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Consumer responses and willingness-to-pay for hibiscus products: A preliminary study

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The rise in diseases like obesity and diabetes is a worldwide challenge. The consumption of functional products such as hibiscus, which has been proven to be high in bioactive compounds and dietary fiber, providing it with anticancer, antiaging, anti-inflammatory and satiety properties, should be promoted. In the U.S., promoting the consumption of hibiscus products can be a good approach to increase fiber consumption and to reduce risk of obesity, diabetes, and hypertension. However, information about knowledge of this functional product among consumers is still sparse and increasing consumption requires designing and marketing desired products made from hibiscus. Therefore in this preliminary study, we assessed consumer response to hibiscus products and investigated whether providing information about potential health benefits could impact consumer willingness-to-pay (WTP) for three types of non-alcoholic hibiscus beverages: ready-made tea, bottled juice, and kombucha. Our web-based survey was distributed through Qualtrics^{XM} and a convenience sampling method was chosen. Most participants identified themselves as female, 18–34 years old, with a graduate degree. Most participants (81%) had consumed hibiscus products before and 57% had a weekly food budget lower than $60. Overall, tea and juices were the most liked hibiscus beverages, respectively. Although taste and health benefits were ranked as the main reasons to consume hibiscus beverages, additional information about hibiscus health benefits did not significantly affect WTP for these products. Without additional health benefit information, consumer WTP for non-alcoholic hibiscus beverages ranged from $2.9 to $3.60 for kombucha and $4.08–4.97 for Ready-made-tea. This study provides valuable insights that can support future research on hibiscus products and promote the development of novel hibiscus-based foods and beverages that are appealing to the U.S. market.

KEYWORDS

***Hibiscus sabdariffa* L., Roselle, functional beverages, consumer preference, choice-based conjoint survey**

1. Introduction

Consumers are more careful about their food and beverage choices because of the rise in health problems associated with poor diets. Healthier diets (including for instance more fruits and legumes, lowering salt and sugar, and increasing whole grains) can, in addition to physical activity, help in the prevention of metabolic disorders (WHO, 2021a). In fact, metabolic risk factors (including diabetes, high blood pressure, overweight, obesity, high blood cholesterol, inflammation, and oxidative stress) are among causes of cardiovascular diseases (CVD) (Reddy and Katan, 2004; Galisteo et al., 2008; Helal et al., 2011; Matsuda and Shimomura, 2014; Senoner and Dichtl, 2019; Uchmanowicz, 2020). In 2020 an analysis of a sample composed of 12,047 US adults obtained from the National Health and Nutrition Examination Survey (NHANES) data of 1999–to 2010), revealed that prevalence of metabolic syndromes was 61.6% among the obese, 33.2% of overweight, and 8.6% of normal-weight people (Shi et al., 2020). These health issues contribute significantly to mortality with high blood pressure being attributed to 19% deaths worldwide, outpacing high blood glucose, overweight and obesity (WHO, 2022) and in 2021, they were considered the main causes of death (WHO, 2021b). This explains some of the reasons why consumers are showing more interest in probiotics, functional, nutraceuticals food products and beverages (Bruss et al., 2005; Carocho et al., 2017) like hibiscus.

Over the last 40 years, hibiscus (*Hibiscus sabdariffa* L.) has attracted a great deal of interest and an exponential increase in the number of scientific publications has been observed. Hibiscus grows in tropical and subtropical areas and is also known as Roselle, Bissab, sorrel, red sorrel, Karkadeh, and Zobo (Ali et al., 2005; Mohamed et al., 2012; Nkumah, 2015; Grumezescu and Holban, 2019). It has been long used in African traditional medicine and diets as an ingredient in foods and drinks, such as teas and juices (Diouf et al., 2007; Ismail et al., 2008; Abaker, 2018; Riaz and Chopra, 2018; Kubuga et al., 2019). Typically, dried calyces, the outermost part of flowers of the plant, are used in the preparation of these functional foods and beverages (Dini, 2019; Grumezescu and Holban, 2019). Several studies have shown that hibiscus provides nutrients such as antioxidants, vitamins, minerals, probiotics, fiber, and electrolytes (Cid-Ortega and Guerrero-Beltrán., 2015; Adadi et al., 2019; Valduga et al., 2019). The growing interest in hibiscus is believed to be related to many factors. It presents health benefits such as antimicrobial activities, antioxidant, liver-protection, hypotensive, and anti-inflammatory activities (Dickel et al., 2007; Cisse et al., 2009, 2010; Hopkins et al., 2013; Da-Costa-Rocha et al., 2014; Singh et al., 2017; Valduga et al., 2019). Hibiscus is naturally very low in calories and its potential to control factors associated with diabetes and to decrease high cholesterol levels and body weight has also been reported (Dickel et al., 2007; Hopkins et al., 2013; Valduga et al., 2019). Additionally, a daily intake of hibiscus tea might lower blood pressure (Herrera-Arellano et al., 2007; McKay et al., 2010).

The interest in hibiscus is also related to the fact that the calyces contain aroma compounds with desirable flavors (described as a mix of sweet and tart close to cranberry) which make it has a unique taste and utilized as a flavoring agent in many food products (Silliman et al., 2004; Pino et al., 2006; Ramirez et al., 2010, Shruthi et al., 2016).

The health properties of hibiscus are related to the presence of bioactive elements such as polyphenols and dietary fiber, which provide it with this wide range of pharmacological properties (Müller and Franz, 1992; Eggensperger and Wilker, 1996; Herrera-Arellano et al., 2004; Cisse et al., 2009; Da-Costa-Rocha et al., 2014; Cid-Ortega and Guerrero-Beltrán, 2015). Polyphenols are known for their capacity to detoxify human organism due of their free radical scavenging activity which interrupt free radical progression and therefore prevent potential harm of such radicals to the body. This can help prevents cancer, neurodegenerative and cardiovascular diseases (Goñi et al., 2009; Villanueva-Carvajal et al., 2013; Mercado-Mercado et al., 2015). Polyphenols found in hibiscus are composed of flavonoids (mainly anthocyanins which provide hibiscus with its intense red color) and phenolic acids (Da-Costa-Rocha et al., 2014). The anthocyanins are made of delphinidin-3-sambubioside also called delphinidin-3-xylosylglucoside or hibiscin (up to 70% of the total anthocyanins), cyanidin-3-sambubioside also known as gossypicyanin, delphinidin-3-glucoside, and cyanidin-3-glucoside; the anthocyanins can reach 1.5 g/kg of dried matter and (Pouget et al., 1990; Wong et al., 2002; Cisse et al., 2010). Fibers include polysaccharides (cellulose, gums, pectin, hemicellulose, and mucilage) and non-polysaccharides (lignins) and are found in the cell wall of plants. Dietary fibers play important roles in the body thanks to some of their properties such as fermentability, viscosity and digestibility but also to their bulking and binding abilities; they are considered as prebiotics. Viscous dietary fiber such as pectin and guar gum can influence blood lipids and delay gastric emptying. Starch and resistant starch provide satiety since they are slowly digested. Binding ability of dietary fibers contribute to cholesterol excretion *via* bile acids. Consumption of dietary fiber diminishes plasma low-density lipoprotein (LDL) cholesterol and therefore can led into lower risk of cardiovascular disease (Theuwissen and Mensink, 2008; Mudgil and Barak, 2013). Another factor that needs further attention is the low intake of dietary fibers observed in several countries. In the U.S., for example, the average fiber intake is only 15 g/day, which is about half of the recently increased FDA recommended daily value (28 g) (Hoy and Goldman, 2014). Hibiscus beverages could be a significant source of dietary fiber and its consumption could help increase this national average intake. Hibiscus contains also organic acids with high levels of a hydroxycitric acid, alternatively called garcinia acid or hibiscus acid; there is some evidence in humans that it can help with obesity and it is also believed to be able to reduce body fat for consumers (Hayamizu et al., 2003). This is the active compound that has made *Garcinia cambogia* so popular around the world.

Metabolic syndrome such as diabetes, obesity are health problems that contribute seriously to mortality rates, so natural ingredients that can help reduce these problems are of great value and importance to consumers and the food and beverage industries (Yusuf et al., 2001; Buttar et al., 2005; Balakumar et al., 2016; Younossi et al., 2019). Thus, the benefit of promoting the use of plants like hibiscus. However, it is unclear if consumers in the U.S. are aware of the health benefits of consuming hibiscus products. Information regarding consumer

knowledge and response to hibiscus products in the U.S. is still sparse. The goal of this preliminary study was to gather data on perception and consumption of hibiscus products that would reveal information useful for the promotion of the consumption of this functional food and its derivatives in US. To do so, first we assessed participants consumption, frequency of consumption, reasons for buying hibiscus products and their likability of specific non-alcoholic hibiscus-based drinks (juice, kombucha, smoothies, and teas). Second, we investigated participants "willingness-to-pay" (WTP) for three of these non-alcoholic hibiscus-beverages: ready-to-drink tea, juice, and kombucha. In this investigation, we tested the hypothesis that providing consumers with information about hibiscus health benefits could increase their WTP for these hibiscus-based drinks. The findings of this study can support the development of new functional hibiscus-based foods and beverages for the benefit of consumers and producers. Additionally, the results of this study can also lead to future marketing and consumer research on hibiscus products.

2. Materials and methods

2.1. Survey

This preliminary study was approved by the Virginia Tech's Institutional Review Board (IRB 19-550) and consisted of a cross-sectional survey with a choice-based conjoint experiment. Participation was open to adults (18 years or older) regardless of hibiscus consumption status and volunteers did not receive any incentive to participate in this study. Recruitment e-mails were sent through public listservs to members of the Virginia Tech community but there was no limitation on who else could complete the survey as far as they were over 18 years old. The survey was distributed through Qualtrics^{XM} (Qualtrics, Provo, UT, USA).

Before completing the survey, participants were informed about the purpose of the study and the low risks associated with it, then they were asked to answer an in-survey consent question.

In the first part of the survey, participants knowledge and consumption of hibiscus products was accessed through multiple-choice, Likert-type, rank question, one open-ended types of questions. The multiple-choice question enabled us to determine participants who consumed hibiscus products and the frequency of their hibiscus consumption. In this question, hibiscus product could be of any kind and possible responses were "a few times a year", "once a month", "once a week", "multiple times a week", and "never". For the Likert-type question, hibiscus consumers likeability of hibiscus- juice, kombucha, smoothies, and teas was assessed. A 7-point Likert-type scale with potential responses being: "like a great deal" (1), "Like a moderate amount" (2), "Like a little" (3), "Neither like nor dislike" (4), "Dislike a little" (5), "Dislike a moderate amount" (6), "Dislike a great deal" (7) was used. The scope of this question was limited to hibiscus juice, kombucha, smoothies, and teas as they are among the most common non-alcoholic beverages made from the hibiscus calyces (Ahmed and Abozed, 2015; Cid-Ortega and Guerrero-Beltrán, 2015; Monteiro et al., 2019). Regarding the rank question, participants who consumers hibiscus products were asked to rank five possible reasons (including "aroma", "color", "health", "taste", and "trendy products") for why they consume hibiscus products. A ranking scale of 1 to 5 was used with 1 equaling the most important or highest reason and 5 the least important or lowest reason. For the open-ended question, participants were asked to list any potential health benefits of consuming hibiscus that they have heard about. All participants (not hibiscus consumers only) could respond to this open-ended question.

In the second part of the survey, participants willingness-to-pay (WTP) for three hibiscus-based drink products was determined. As for the Likert-type question, here as well, the most common hibiscus beverages ready-made tea, bottled juice, and kombucha were considered except smoothie. We decided to limit this part of the survey to just three products to reduce the length of the questionnaire; that is why smoothies was not included. A choice-based conjoint experiment was conducted to determine the willingness-to-pay (WTP) for these hibiscus-based drinks. In particular, the question of interest was whether the mean WTP for each drink product was statistically different before and after an information treatment was introduced about the potential health benefits of hibiscus. To construct the choice experiment, a full factorial design was used. The attributes were type of drink and price with both varied at three levels (kombucha, ready-made tea, and juice) and ($2, $3, $4) respectively for type of drink and price. This resulted in a total of eight choice questions where participants were asked to choose between two types of hibiscus flavored drinks for consumption at home. Every choice question had the option of not purchasing either option. See part A in the Supplementary material for an example of a choice question. After completing the choice experiment, an information treatment was introduced (see Supplementary material, part B). After reviewing the statement on hibiscus health properties, participants were asked to complete the same choice experiment a second time.

In the last part of the survey, participants were asked to complete a series of demographic questions. Demographic categories included age, gender, income, and education level.

2.2. Data analysis

A total of 181 volunteers agreed to participate in this study. However, not all participants completed the entire survey. Furthermore, for larger questions that had sub questions because of the presence of two variables (likability and type of hibiscus-based drinks), different number of participants responded to each sub question. For these reasons the number of respondents differ across questions and even within one large question. Descriptive statistics (means ± standard deviation and/or frequencies) were used to analyze multiple-choice/frequency of hibiscus consumption (n = 168 respondents), Likert-type scales (n = 145, 138, 139, 144, respondents respectively for juice, kombucha, smoothies, and teas), ranking of hibiscus attributes (n = 135 respondents), and demographics data (n = 139 respondents).

Differences in demographic characteristics between hibiscus consumers (code = yes) and non-consumers (code = no)

were assessed *via* chi-squared tests (χ^2). *T*-tests and one-way ANOVA were performed to compare likability of hibiscus products differences within demographic groups. IBM SPSS Statistics software (Chicago, IL, USA) was used for all statistical analyses described above.

A total of 147 observations were used in the WTP analysis (choice-based conjoint experiment data). The WTP analysis consisted of a conditional logit model. Consumer heterogeneity was tested *via* mixed logit models; however, the random parameters were statistically insignificant. Thus, the conditional logit model is presented. Moreover, the resulting WTP values between the conditional and mixed logit models were not statistically different. The lack of heterogeneity is likely due to the small, convivence sample that was collected. This is also evident in the lack of variation among the summary statistics of the sample. All parameters were significant in the conditional logit model at the <1% level. From the conditional logit model, WTP was calculated as the negative ratio of the drink product parameters and the price parameters. In addition, the 95% confidence intervals for each WTP value was constructed using the Krinsky-Robb method (Krinsky and Robb, 1986). A p-value ≤ 0.05 was used as a criterion of significance for all analyses (5% significance level).

3. Results and discussion

Participants who completed the demographics questions at the end of the survey ($n = 139$) were mostly females (73%), with the majority having an age ranging between 18 and 34 years old (76%), and were highly educated (post-graduate degree = 54%) (Table 1). The young and highly educated profile of our participants may be due to the fact that our recruitment e-mails were mostly shared locally to the Virginia Tech community, which is mainly composed by students. The younger female emphasis of our survey/result was not anticipated, so it may cause some differences if compared directly to the entire U.S. population. Demographic comparisons with the U.S. population show that we had much higher number of females in this survey (73%) against 50.8% for the U.S. population (https://data.census.gov). As well, our population was younger, with most of our respondents (76%) being under 34 years of age even though no upper limit age was set for participation in the study meaning all people above 18 years old could participate. However, the survey was voluntary and may represent consumers/people who are more interested in hibiscus-based beverages. To address these limitations of our work and obtain a more balanced dataset, probability sampling methods and better recruitment channels, including collaboration with other institutions, are suggested when designing a broader study that aims to draw a precise picture of the entire U.S. population. Although the relatively small sample size of this study does not allow us to generalize our findings, it can provide guidance to further nationwide consumer studies on hibiscus products.

Among these 139 respondents who completed the demographic questions, 81% reported consumption of a hibiscus product in some form over the past year and no significant differences between hibiscus consumers and non-consumers were found within gender, age, education, or income groups (Table 1). The fact that most participants reported familiarity with hibiscus products did not appear as a complete surprise after noticing the highly educated profile of our survey respondents.

A total of 168 participants answered the multiple-choice question "How often do you consume hibiscus product of any kind?". Overall, consumption of hibiscus products was not very frequent among participants. Most respondents (50.6%) reported they consume hibiscus products few times a year, 20.2% stated they never consume them, 16.7% consume them once a month, 7.1% once a week, and only 5.4% reported consumption of hibiscus products multiple times per week.

For the likability question, regardless of demographic categories (age, gender, income, or education level), hibiscus tea was the most liked beverage (mean $\pm$ SD = 2.4 $\pm$ 1.2) followed by juice, smoothies, and kombucha (mean $\pm$ SD = 3.2 $\pm$ 1.3, 3.5 $\pm$ 1.1, and 3.8 $\pm$ 1.8, respectively). Table 2 shows more details on participants likability of these specific hibiscus-based beverages with tea counting more "Like a great deal" (29.2%), less neutral (e.g., "Neither like nor dislike", 20.8 %), and 0.0% "Dislike a great deal" response among 144 respondents of this specific product always regardless of demographic aspects.

Similar likability responses were found when demographic categories (age, gender, income) were considered individually, see Table 3. The only exception was that male consumers significantly liked hibiscus juice more than female consumers (2.9 $\pm$ 1.4 vs. 3.4 $\pm$ 1.2). Hibiscus is considered a superfood and hibiscus-based drinks are among the functional beverages categorized as "energy drinks" that provide the body with substances that enhance physical and mental performance (Gunja and Brown, 2012; Ekesa, 2017). However, our study had a much greater number of female respondents. Although our result suggests that male consumers significantly liked hibiscus juice more than female consumers, further confirmation is needed.

The higher consumer preference for tea and juice products observed in our study might be related to the fact that they are convenient and easier to make than smoothies and kombuchas. The popularity surge of ready-to-drink tea in western markets is related to their functional properties, innovation in flavorings such as hibiscus blossoms and spices and also consumers interest in convenience; for these reasons, these non-alcoholic beverages are considered a good option to replace carbonated soft drinks (Renfrew and Ashurst, 2016). Consumers preferring these two beverages is interesting as some studies have established the benefit of taking such products. For instance, there is clinical evidence that hibiscus products can lower blood pressure in humans. According to Nwachukwu et al., drinking hibiscus infused water (standardized at 150 mg extract/kg) daily for 4 weeks with breakfast significantly lowered blood pressure in people with mild to moderate hypertension (Nwachukwu et al., 2015a) and hibiscus was a more effective antihypertensive than hydrochlorothiazide and did not cause electrolyte imbalance. McKay et al. (2010) reported a significant systolic blood pressure decrease (relative to placebo) with three 240 ml servings of hibiscus tea per day for 6 weeks and noted that consumption of hibiscus tea by pre- and mildly hypertensive people may lower blood pressure as part of a modest dietary change. In a study comparing hibiscus extract (150 mg extract/kg/day) with 10 mg/day lisinopril in mild to moderate hypertensives, Nwachukwu et al. (2015b) reported that hibiscus extract was equally effective in decreasing plasma aldosterone

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TABLE 1 Hibiscus consumption by participants' demographic characteristics.

Characteristic	Total sample count (%)	Hibiscus consumer count (%)		χ^2	*p*-value
	($n = 139$)	Yes ($n = 113$)	No ($n = 26$)		
Gender					
Male	37 (26)	27 (24)	10 (38)	2.460	0.292
Female	101 (73)	85 (75)	16 (62)		
Other	1 (1)	1 (1)	0 (0)		
Age categories					
18–34 years	106 (76)	89 (79)	17 (65)	2.089	0.148
35–65 years	33 (24)	24 (21)	9 (35)		
Education (highest level completed)					
Some college/2-year degree	26 (19)	19 (17)	7 (27)	2.909	0.234
4-year degree	38 (27)	34 (30)	4 (15)		
post-graduate degree	75 (54)	60 (53)	15 (58)		
Household Income ($/year)					
<59,999	86 (61.9)	73 (64.6)	13 (50.0)	4.864	0.088
60,000–119,999	34 (24.5)	28 (24.8)	6 (23.1)		
>120,000	19 (13.7)	12 (10.6)	7 (26.9)		
Food Budget ($/week)					
0–59	57 (41)	48 (42)	9 (35)	4.660	0.198
60–99	23 (17)	17 (15)	6 (23)		
100–159	45 (32)	39 (35)	6 (23)		
>160	14 (10)	9 (8)	5 (19)		

TABLE 2 Likability of hibiscus beverages: Juices, kombuchas, smoothies, and teas.

How well do you like to consume hibiscus in each of the following forms?	Juice		Kombucha		Smoothie		Tea	
	Count	%	Count	%	Count	%	Count	%
1. Like a great deal	22	15.1	18	13.0	6	4.3	42	29.2
2. Like a moderate amount	22	15.1	22	15.9	24	17.3	39	27.1
3. Like a little	19	13.0	6	4.3	19	13.7	29	20.1
4. Neither like nor dislike	75	51.4	61	44.2	83	59.7	30	20.8
5. Dislike a little	3	2.1	8	5.8	0	0.0	3	2.1
6. Dislike a moderate amount	4	2.7	6	4.3	4	2.9	1	0.7
7. Dislike a great deal	1	0.7	17	12.3	3	2.2	0	0.0
Total	146	100.0	138	100.0	139	100.0	144	100.0

and angiotensin-converting enzyme and reduced systolic blood pressure significantly better than lisinopril. This means that encouraging hibiscus teas and juice intake is a good option in helping people dealing with high blood pressure issues as it can be a good relief and help save money on drugs.

Smoothies are trendy drinks, often thicker than juices, that can be a good source of bioactive compounds like polyphenols, dietary fiber, electrolytes, and energy. Hibiscus smoothies may require larger amounts of hibiscus calyces in their preparation, which can result in an intense sour taste that may not be appreciated by some consumers. Thus, clear specifications for application of hibiscus calyces as an ingredient in smoothies and product development efforts are some alternatives to increase consumer interest in this type of hibiscus-based product.

While answering to the ranking question, respondents ($n = 135$) ranked taste as the most important reason, which was followed by health benefits, aroma, trendy product, and color, respectively (Table 4). This result agrees with previous literature.

TABLE 3 Likeability of hibiscus beverage (juice, kombucha, smoothies, and teas) while considering demographic categories (age, gender, income).

Characteristics	Juice		Kombucha		Smoothie		Tea	
	n (%)	mean ± SD	*n* (%)	mean ± SD	*n* (%)	mean ± SD	*n* (%)	mean ± SD
Gender								
Male	37 (28)	2.9 ± 1.4	30 (24)	4.2 ± 1.5	31 (25)	3.7 ± 1.2	34 (26)	2.8 ± 1.0
Female	97 (72)	3.4 ± 1.2	96 (76)	3.6 ± 1.9	95 (75)	3.5 ± 1.2	98 (74)	2.3 ± 1.2
Age categories								
18–34 years	104 (77)	3.2 ± 1.3	99 (78)	3.6 ± 1.8	99 (78)	3.4 ± 1.2	101 (76)	2.4 ± 1.2
35–65 years	31 (23)	3.3 ± 1.2	28 (22)	4.1 ± 1.7	28 (22)	3.9 ± 0.8	32 (24)	2.5 ± 1.3
Household Income ($/year)								
<59,999	84 (62)	3.1 ± 1.4	77 (61)	3.8 ± 1.9	77 (61)	3.6 ± 1.3	81 (61)	2.5 ± 1.1
60,000–119,999	33 (24)	3.4 ± 1.1	32 (25)	3.4 ± 1.7	32 (25)	3.4 ± 0.9	34 (26)	2.3 ± 1.3
>120,000	18 (13)	3.9 ± 1.1	18 (14)	3.9 ± 1.5	18 (14)	3.6 ± 0.8	18 (14)	2.6 ± 1.4

TABLE 4 Rank of reasons to why participants consume hibiscus products.

Reason to consume hibiscus products	Rank*									
	1		2		3		4		5	
	%	Count	%	Count	%	Count	%	Count	%	Count
Aroma	9.6%	13	34.8%	47	28.9%	39	23.7%	32	3.0%	4
Color	4.4%	6	14.1%	19	29.6%	40	37.8%	51	14.1%	19
Health benefits	25.9%	35	20.7%	28	21.5%	29	26.7%	36	5.2%	7
Taste	54.8%	74	25.9%	35	11.9%	16	4.4%	6	3.0%	4
Trendy product	5.2%	7	4.4%	6	8.1%	11	7.4%	10	74.8%	101

*1 = most important reason. Respondents: n = 135.

Troderman (2020) associated the likability of hibiscus calyces with their sour taste, natural flavor, and sensory qualities. Another study reported that taste was the reason for hibiscus syrup likability by consumers (Bechoff et al., 2014). Regarding different products that also have appealing health benefits, Carneiro et al. (2021) recently reported that, in a consumer study of edamame (vegetable soybean), "like the taste" was a stronger motivator to consume soy products than "for health reasons" in both years the study was conducted. This suggests that organoleptic properties could drive consumption and acceptability of hibiscus products more than their potential health benefits. However, the fact that health benefits ranked second suggests that it is also an important factor that can drive purchase decisions. Participants choosing taste before health benefits is not necessarily something negative; hibiscus health benefits are associated with regular consumption and whenever consumers like the taste of a product there are greater chances they will continue to consume it. For instance, while investigating the differential role of smell and taste for eating behavior in 2017, Boesveldt and de Graaf (2017) made this statement: "Together with texture, taste is responsible for eating rate" (Boesveldt and de Graaf, 2017). This means that hibiscus-based functional foods and non-alcoholic beverages with appealing taste can be important allies to improve nutrition and effectively reduce high blood pressure (hypertension) numbers in the country as it affects a great number of people. According to the CDC, nearly half of American adults have hypertension and only a quarter of hypertensives have their blood pressure under control (CDC, 2020). Another point to consider is that consumers may consider other factors when deciding to purchase and consume (or not purchase/consume) hibiscus products that were not provided in our survey (e.g., price, convenience, availability). Therefore, future studies that consider such parameters are needed.

In the open-ended question, participants were asked to list any potential health benefits of consuming hibiscus that they have heard about. The five most frequent responses were that hibiscus "is an antioxidant", "lowers blood pressure", "helps with weight loss", "has lots of vitamin C", and "is anti-inflammatory", but several respondents were not able to name a health benefit associated with hibiscus consumption. The majority of the potential health benefits listed by participants corresponded to the ones frequently mentioned in scientific studies on hibiscus (Ali et al., 2005; Ismail et al., 2008; Da-Costa-Rocha et al., 2014; Ekesa, 2017).

WTP for the three chosen hibiscus drink products (kombucha, ready-made tea, and bottled juice) was determined through a choice-based conjoint experiment and results are presented in Table 5. The treatment effect lowered the mean WTP for each of the drink products, but note that the 95% confidence intervals overlap before and after the treatment for every drink product.

TABLE 5 Willingness-to-pay (WTP) for non-alcoholic hibiscus beverages pre- and post- health information provision ($n = 147$).

Hibiscus product	Before information			After information		
	Mean WTP	2.50%	97.50%	Mean WTP	2.50%	97.50%
Kombucha	$3.23	$2.91	$3.60	$2.84	$2.59	$3.10
Ready-made tea	$4.47	$4.08	$4.97	$4.01	$3.73	$4.34
Bottled juice	$3.87	$3.54	$4.27	$3.30	$3.07	$3.57

This suggests that a simple information treatment about the health benefits of hibiscus does not change the mean WTP for hibiscus drink products. The result indicates that those who do not consume hibiscus drink products are unlikely to purchase the drink products after learning about the potential health benefits. It also implies that those who regularly purchase the products already know about the health benefits of hibiscus. However, this was a relatively small sample and not representative of the U.S. population. It is likely that a larger sample size would show differences in WTP before and after the treatment. Consumer sensory preferences (taste and aroma, specifically) could be driving liking of hibiscus products more than the potential health benefits. Further research into sensory liking would be useful in determining if there are hibiscus drinks that are more preferable to those who do not regularly consume hibiscus products.

4. Conclusions

The main objective of this preliminary study was to gather scientific evidence on facts like consumers knowledge, preference, likability, and willingness to pay for hibiscus products with the ultimate goal being to contribute to providing good information for the promotion of healthy product for consumers wellbeing. The results of this study show that taste was considered the main reason for consuming hibiscus products, and it was followed by health benefits. This suggests that the development and commercialization of tasty functional products may be fundamental to promote hibiscus consumption among U.S. consumers and improve nutritional wellbeing. Results of this Preliminary study suggest teas as the most preferred hibiscus-based beverages, followed by juices, smoothies, and kombuchas. Considering that only 14% of the participants reported weekly intake of hibiscus, future behavioral study is suggested to identify which major factors could help consumers who are familiar with the health benefits of hibiscus to increase its consumption (e.g., price, availability, convenience). Mean WTP values before and after information means were not statistically different, so our initial hypothesis that providing consumers with information about hibiscus health benefits could increase their WTP for hibiscus products was not confirmed. Finally, it is important to mentioned that participants in this study had a certain degree of knowledge of hibiscus products even though it should be larger than that given the important health attributes of hibiscus. This study provides valuable information to the non-alcoholic beverage industry and also contributes to the growing body of literature on consumer research on hibiscus products which can help in raising awareness with regard to this plant-based product.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Virginia Tech Institutional Review Board (FWA00000572). IRB Number 19-1109. The patients/participants provided their written informed consent to participate in this study.

Author contributions

ON wrote the first draft of the manuscript and collected consumer data. ON, VH, and CN contributed with questionnaire design and data analyses. ON, VH, RC, and SO'K edited manuscript, which was reviewed, and approved by all the authors. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2023.1039203/full#supplementary-material

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