on the manuscript. The article was subject to the journal's standard procedures, with peer-review handled independently of this Editorial Board member and the research groups.

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