



# Effect of Sustainability Claim on Willingness to Pay for Upcycled Food in Digital Era: Differential Effect of Sustainability Claim Between Virtue and Vice Product Category

Sidra Ghazanfar<sup>1</sup>, Muhammad Abdullah<sup>1</sup>, Rakhshan Ummar<sup>2</sup>, Rizwan Shabbir<sup>3\*</sup> and Shahnawaz Saqib<sup>1</sup>

<sup>1</sup>Department of Management Sciences, Khwaja Fareed University of Engineering and Information Technology, Rahim Yar Khan, Pakistan, <sup>2</sup>Department of Management Sciences, National University of Modern Languages, Islamabad, Pakistan, <sup>3</sup>Lyallpur Business School, Government College University, Faisalabad, Pakistan

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### \*Correspondence:

Rizwan Shabbir  
rizwanshabbir@gcuf.edu.pk

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The growing demand for food availability is persuading researchers, marketers, and consumers to opt for various solutions that could ensure food sustainability for our upcoming generations. Upcycled food is one of the solutions which could lead to food sustainability by upcycling discarded food ingredients. However, marketers seem less interested in producing upcycled food because of their low acceptance and willingness to pay. This study investigated when sustainability claims prompt premium prices for upcycled food; whether it varies between virtue and vice product categories? The research incorporates two experiments on the willingness to pay for upcycled food and examines the role of the intervention product category (virtue vs. vice). Overall, the results confirm the original findings; however, some differences in the context of virtue vs. vice product categories have been observed. The results (study I, without sustainability claim) indicated that consumers showed more willingness to pay for conventional (virtue and vice) products as compared to upcycled (virtue and vice) products. The results further revealed that willingness to pay for vice products was low compared to virtue products, particularly for upcycled vice products. The findings of study II indicated that sustainability claim increases the willingness to pay for upcycled food, both for virtue and vice product categories. However, willingness to pay for upcycled vice products increases more than for upcycled virtue products.

**Keywords:** upcycled food, vice product, virtue product, sustainability, willingness to pay, environmental concerns

## 1 INTRODUCTION

The World Food Programme (WFP) and Sustainable Development Goals (SDGs) by the United Nations have targeted to achieve zero hunger. The growing population of the world is causing pressure on food availability. The United Nations reported that roughly 957 million people out of 93 countries do not have enough food to eat (UN, 2021). An estimation revealed that nearly 33% of total food production is wasted globally (Jan et al., 2011), which forces 800 million people into hunger and malnourishment (Bravi et al., 2020). Food production is an agricultural activity that relies upon water

availability. The water shortage is the main hurdle in agriculture sustainability, which results in food insecurity and hunger for millions of people worldwide (Hegnsholt et al., 2018). Various artificial or fabricated food products are available in the consumer market to attain food security and improved nutritional value from agricultural products. Such techniques include reducing food waste (Mourad, 2016), which leads to a new variety of food products known as upcycled food (Bhatt et al., 2020; McCarthy et al., 2020).

Food waste refers to the part of comestible food which is left unused (Smith and Landry, 2021) and could further be processed for human consumption but eventually discarded or wasted due to contamination (Giroto et al., 2015). Considering this wastage of food, the researchers view that the problem of food insecurity could be handled by controlling the amount of food waste (Mourad, 2016; Galli et al., 2019). Considering nutritional values based on the Food Service Sensitive Model, it has been observed that discarded ingredients could produce foodstuffs (O'Donnell et al., 2015). Many foodstuff manufacturers have invested in products made from such ingredients in response to that and have named them upcycled food.

Growing population and food insecurity issues have forced the researchers to focus on the food losses within the supply chain, particularly from a consumer perspective (Parfitt et al., 2010). One of the possible solutions for food waste is upcycled food, which could reduce food waste by controlling the source of food waste (Bhatt et al., 2018), such as some food ingredients called co-stream/byproducts, wasted during the production or processing stage of food, could be used by upcycled food as ingredients to create some other safe and consumable food products for humans. Hence, upcycled food reduces wastage of food and contributes to environmental and food sustainability. Globally, many food industries are presently using upcycled food as their source of raw ingredients. The nutritional value of upcycled food is collected when a food product is discarded, such as dried fruits and vegetables are used as ingredients for a powdered soup or other foodstuffs like candies.

A product category is vital for differentiating healthy and unhealthy products. Particularly, sustainable consumption claims that products have a bundle of beneficial values in themselves and their supply chain. This concept is similar to virtue or vice products, where the difference among the product is a relative measure of benefits that consumers demand while purchasing the product (Parreño-Selva et al., 2014). Wertenbroch (1998) described the virtue/vice product category as healthy or unhealthy products that delight consumers' experience yet present negative consequences in the long term, such as the virtue food product is manufactured from organic ingredients with authentic taste but wastes food resources when the product is not consumed in a given time. On the other hand, the vice food product is manufactured with upcycled food with a general taste, but food resources were not wasted in a given time (Thomas et al., 2011).

From a consumer's perspective, the benefits of upcycled food are not well communicated and promoted as it highlights sustainable nature. Many studies have already been conducted to assess the effect of sustainability claims on customers'

acceptability and willingness to pay (WTP) for upcycled food (Bhatt et al., 2020; Asioli and Grasso, 2021; Coderoni and Perito, 2021). Nevertheless, consumers' recognition regarding purchase decisions for an upcycled food product still needs to be investigated. Significantly, when product category (virtue/vice) impacts the claim for sustainability on WTP for the upcycled food product. Upcycled products have been introduced in many developed countries like the United States, the United Kingdom, and the European Union (Bhatt et al., 2021). The study by Zhang et al. (2021) claimed that in the United States, 22% of total participants assume that upcycled food is environmentally-safe and generates sustainable food processes in its value chain. This concept is now gaining acceptance in Asian countries also.

This new food category demands that consumer perception be known for designing marketing strategies and how marketing communication tools could be applied to enhance one's image, attitude, and sustainable behavior. A previous study by Zhang et al. (2021) examined which segment of market generations is best for targeting upcycled food products. Prior research investigation showed that very little had been known about the consumer's perspective of upcycled food products and their consumer acceptability in different regions. The work of Bhatt et al. (2018) concluded that customers seek benefits from upcycled food which enhance their sustainable perception regarding the environment and food security.

The market success of upcycled food is built upon the customers' acceptability of upcycled product image and their willingness to pay for such products. Few studies have identified why and when consumers are WTP for upcycled food (Bhatt et al., 2020; Asioli and Grasso, 2021; Coderoni and Perito, 2021). The work of Asioli et al. (2014) studied the price range that is acceptable for the customer to pay for the upcycled product. Researchers have explored new domains that affect the supply chain process and consumers' acceptability, such as investigating market generations, environmental claims, and product types (Bhatt et al., 2020; Coderoni and Perito, 2021). However, past researchers have neglected the role of the product category (virtue vs. vice), which could alter the effect of sustainability claim on consumer WTP for upcycled food. Although researchers have studied the effect of sustainability claims on WTP for upcycled food, they neglected the possibility that sustainability claims might work differently for virtue vs. vice products. It has already been studied that consumers respond differently to virtue and vice products and price promotions (Wertenbroch, 1998; Milkman et al., 2008; Hui et al., 2009; Mishra and Mishra, 2011).

The article is outlined in five sections. The introduction highlights the background of upcycled food and its impact on society and commercial markets. The value of claiming sustainability features among virtue and vice product categories is also mentioned. The gap emphasized the impact of sustainability claims on willingness to pay for upcycled food in the digital era. The second part described the conceptual background by reviewing the prior studies on willingness to pay for conventional/organic food and the effect of the virtue/vice product category while making purchase decisions. The

following section describes methodological techniques based on Bhatt et al.'s (2020) research techniques. The part also mentions data collection and analysis approaches for study I and study II samples. The fourth section interprets the results and explains their relationship among selected product categories (virtue/vice). The last section brought out practical implications, theoretical justification, and significance of the study.

## 2 LITERATURE REVIEW

### 2.1 Consumers' Willingness to Pay for Upcycled Food

The extended theory of planned behavior described that WTP as a critical factor that explains sustainable behavior (Carfora et al., 2019; Ateş, 2021). Intentions and perceived quality are the measures based on which consumer perception could be formulated. A purchase intention regarding upcycled products depends on WTP, self-identity, and ecological knowledge. In order to understand consumers' acceptability for upcycled products, prior studies have examined different generational segments and their WTP for upcycled/conventional food based on price or quality (Barber et al., 2010; Bhatt et al., 2021). The study by Mukherjee et al. (2017) suggested that product price is essential for investigating WTP. However, customers evaluate the price when a product claims sustainable features, such as conventional food vs. upcycled food (Lee et al., 2018).

The acceptability of upcycled products in the United States concluded that customers were likely to pay less money for the upcycled product than for conventional/organic products (Bhatt et al., 2020). However, a promotional message as an intervention could urge the customers to pay a higher price for upcycled products. Similarly, Zhang et al. (2021) investigated the acceptance of upcycled food among different generations, and findings revealed that the likelihood of purchase of it was higher among Baby Boomers than other generations, while it was found least among Generation X. Aschemann-Witzel and Peschel (2019) found that information, branding, and design are the factors that can shape the attitude of the consumer toward upcycled food. The market success of upcycled food depends upon consumers' acceptance of food, which contributes to food wastage. The work of Bhatt et al. (2018) found that such value-added foods are perceived as premium organic food by consumers, and they believe that the consumption of this kind of food offers many benefits to others by contributing to food sustainability. (Bhatt et al., 2018). McCarthy et al. (2020) studied the factors which persuaded customers toward upcycled food and concluded that convenience-oriented behavior, status-seeking, environmental and food waste concerns, and price consciousness were the factors that persuaded customers to purchase upcycled food.

Furthermore, Grasso and Asioli (2020) investigated a study in Europe, suggesting that consumers' WTP is more influenced by product informational benefits presented to participants for upcycled food products. However, the study by Köpcke (2020) analyzed that German customers are willing to pay more for upcycled food than conventional/organic food without any

intervention. Therefore, developed countries seem to have a higher WTP for upcycled food. The industrial perspective of upcycled food focuses on product commercializing aspects that require a clear understanding of target market parameters. The stimuli that enhance consumer acceptance of upcycled food are not fully observed/investigated. Prior studies on upcycled food investigated attributes of purchase intentions (Bhatt et al., 2018), price, product information (Aschemann Witzel et al., 2021), the role of the message (Asioli and Grasso, 2021), and price sensitivity (Zhang et al., 2021). Coderoni and Perito (2020) studied olive byproducts and found that marketers could offset consumer technophobia by communicating the benefits. Perito et al. (2019) also recommended that appropriate marketing campaigns focusing on the benefits of byproducts could be helpful to enhance the consumer acceptance of such products. However, few studies have explored sustainable consumption behavior, such as sustainable WTP. Some other studies recommended that the commercial success of upcycled ingredients and products could be achieved by labeling the environmental and health benefits (Giesen and Hooge, 2019; Bhatt et al., 2020; Asioli and Grasso, 2021; Coderoni and Perito, 2021). However, the extent to which sustainability claims affect consumers' perceptions and their WTP for upcycled food might vary under different circumstances. Product category (virtue vs. vice) is one of the conditions, where the effect of sustainability claim might vary between virtue and vice products.

### 2.2 Role of Virtue vs. Vice Product

Most literature conceptualizes virtue and vice in relation to each other. Relative virtue is defined as a product that does not provide immediate pleasure or maybe less appealing but does not negatively affect health in the long run. While vice is defined as a product, which may appear more appealing and gratifying but has long-term negative consequences on health (Wertenbroch, 1998; Milkman et al., 2008). Yan et al. (2017) classified virtue and vice products into four categories: 1) healthy virtue products: represents a healthy food product with virtuous features (e.g., low calories natural juice), 2) healthy vice product: represents a healthy food product with fewer virtuous features (e.g., a regular natural juice), 3) unhealthy virtue product: represents an unhealthy food product with virtuous features (e.g., low fats potato crisps), and 4) unhealthy vice product: represents an unhealthy food product with no or fewer virtuous features (e.g., regular potato crisps). Winterich and Haws (2011) suggested that less self-control is needed for a healthy consumption than an unhealthy consumption. Therefore, consumers can limit the consumption of vice products by controlling their purchase quantity (Wertenbroch 1998). Wertenbroch (1998) suggested that consumers apply self-control on vice products by limiting their purchase quantity; even price promotions could not encourage them to purchase more. However, Parreño-Selva et al. (2014) supported a contrasting argument; they stated that regret of not purchasing vice products long-term encourages consumers to select the vice product compared to the virtue product at the time of price promotion. Bezawada and Pauwels (2010) suggested that virtue and vice product choices influence the consumer's

response toward organic products and found that the consumers were more reactive to the price promotions of organic virtue products. Hence, the literature supported that product category (virtue vs. vice) influences the consumer's response toward organic food.

The digital era has driven consumption patterns for sustainable food by featuring stimuli for each customer generation based on their marketing positioning approach. Baby Boomers are engaged in ecological behavior that transforms their promotional marketing campaigns (Straughan and Roberts, 1999; Gordon-Wilson and Modi, 2015). Generation X and Y have aroused their environmental stimuli to address their sustainable consumption patterns (Singh and Verma, 2017), such as their interest in recognizing environmental messages (D'Souza et al., 2007) and knowledge about reusing/recycling techniques (Laroche et al., 2001). Suchard and Polonski (1991) suggested that customers who understand ecological behavior are willing to contribute to environmental activities like recycling and purchasing organic products. Still, it is not clear that such customers have the propensity to pay for upcycled food as their behavior is correlated with green purchase intentions. The study by Pickett et al. (1993) concluded that customers who intend to recycle products might not have the same tendency toward purchasing recycled/reused material products. Hence, this study investigates whether the effect of sustainability claim for virtue vs. vice upcycled products works differently or not. Previous studies have shown that consumers' attitudes toward products, assortments, and promotions might vary between virtue and vice products (Wertenbroch, 1998; Okada, 2005; Milkman et al., 2008; Hui et al., 2009; Mishra and Mishra, 2011; Van Doorn and Verhoef, 2011).

### 3 METHODOLOGY

The objectives of this study followed the methodological techniques and replicated study I of Bhatt et al. (2020) by applying the same research strategy. Overall, two studies were conducted; the first study (study I) examined the consumers' WTP for upcycled (virtue/vice) food products vs. conventional (virtue/vice) food products, and the second study (study II) analyzed the effects of intervention sustainability claim on WTP for upcycled (virtue vs. vice) food products.

#### 3.1 Study I

##### 3.1.1 Sampling and Procedure

The sample consisted of 300 Pakistani undergraduate second-year students from the business department: 60% of participants were men, and 40% were women. The demographic presentation showed that 8% of participants are part-time employed, with an average age of 21.9 years. In the introduction phase, participants were given the descriptions of foods (conventional and upcycled), with the relative definition of product categories (virtue and vice). The descriptions and examples were presented in English and the national (Urdu) languages.

Conventional food was described as food that is prepared from whole ingredients. However, upcycled food was

described as food prepared from the ingredient's leftover/wasted during the production process of other food products. For example, a muffin can be made from grain residue obtained from the edible oil extraction process, a pasta sauce can be made from tomato peel, and ice cream can be made from a fruit peel. The virtue food product was described as food that consumers do not find delightful and appealing in the short run but had long-term positive consequences on health. For example, baked beans and fresh fruit juices might be classified as relatively healthy or unhealthy; similarly, crisps and beer might be classified as relatively unhealthy or healthy, depending upon the level of fats, calories, or sugar in them; any product labeled with "low" fat, calories, or sugar might be considered as relative virtue (Scarborough et al., 2007). In contrast, vice food product was described as food that consumers find more appealing and delightful in the short-term but had long-term negative consequences on health.

After reading/understanding the description and examples, the participants were randomly presented with figures of five food items (pasta sauce, muffins, ice cream, granola bar, and chicken nugget) selected by Bhatt et al. (2020) for insight judgment with conventional or upcycled labeling. The description included the descriptor of the food category (conventional vs. upcycled), the product category (virtue vs. vice), an image of the food item, and its average market price. Furthermore, conventional or upcycled food descriptions were shown to participants to differentiate products. This study primed a virtue vs. vice mindset by framing the products as either 25% fat (relative vice) or 75% fat-free (relative virtue), the same method as was used by Wertenbroch (1998). After that, participants were asked to review products and record their WTP for each food item.

To determine the acceptable price for each food item, we looked at market rates. The midpoint of the market prices was calculated to get an acceptable price for each unit of a food item: muffin (30 PKR), ice cream (80 PKR), chicken nugget (20 PKR), snack/granola bar (70 PKR), and pasta sauce (120 PKR). The same prices were used for both upcycled and conventional food categories for the aforementioned five food items. Three items measured consumers' willingness to pay on a seven-point Likert scale (1 = strongly disagree to 7 = strongly agree), adopted from the work of Prakash and Pathak (2017)—online—and Laroche et al. (2001) with Cronbach's alpha of 0.88. The items include "It is acceptable to pay this given price for the advertised product (name)/(category);" "I would accept paying this price for the advertised product (name)/(category);" "I would be willing to spend the given amount of price for the advertised product (name)/(category)." The shopping frequency for grocery/food items was recorded on a three-point Likert scale (1 = once, 2 = occasionally, 3 = regularly) by asking, "How often do you shop for the food product (name)/(category)." Lastly, familiarity with upcycled food and virtue and vice products was rated on a given scale (0 = not familiar, 1 = familiar). Participants recorded their familiarity by answering the question ["how familiar were you with (product classification)"].

**TABLE 1** | WTP for upcycled and conventions food (Study 1).

	All products F value	Chicken nugget F value	Granola bar F value	Pasta sauce F value	Muffin F value	Ice cream F value
Corrected model	129.346***	47.943***	35.603***	11.318***	5.187***	29.214***
Intercept	626.682***	93.748***	160.538***	87.469***	152.120***	202.897***
Intervention (virtue vs. vice)	695.517***	275.778***	25.091***	3.466*	1.69	0.946***
Food category (conventional vs. upcycled)	41.789***	1.223	136.749***	0.084	1.378	87.771***
Shopping frequency (respective food item)	2.042	0.418	0.001	2.305	0.133	0.946***
Familiarity (with upcycled food)	0.269*	0.375	1.765	0.181	0.602	10.966
Familiarity (with virtue vs. vice products)	1.255	0.183	0.892	1.339	0.076	0.437
[Food category: (conventional vs. upcycled)] * [intervention: (virtue vs. vice)]	11.735**	3.288*	21.757***	58.856***	18.509***	63.820***
Adjusted R-square	0.339	0.485	0.410	0.172	0.077	0.362

\*\*\*Significant at  $p < 0.01$ , \*\* $p < 0.05$ , and \* $p < 1.0$ .

Cronbach's  $\alpha = 0.88$ .

**TABLE 2** | Descriptive statistics of study 1.

	Chicken nugget F Value	Granola bar F value	Pasta sauce F value	Muffin F value	Ice cream F value
WTP (conventional Food)					
Mean	3.74	3.91	4.36	3.89	4.02
SD	1.02	1.09	1.98	1.99	2.21
WTP (upcycled food)					
Mean	3.63	3.16	2.92	2.99	3.34
SD	1.12	1.06	0.98	1.87	1.99
WTP (conventional virtue product)					
Mean	5.07	5.12	5.48	4.37	5.36
SD	2.11	1.40	1.17	1.21	1.01
WTP (conventional vice product)					
Mean	2.41	2.70	3.24	3.42	2.68
SD	0.98	1.27	1.36	2.03	1.76
WTP (upcycled virtue product)					
Mean	4.67	3.56	3.23	3.50	4.44
SD	2.22	2.38	1.78	1.85	2.35
WTP (upcycled vice product)					
Mean	2.23	2.75	2.52	2.48	2.23
SD	0.43	1.31	0.63	0.79	1.50
Shopping frequency (respective food item)					
Mean	2.35	2.33	3.65	3.25	4.21
SD	2.01	1.27	0.68	1.41	1.77

### 3.1.2 Results

The general linear model (GLM) was analyzed by combining all five food items with studying the effect of food category (conventional vs. upcycled) and intervention product category (virtue vs. vice) on consumers' WTP. For analysis, the food category (conventional vs. upcycled) was considered a factor, the product category (virtue vs. vice) as an intervention, and WTP as a dependent variable. The shopping frequency for food items, familiarity with upcycled food, and familiarity with virtue/vice products were considered covariates.

The results from study I showed that the food category (conventional vs. upcycled) [ $F(1,496) = 41.789$ ,  $p < 0.001$ ;  $M_{\text{conventional}} = 3.836$ ,  $M_{\text{upcycled}} = 3.370$ ] and intervention (virtue vs. vice) [ $F(1,496) = 695.517$ ,  $p < 0.001$ ;  $M_{\text{virtue}} = 4.493$ ,  $M_{\text{vice}} = 2.714$ ] were found to have a significant effect on WTP. However, the interaction between the two was found to have a marginal significant effect [ $F(1,496) = 11.735$ ,  $p < 0.5$ ]; **Table 1**.

The results further showed that for conventional food category, participants showed higher WTP for virtue products as compared to vice products [ $M_{\text{virtue}} = 4.834$ ,  $M_{\text{vice}} = 2.808$ ;  $t(746) = 9.812$ ,  $p < 0.001$ ]. Similar results were found for upcycled food. Participants showed higher WTP for virtue products than vice products [ $M_{\text{virtue}} = 4.155$ ,  $M_{\text{vice}} = 2.615$ ;  $t(746) = 5.412$ ,  $p < 0.001$ ]. The study further estimated the consumers' WTP for each food item by using GLM. The mean and the standard deviation of variables have been presented in **Table 2**.

#### 3.1.2.1 Chicken Nugget

For chicken nugget, the food category (conventional vs. upcycled) [ $F(298) = 1.233$ , NS] was found to be insignificant with WTP, while there exists a significant effect of intervention product category (virtue vs. vice) [ $F(298) = 275.77$ ,  $p < 0.001$ ] on WTP. However, the interaction between the two was found to be marginally significant [ $F(298) = 3.288$ ,  $p < 0.10$ ]. For

conventional food, participants showed higher WTP for a virtue product than a vice product [ $M_{\text{virtue}} = 5.071$ ,  $M_{\text{vice}} = 2.418$ ;  $t(149) = 14.14$ ,  $p < 0.001$ ]. Similar results were found [ $M_{\text{virtue}} = 4.676$ ,  $M_{\text{vice}} = 2.236$ ;  $t(149) = 9.94$ ,  $p < 0.001$ ] for upcycled food. The results further showed that there was an insignificant difference in WTP between conventional food and upcycled food [ $M_{\text{conventional}} = 3.7444$ ,  $M_{\text{upcycled}} = 3.6356$ ;  $t(149) = -0.817$ ,  $p < 0.415$ ].

### 3.1.2.2 Granola Bar

For granola bar, the food category (conventional vs. upcycled) [ $F(298) = 25.091$ ,  $p < 0.001$ ] and the intervention product category (virtue vs. vice) [ $F(298) = 136.749$ ,  $p < 0.001$ ] were found to be significant with WTP. And the interaction between the two was also found to be significant [ $F(298) = 21.757$ ,  $p < 0.001$ ]. For conventional food, the participants showed higher WTP for a virtue product as compared to a vice product [ $M_{\text{virtue}} = 5.124$ ,  $M_{\text{vice}} = 2.707$ ;  $t(149) = 15.33$ ,  $p < 0.001$ ]. Similar results were found for upcycled food [ $M_{\text{virtue}} = 3.569$ ,  $M_{\text{vice}} = 2.756$ ;  $t(149) = 3.612$ ,  $p < 0.001$ ]. The results further revealed that participants showed higher WTP for conventional food than for upcycled food [ $M_{\text{conventional}} = 3.916$ ,  $M_{\text{upcycled}} = 3.1622$ ;  $t(149) = 5.11$ ,  $p < 0.001$ ].

### 3.1.2.3 Pasta Sauce

For pasta sauce, there was an insignificant effect of food category (conventional vs. upcycled) [ $F(298) = 0.084$ , NS] on WTP, while the intervention product category (virtue vs. vice) [ $F(298) = 3.466$ ,  $p < 0.10$ ] had a marginal significant effect on WTP. However, the interaction between the two was found to be significant [ $F(298) = 58.856$ ,  $p < 0.001$ ]. For the conventional food category, participants showed higher WTP for a virtue product as compared to a vice product [ $M_{\text{virtue}} = 5.484$ ,  $M_{\text{vice}} = 3.249$ ;  $t(149) = 13.615$ ,  $p < 0.001$ ]. Similar results were found for upcycled food. Participants were willing to pay more for a virtue product than for a vice product [ $M_{\text{virtue}} = 3.238$ ,  $M_{\text{vice}} = 2.520$ ;  $t(149) = 4.163$ ,  $p < 0.001$ ]. The results further revealed that participants showed higher WTP for conventional food than for upcycled food [ $M_{\text{conventional}} = 4.3667$ ,  $M_{\text{upcycled}} = 2.9244$ ;  $t(149) = 9.949$ ,  $p < 0.001$ ].

### 3.1.2.4 Muffin

For muffin, the food category (conventional vs. upcycled) [ $F(298) = 1.169$ , NS] and the intervention product category (virtue vs. vice) [ $F(298) = 1.378$ , NS] were found to have an insignificant effect on WTP; however, the interaction between the two was found to be significant [ $F(298) = 18.509$ ,  $p < 0.001$ ]. For the conventional food category, participants showed higher WTP for a virtue product than a vice product [ $M_{\text{virtue}} = 4.373$ ,  $M_{\text{vice}} = 3.422$ ;  $t(149) = 4.012$ ,  $p < 0.001$ ]. Similar results were found for upcycled food [ $M_{\text{virtue}} = 3.502$ ,  $M_{\text{vice}} = 2.489$ ;  $t(149) = 5.06$ ,  $p < 0.001$ ]. The results further revealed that participants showed higher WTP for conventional food than for upcycled food [ $M_{\text{conventional}} = 3.8978$ ,  $M_{\text{upcycled}} = 2.9956$ ;  $t(149) = 5.580$ ,  $p < 0.001$ ].

### 3.1.2.5 Ice Cream

For ice cream, the food category (conventional vs. upcycled) [ $F(298) = 30.771$ ,  $p < 0.001$ ] and intervention product category (virtue vs. vice) [ $F(298) = 403.336$ ,  $p < 0.001$ ] were found to have a significant effect on WTP. Also, the interaction between the two was also found to be significant [ $F(298) = 3.562$ ,  $p < 0.001$ ]. The results further revealed that for conventional food, participants showed higher WTP for a virtue product as compared to a vice product [ $M_{\text{virtue}} = 5.369$ ,  $M_{\text{vice}} = 2.689$ ;  $t(149) = 16.165$ ,  $p < 0.001$ ]. Similar results were found for upcycled food [ $M_{\text{virtue}} = 4.445$ ,  $M_{\text{vice}} = 2.234$ ;  $t(149) = 12.614$ ,  $p < 0.001$ ]. The results further revealed that participants showed higher WTP for conventional food than for upcycled food [ $M_{\text{conventional}} = 4.029$ ,  $M_{\text{upcycled}} = 3.3400$ ;  $t(149) = -5.892$ ,  $p < 0.001$ ].

## 3.1.3 Discussion

Findings of study I showed that participants' WTP for conventional (virtue vs. vice) food products were higher than the WTP for upcycled (virtue vs. vice) food products. The findings further showed that the WTP for a virtue product was higher than WTP for a vice product. By considering the results for upcycled food, we organized another study to estimate whether a food sustainability claim for upcycled food increases willingness to pay or not.

## 3.2 Study II

### 3.2.1 Sampling and Procedure

To evaluate the effect of sustainability claims on consumers' WTP for upcycled (virtue vs. vice) products, 300 participants who are final-year undergraduate students were selected. The demographics presentation showed that 75% are men and 25% are women with an average age of 20.23 years, and 15% of participants are employed. At the beginning of the study, participants were presented with a description of upcycled food, virtue and vice products, and a detailed description of food sustainability and its importance based on SDGs.

The following description was taken from the United Nations Environment Programme (UNEP):

A sustainable food system (SFS) is a food system that delivers food security and nutrition for all in such a way that the economic, social, and environmental bases to generate food security and nutrition for (current and) future generations are not compromised. A food system gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities related to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socio-economic and environmental outcomes.

After reading the description on food sustainability, participants were shown either upcycled or conventional virtue and vice alternatives of five food items along with their images and prices, the same as was presented in study I in random order. However, study II highlights the food sustainability benefits

**TABLE 3** | WTP after sustainability claim (study 2).

	All products F value	Chicken nugget F value	Granola bar F value	Pasta sauce F value	Muffin F value	Ice cream F value
Corrected model	14.108***	50.382***	24.328***	11.318***	5.187***	27.051***
Intercept	786.552***	222.031***	215.871***	87.469***	152.120***	191.567***
Intervention 1 (virtue vs. vice)	67.537***	39.675***	9.150**	3.466**	1.169	99.351***
Food category (conventional vs. upcycled)	4.675**	27.352***	39.962***	0.084	1.378	3.348*
Shopping frequency (respective food items)	0.469	5.262**	0.808	1.339	0.076	0.539
Familiarity (with upcycled food)	0.778	3.671*	0.078	2.305	0.602	1.009
Familiarity (with virtue vs. vice products)	1.438	4.496**	0.200	0.181	0.133	0.483
Food category × intervention 1	5.974**	73.806***	78.587***	58.856***	16.022***	58.534***
Adjusted R-square	0.050	0.498	0.319	0.172	0.077	0.343

\*\*\*Significant at  $p < 0.01$ , \*\* $p < 0.05$ , and \* $p < 1.0$ .  
Cronbach's  $\alpha = 0.79$ .

**TABLE 4** | Descriptive statistics of study-2.

	Chicken nugget F value	Granola bar F value	Pasta sauce F value	Muffin F value	Ice cream F value
WTP (conventional food)					
Mean	3.92	3.85	4.30	4.17	4.27
SD	1.31	1.49	2.01	0.95	0.87
WTP (upcycled food)					
Mean	5.14	4.90	4.24	4.42	4.58
SD	0.76	0.54	0.64	1.35	1.49
WTP (conventional virtue product)					
Mean	5.03	4.83	5.23	4.66	5.76
SD	1.67	2.33	3.45	2.76	3.11
WTP (conventional vice product)					
Mean	2.82	2.87	3.38	3.68	2.78
SD	0.76	1.59	1.67	1.77	1.34
WTP (upcycled virtue product)					
Mean	4.93	4.40	3.65	4.12	4.73
SD	0.31	1.23	1.39	1.41	1.11
WTP (upcycled vice product)					
Mean	5.36	5.40	4.83	4.72	4.44
SD	0.82	2.43	0.97	0.61	0.72
Shopping frequency (respective food item)					
Mean	2.01	2.03	2.99	4.53	4.76
SD	0.70	0.91	3.21	3.00	0.60

associated with upcycled food. Participants were requested to show their WTP toward already defined prices, the same as those presented in study I, with Cronbach's  $\alpha$  of 0.79. Similarly, participants were also asked about their respective shopping frequency for each food item, familiarity with upcycled food, and familiarity with virtue and vice products with the same Likert scale.

### 3.2.2 Results

The data collected (after sustainability claim) from study II was analyzed by using the general linear model (GLM) to study the effect of food category (conventional vs. upcycled) and intervention product category (virtue vs. vice) on consumers' WTP after sustainability claim. The results of study 2 showed that there exists a marginal significant effect of food category (conventional vs. upcycled) [ $F(1,496) = 4.675, p < 0.05$ ] and a significant effect of intervention (virtue vs. vice) [ $F(1,496) =$

$67.537, p < 0.001$ ] on WTP. Furthermore, the interaction between the two was found to be marginally significant [ $F(1,496) = 5.974, p < 0.05$ ] (**Table 3**). For conventional food, participants showed higher WTP for virtue products than vice products [ $M_{virtue} = 4.933, M_{vice} = 4.050; t(749) = 9.044, p < 0.001$ ]; however, there exists a marginal significant difference for upcycled food [ $M_{virtue} = 4.534, M_{vice} = 4.051; t(749) = 9.044, p < 0.05$ ]. GLM also estimates the effect of food category (conventional vs. upcycled) and intervention product category (virtue vs. vice) on consumers' WTP of each food item for data collected after the sustainability claim. The mean and the standard deviation of variables have been presented in **Table 4**.

#### 3.2.2.1 Chicken Nugget

For chicken nuggets, the food category (conventional vs. upcycled) [ $F(298) = 27.352, p < 0.001$ ] and the intervention product category (virtue vs. vice) [ $F(298) = 39.675, p < 0.001$ ]

**TABLE 5** | General linear model—intervention of sustainability message on WTP (study 2).

	All products F value	Chicken nugget F value	Granola bar F value	Pasta sauce F value	Muffin F value	Ice cream F value
Corrected model	91.878***	64.603***	21.508***	34.329***	15.483***	57.808***
Intercept	1,442.265***	367.250***	234.276***	193.708***	209.569***	389.611***
Intervention1 (virtue vs. vice)	521.625***	268.075***	9.901**	62.619***	24.864***	392.005***
Food category (conventional vs. upcycled)	35.706***	50.537***	38.847***	62.436***	10.093**	4.266*
Shopping frequency (respective food)	0.002	0.006	1.975	2.117	0.001	0.706
Familiarity (with upcycled foods)	0.139	0.061	4.196*	1.186	0.461	0.734
Familiarity (with virtue vs. vice products)	2.640	0.040	3.247*	0.175	0.741	0.353
Sustainability claim	213.764***	69.628***	10.206**	35.515***	52.369***	49.883***
Food category × intervention 1 × intervention 2	30.913***	54.474***	62.669***	40.451***	15.780***	28.049***
Adjusted R-square	0.233	0.515	0.277	0.357	0.195	0.487

\*\*\* Significant at  $p < 0.01$ , \*\* $p < 0.05$ , and \* $p < 1.0$ .

Cronbach's  $\alpha = 0.79$ .

were found to have a significant effect on WTP. Also, their interaction was also found to be significant [F (298) = 73.806,  $p < 0.001$ ]. For conventional food, participants showed higher WTP for a virtue product [Mvirtue = 5.032, Mvice = 2.828; t (149) = 10.63,  $p < 0.001$ ]. However, for upcycled food, participants showed higher WTP for a vice product [Mvirtue = 4.934, Mvice = 5.366; t (149) = 9.94,  $p < 0.001$ ].

### 3.2.2.2 Granola Bar

For granola bar, the food category (conventional vs. upcycled) [F (298) = 39.962,  $p < 0.001$ ] had effect on WTP, while the intervention product category (virtue vs. vice) [F (298) = 9.150,  $p < 0.5$ ] was found to have a marginal significant effect on WTP. However, the interaction between the two was found to be significant [F (298) = 78.587,  $p < 0.001$ ]. For conventional food, participants showed higher WTP for a virtue product [Mvirtue = 4.837, Mvice = 2.878; t (149) = 9.044,  $p < 0.001$ ]; however, for upcycled food, participants showed higher WTP for a vice product than a virtue product [Mvirtue = 4.407, Mvice = 5.407; t (149) = -4.694,  $p < 0.001$ ].

### 3.2.2.3 Pasta Sauce

For pasta sauce, the food category (conventional vs. upcycled) [F (298) = 0.084, NS] was found to have an insignificant effect on WTP, while the intervention product category (virtue vs. vice) [F (298) = 3.466,  $p < 0.05$ ] was found to have a marginal significant effect on WTP. However, the interaction between the two was found to be significant [F (298) = 58.856,  $p < 0.001$ ]. In case of conventional food category, participants showed higher WTP for a virtue product when compared to a vice product [Mvirtue = 5.239, Mvice = 3.385; t (149) = 7.289,  $p < 0.001$ ]. However, for upcycled food, the WTP for a vice product was found to be higher than the WTP for a virtue product [Mvirtue = 3.657, Mvice = 4.834; t (149) = -3.3,  $p < 0.001$ ].

### 3.2.2.4 Muffin

For muffin, the food category (conventional vs. upcycled) [F (298) = 1.378, NS] and the intervention product category (vice vs. virtue) [F (298) = 1.169, NS] were found to have an insignificant effect on WTP. However, the interaction between the two was found to be significant [F (298) = 16.022,  $p < 0.001$ ]. For

conventional food, participants showed higher WTP for a virtue product as compared to a vice product [Mvirtue = 4.664, Mvice = 3.689; t (149) = 4.286,  $p < 0.001$ ]. However, for upcycled food, there was a marginal significant difference between the two [Mvirtue = 4.126, Mvice = 4.727; t (149) = -2.891,  $p < 0.05$ ].

### 3.2.2.5 Ice Cream

For ice cream, the food category (conventional vs. upcycled) [F (298) = 3.348,  $p < 0.10$ ] had a marginal significant effect on WTP, while the intervention product category (vice vs. virtue) [F (298) = 99.351,  $p < 0.001$ ] was found to have a significant effect on WTP. Moreover, the interaction between the two was found to be significant [F (298) = 58.534,  $p < 0.001$ ]. For conventional food, participants showed higher WTP for a virtue product as compared to a vice product [Mvirtue = 5.760, Mvice = 2.787; t (149) = 14.702,  $p < 0.001$ ]. However, for upcycled food, there exists a marginal difference between the two [Mvirtue = 4.732, Mvice = 4.446; t (149) = 1.636,  $p < 0.05$ ]. To study the effect of sustainability claim on change in WTP between study 1 and study 2 for upcycled foods, GLM estimated the effect of food category (conventional vs. upcycled) with two interventions; intervention 1 (product category: virtue vs. vice) and intervention 2 (sustainability message) on consumers' WTP for upcycled food. The data from both studies, study I and study II, were collectively analyzed with the intervention sustainability claim ("1" = with the claim; "0" = without claim) to understand the change in prices after the sustainability claim.

Results revealed that food category (conventional vs. upcycled) [F (2,998) = 35.706,  $p < 0.001$ ], intervention product category (virtue vs. vice) [F (2,998) = 521.625,  $p < 0.001$ ], and intervention sustainability claim [F (2,998) = 213.76,  $p < 0.001$ ] were found to have a significant effect on WTP. The interaction between the three was also found to be significant with WTP [F (2,998) = 30.913,  $p < 0.001$ ] (Table 5). The results further showed that for upcycled food, there was a marginal difference between virtue and vice products [Mvirtue = 4.525, Mvice = 4.055; t (1,496) = 9.94,  $p < 0.05$ ]. For upcycled virtue products, there exists a marginal difference in WTP between "with" and "without" sustainability claims [Mclaim = 4.525, Mwithoutclaim = 4.142; t (749) = 4.061,  $p < 0.05$ ]. However, for upcycled vice food products, there also



exists a significant difference in WTP between “with” and “without” sustainability claims [ $M_{\text{claim}} = 4.055$ ,  $M_{\text{withoutclaim}} = 2.585$ ;  $t(749) = 18.271$ ,  $p < 0.001$ ]. GLM also analyzed the effect of food category (conventional vs. upcycled) with intervention 1 (product category: virtue vs. vice) and intervention 2 (sustainability message) on the consumer’s WTP for upcycled food for each of five food items.

### 3.2.2.6 Chicken Nugget

For chicken nugget, results revealed that food category (conventional vs. upcycled) [ $F(598) = 50.537$ ,  $p < 0.001$ ], intervention product category (virtue vs. vice) [ $F(598) = 268.075$ ,  $p < 0.001$ ], and intervention sustainability claim [ $F(598) = 69.628$ ,  $p < 0.001$ ] were found to have significant effect on WTP. The interaction between the three was also found to be significant [ $F(598) = 54.474$ ,  $p < 0.001$ ]. The results further showed that for upcycled virtue products, there exists a marginal significant difference in WTP between “with” and “without” sustainability claims [ $M_{\text{claim}} = 5.6044$ ,  $M_{\text{withoutclaim}} = 5.1378$ ;  $t(148) = 2.571$ ,  $p < 0.05$ ]. Similar results were found for upcycled vice products, and there exists a marginal significant difference in WTP between “with” and “without” sustainability claims [ $M_{\text{claim}} = 2.9521$ ,  $M_{\text{withoutclaim}} = 2.5956$ ;  $t(148) = -2.119$ ,  $p < 0.05$ ].

### 3.2.2.7 Granola Bar

For granola bar, results showed that food category (conventional vs. upcycled) [ $F(598) = 38.847$ ,  $p < 0.001$ ] had a significant effect on WTP, while intervention product category (virtue vs. vice) [ $F(598) = 9.901$ ,  $p < 0.05$ ] and intervention sustainability claim [ $F(598) = 10.206$ ,  $p < 0.05$ ] were found to have a marginal significant effect on WTP. However, the interaction between the three was found to be significant [ $F(598) = 62.669$ ,  $p < 0.001$ ]. The results further showed that for upcycled virtue products, there exists a marginal significant difference in WTP between “with” and “without” sustainability claims [ $M_{\text{claim}} = 5.1244$ ,  $M_{\text{withoutclaim}} = 4.8178$ ;  $t(148) = 2.039$ ,  $p < 0.05$ ]. Similar results were found for upcycled vice products, and there exists a marginal significant difference in WTP between “with” and “without” sustainability claims [ $M_{\text{claim}} = 2.9511$ ,  $M_{\text{withoutclaim}} = 2.7067$ ;  $t(148) = 2.287$ ,  $p < 0.05$ ].

### 3.2.2.8 Pasta Sauce

For pasta sauce, results showed that food category (conventional vs. upcycled) [ $F(598) = 62.436$ ,  $p < 0.001$ ], intervention product category (virtue vs. vice) [ $F(598) = 62.619$ ,  $p < 0.001$ ], and intervention sustainability claim [ $F(598) = 35.515$ ,  $p < 0.001$ ] were found to have significant effect on WTP. The interaction between the three was also found to be significant [ $F(598) = 40.451$ ,  $p < 0.001$ ]. The results further showed that for upcycled virtue products, there exists a marginal difference in WTP between “with” and “without” sustainability claims [ $M_{\text{claim}} = 5.4844$ ,  $M_{\text{withoutclaim}} = 5.1689$ ;  $t(148) = 885$ ,  $p < 1.0$ ]. However, for upcycled vice food products, there exists a significant difference in WTP between “with” and “without” sustainability claims [ $M_{\text{claim}} = 3.9844$ ,  $M_{\text{withoutclaim}} = 2.520$ ;  $t(148) = 2.206$ ,  $p < 0.001$ ].

### 3.2.2.9 Muffin

For muffin, results revealed that food category (conventional vs. upcycled) [ $F(598) = 10.093$ ,  $p < 0.05$ ] had a marginal significant effect on WTP, while intervention product category (virtue vs. vice) [ $F(598) = 24.864$ ,  $p < 0.001$ ] and intervention sustainability claim [ $F(598) = 52.369$ ,  $p < 0.001$ ] were found to have significant effect on WTP. The interaction between the three was also found to be significant [ $F(598) = 15.780$ ,  $p < 0.001$ ]. The results further showed that for upcycled virtue products, there exists a significant difference in WTP between “with” and “without” sustainability claims [ $M_{\text{claim}} = 4.373$ ,  $M_{\text{withoutclaim}} = 3.502$ ;  $t(148) = 1.885$ ,  $p < 0.001$ ]. Similar results were found for upcycled vice products [ $M_{\text{claim}} = 3.666$ ,  $M_{\text{withoutclaim}} = 2.489$ ;  $t(148) = 2.206$ ,  $p < 0.001$ ].

### 3.2.2.10 Ice Cream

For ice cream, results revealed that the food category (conventional vs. upcycled) [ $F(598) = 4.266$ ,  $p < 1.0$ ] had a marginal significant effect on WTP, while the intervention product category (virtue vs. vice) [ $F(598) = 392.005$ ,  $p < 0.001$ ] and the intervention sustainability claim [ $F(598) = 49.883$ ,  $p < 0.001$ ] were found to have significant effect on WTP. The interaction between the three was also found to be significant [ $F(598) = 28.049$ ,  $p < 0.001$ ].

The results further showed that for upcycled virtue products, there exists a marginal difference in WTP between “with” and “without” sustainability claims [ $M_{\text{claim}} = 4.8089$ ,  $M_{\text{withoutclaim}} = 4.440$ ;  $t(148) = -3.122$ ,  $p < 0.05$ ]. However, for upcycled vice products, there exists a significant difference in WTP between “with” and “without” sustainability claims [ $M_{\text{claim}} = 4.3778$ ,  $M_{\text{withoutclaim}} = 2.2400$ ;  $t(148) = -9.454$ ,  $p < 0.001$ ].

## 3.2.3 Discussion

Findings from study II showed that sustainability claim was found to effectively affect WTP for both upcycled (virtue and vice) products. However, the increase in WTP for upcycled vice products was more than for upcycled virtue products.

## 4 GENERAL DISCUSSION

Food wastage is one of the biggest challenges for the world, and pressure on food availability is increasing day by day (San-Epifanio and de Renobales Scheifler, 2015; Hegnsholt et al., 2018). About 30% of food production is wasted during the food processing system at the consumption level, approximately 1.3 billion tons (Jan et al., 2011). Therefore, researchers have proposed that food insecurity could be handled by controlling the amount of food waste (Mourad, 2016; O’Donnell et al., 2015). Food waste that occurs during the production/processing stage could be controlled by promoting alternatives (Parfitt et al., 2010), such as upcycled food. Upcycled food provides an optimistic solution to food sustainability, as upcycled food helps reduce food wastage by controlling it at the source of food waste (Bhatt et al., 2018). Sustainability labels (i.e., environmental, animal welfare, upcycled food, or organic food) effectively lead consumers to make appropriate food decisions (Bhatt et al., 2020; Asioli and

Grasso, 2021; Coderoni and Perito, 2021). Literature suggests that sustainability claim helps in the acceptance of food, which contributes to food sustainability (Michel et al., 2001; Giesen and Hooge, 2019; Bhatt et al., 2020; Asioli and Grasso, 2021; Coderoni and Perito, 2021).

Despite this vital contribution, few studies are conducted on the commercial acceptance of upcycled food. Researchers have studied the role of sustainability claims on WTP for upcycled food (Giesen and Hooge, 2019; Bhatt et al., 2020; Asioli and Grasso, 2021; Coderoni and Perito, 2021), but they did not explore the effect of sustainability claims along with product category (virtue vs. vice) on WTP for upcycled food. Previous studies have shown that consumers respond differently to virtue and vice products and promotions. (Mishra and Mishra, 2011; Van Doorn and Verhoef, 2011). Therefore, the current research fills the gap by examining the differential effects of sustainability claims on consumers' WTP for upcycled (virtue and vice) products.

Two studies were conducted to estimate the effect of sustainability claims on consumers' WTP for upcycled (virtue vs. vice) products with their conventional alternatives. Findings from study I revealed that consumers' WTP for upcycled (virtue and vice) products was lower than the conventional (virtue and vice) products, which is in line with the results (Bhatt et al., 2020). A possible explanation is that consumers might find it hard to buy upcycled food because of its unconventional ingredients and food quality concerns (Saba and Messina, 2003; Williamson, 2007; Barber et al., 2010). Findings further showed that the WTP for vice products was lower than for virtue products. A possible explanation is that consuming a vice product produces a sense of guilt that requires justification (Mishra and Mishra, 2011). Additionally, study II showed that food sustainability claim increases the WTP for upcycled vice products more than for upcycled virtue products. The results are consistent with the findings of Strahilevitz and Myers (1998), which stated that consumers would respond to good motives only when associated with vice products.

The study by Lasca (1991) stated that consumers have to pay the price to enjoy the pleasure associated with hedonic products; this price could be a guilt that contributes to a negative experience of consumption. Therefore, to justify this feeling of guilt, the consumer looks for a good cause; that is why the consumer seems to respond only to those good motives associated with vice products (Strahilevitz and Myers, 1998; Van Doorn and Verhoef, 2011). The findings further suggest that marketers could gain premium prices for upcycled vice products by promoting food sustainability concerns and highlighting the role of upcycled food in food sustainability as referred to in study II.

## 5 CONCLUSION

Upcycled products are generally preferred less than conventional food, and consumers are less willing to pay for upcycled food. So,

marketers could position upcycled food as a cheap alternative to conventional food. However, marketing communication focusing on the benefits of such foods might enhance consumers' WTP. Similarly, the consumer prefers virtue food products more than vice products. The WTP for vice products seems lower than for virtue products, especially for upcycled vice products. Designing a positioning strategy for vice products with a good cause may enhance consumers' willingness to pay. Existing literature on pricing recommends that consumers use price to measure the monetary sacrifice in exchange for a product when they do not know the product (Lee et al., 2018; Suri and Monroe, 2003). When consumers perceive the price as a monetary tool used to purchase a product, they try to reduce their monetary spending, resulting in a lower willingness to pay (study I). However, many other factors may shape the consumer's perceptions of price (Adaval and Monroe, 2002; Grewal et al., 1998; Puccinelli et al., 2013; Suri and Monroe, 2003; Ye et al., 2020). The results of this study are in line with this stream of literature, supporting the role of sustainability claims on consumers' willingness to pay.

The limitation of this study is that it does not investigate the reasons behind the differential effect of sustainability claims on WTP for upcycled (vice vs. virtue) products. So, there is a need to explore the antecedents that transform sustainable behavior. As this study was conducted in Pakistan, similar studies could be conducted in other developing countries to get a broad overview of this topic. Future research might also investigate the impact of other aspects, i.e., branding, quality perceptions, packaging, prosocial benefits, or consumers' concern for sustainability on consumer acceptability of upcycled foods. In conclusion, the future of upcycled food products depends on consumers' acceptance of these foods. Consumers' willingness to pay premium prices for upcycled (virtue vs. vice) food products depend upon the information about the environmental benefits of these foods.

## DATA AVAILABILITY STATEMENT

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

## ETHICS STATEMENT

Ethical review and approval was not required for this study in accordance with the local legislation and institutional requirements.

## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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