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## Upcycled Food Practices among Indian Household and Consumers: A Selective Study of Delhi NCR

Mizna Naqvi\* and Sanjay Bhayana

Department of Food Business Management & Entrepreneurship Development, National Institute of Food Technology Entrepreneurship & Management (NIF-TEM), Sonipat, Haryana, India

### ABSTRACT

Over one third of the food produce globally is being wasted. Upcycling foods is a promising approach which involves transforming edible food waste into new consumable products. While upcycling has significant potential, there is a notable lack of research on consumer attitudes and awareness towards upcycled foods in India. This study aims to address this gap by examining the perceptions and acceptance of upcycled food products among Indian consumers, specifically those in the Delhi NCR region.

The study surveyed 361 respondents to gauge their awareness and attitudes towards upcycled foods. The results revealed that 46% of respondents had previously heard of 'upcycled foods,' while 65.5% were aware of the concept of upcycling at the household level. Factors influencing their opinions about upcycled foods were examined, along with potential barriers to acceptance. The primary concerns identified were related to health and safety implications and a lack of trust in the ingredients or production processes.

The research highlighted the importance of consumer education in promoting the acceptance of upcycled foods. Many respondents showed a willingness to try upcycled foods if available at local grocery stores or restaurants, and some were even willing to pay a premium for these products. However, concerns about taste and quality were significant barriers that need to be addressed to increase consumer acceptance.

### \*Corresponding author

Mizna Naqvi, Department of Food Business Management & Entrepreneurship Development, National Institute of Food Technology Entrepreneurship & Management (NIFTEM) under Ministry of Food Processing, Govt of India, Kundli (Sonipat), Tel: 8920585633, 7082410850, India.

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### Introduction

Almost half of the food generated globally is wasted and food insecurity is one of the main problems that need to be resolved for sustainable development. It is a worldwide catastrophe when food waste is this high and food insecurity is rising at the same time. In 2018, more over 700 million people were severely food insecure [1,2].

Upcycled foods use ingredients that would otherwise not have gone to human consumption, are sourced and produced via traceable supply chains, and have a positive influence on the environment. Upcycling food reduces food waste by transforming otherwise discarded food items into new and high-quality goods. Upcycled food makes greater use of the energy invested in growing, transporting, and preparing food by avoiding food waste destinations such as incinerators, animal feed, and landfills [3].

Renewal Mill in San Francisco, California is an example of an upcycled food enterprise which produces okra flour from soybean pulp that is a byproduct of soymilk production. The pulp is typically wasted, despite being abundant in nutrients like protein and fiber and is totally safe to consume.

Additionally, the Sustainable Development Goals (SDG) offer a worldwide road map for achieving a more prosperous and sustainable future. (UN, 2019). In the 2030 Agenda for Sustainable Development, the member states of the United Nations (UN) set forth the Sustainable Development Goals (SDGs) in an effort to advance broader societal objectives by calculated action. The primary objective of Sustainable Development Goal 12 is to cut food losses throughout the production and supply chains, including post-harvest losses, and to cut global food waste per capita by half at the retail and consumer levels. By 2030, SDG 12: "Responsible Consumption and Production" seeks to create sustainable patterns of consumption and production that will reduce the negative effects of commercial and industrial activity on the environment and encourage resource management [4].

The behaviour of food choice is intricate, influenced by numerous multidimensional health related and non-health-related factors. These factors include familiarity, cost, price, weight control, health, mood, ease of use, sensory appeal, natural content, and ethical considerations [5-8].

In the context of sustainable foods, factors such as animal and environmental welfare, along with other ethical concerns, and aspects like local and seasonal production drive food choices. Conversely, for foods produced using novel technologies, factors like food technology neophobia are significant in influencing

food choices. Consequently, different categories of food have varying motivations behind their choices. Given that food choice factors affect product acceptability in diverse ways, recognizing the factors influencing upcycled food choices can enhance the acceptability of these products [5,9-11].

Food potential is lost when an ingredient intended for food is diverted as a side-stream and ends up as fuel or feed, or it might be lost when an item stays out of the food chain entirely. Upcycled meals are a better way to solve the issue of food waste because they help reduce it closer to the source than other approaches like feeding animals and composting. Understanding how consumers view these meals is crucial for them to establish themselves as a new food category, since the commercial viability of upcycled foods depend on public acceptability.

In India, research on consumer perception of upcycled foods is limited, making this a crucial area for study given the country's diverse population. This exploratory study focuses on the Delhi region, using both quantitative and qualitative data to understand consumer attitudes and behaviours.

### **Literature Review**

Research consistently shows that consumers generally have positive associations with upcycled foods, viewing them as innovative, sustainable, and a means to avoid food waste. AschemannWitzel surveyed 2,405 respondents from five European countries (United Kingdom, Denmark, Germany, Portugal, and Italy) and found that terms like innovation, recycling, avoiding food waste, and sustainability were commonly associated with upcycled foods. Bhatt highlighted the distinctive attribute of upcycled food as its food waste management feature, distinguishing it from organic and conventional foods. McCarthy noted that the food waste management aspect of upcycled food appeals to consumers, as it helps farmers reduce food waste. Bhatt investigated consumer acceptance of novel food products derived from food waste, involving 147 participants and finding strong potential for these foods to establish themselves as a distinct category separate from conventional and organic foods [12-15].

Effective marketing and communication strategies play a crucial role in enhancing consumer acceptance of upcycled foods. Aschemann-Witzel recommended targeting environmentally concerned consumers by emphasizing frugality benefits and efficient resource use. Taufik analysed the effects of abstract and concrete communication on moral signalling and purchase intentions, finding that communication styles significantly influence consumer behaviour. Rahmani & Gil emphasized the importance of food safety characteristics, with concerns about ingredient traceability and uncertainties regarding legislation affecting consumer perceptions. Educating customers about the health and environmental advantages of upcycled foods can greatly boost their willingness to pay (WTP). Asioli & Grasso found that providing information about the benefits of upcycled ingredients, such as defatted sunflower cake flour in biscuits, positively affected individual WTP distributions. Bhatt conducted a study with 288 participants, revealing that although consumers were initially willing to pay less for upcycled foods compared to conventional alternatives, targeted messaging could increase their willingness

to pay. Bhatt also found that a well-designed upcycled logo could enhance perceived quality and increase willingness to buy these foods [16-20].

Consumer background characteristics, such as age, gender, education, and environmental consciousness, influence favourable attitudes towards upcycled foods. Aschemann-Witzel noted that females and younger consumers showed more positive attitudes towards upcycled foods. Coderoni & Perito studied 317 participants in Italy and found that higher education, lower income, lack of food neophobia, and attention to food labels positively influenced willingness to buy upcycled foods. Yilmaz & Kahveci conducted an online survey with 447 Turkish participants and found that generation, gender, and dedication to recycling at home affected willingness to buy upcycled foods, with younger consumers showing more interest. The perception of safety is crucial for upcycled foods, as food neophobia and food technology neophobia negatively affect purchasing intentions. Coderoni & Perito concluded that the perception of safety significantly influences consumer acceptance of upcycled foods. Moshtaghian emphasized that factors such as nutritional content, environmental features, and food safety attributes significantly influence the acceptability of upcycled foods. Educational strategies to promote the nutritional benefits of upcycled foods can further boost their acceptance across diverse demographic groups. Moshtaghian studied public preferences in Sweden, finding that while environmental benefits and food safety aspects were crucial for acceptability, nutritional attributes were less important. Yilmaz & Kahveci also found that proper explanation of the upcycling concept could persuade consumers unfamiliar with upcycling to consider purchasing such products [21-26].

Consumer acceptance of upcycled foods varies across regions and cultures. Grasso compared consumer attitudes and preferences towards upcycled foods in the USA and China, concluding that more participants in China were familiar with upcycled foods than those in the USA. Despite low familiarity in both countries, liking for upcycled foods was higher in the USA, with plant-based byproducts being preferred in both regions. Yang conducted a study with 450 respondents across China using scenario simulations and found that mental simulations significantly increased product evaluation and purchase intentions for upcycled foods. Perito explored consumer attitudes towards local and organic food with upcycled ingredients through a web-based survey with 852 Italian consumers, demonstrating the potential for increased acceptance in these markets [27-29].

### **Methodology**

The primary purpose of the study is to examine the various aspects of consumer buying behaviour, especially regarding upcycled foods, which are a sustainable substitute for conventional eating habits. The objectives are to (a) assess the awareness levels regarding the concept of upcycling at household level, (b) To identify the potential barriers to adoption of upcycled foods, (c) To understand the preference for upcycled foods. Data were collected through questionnaires based on the tri-component model (Table 1), assessing knowledge, emotional responses, and behavioural intentions, supplemented by secondary data from existing research and reports.

**Table 1: Items of Attitude (Tri Component Model)**

Tri Component Attitude	
Cognitive Component	The environmental impact of a product will affect my buying choices.
	I actively seek out products labelled as eco-friendly or sustainable.
	It is important for me to know the specific ingredients and sources used in upcycled food products.
	I frequently make fried rice using leftover rice from previous meals.
Affective Component	I am hesitant to purchase upcycled foods due to concerns about the taste or quality.
	I feel that upcycled foods can play a significant role in solving environmental issues
Conative Component	I am willing to try upcycled foods if they are available at my local grocery store or restaurant.
	I am willing to pay a premium for upcycled foods compared to regular foods.

The study focused on individual citizens of Delhi and satellite towns (Sonipat, Faridabad, Ghaziabad, Noida, and Gurgaon), employing a convenience sampling method due to its practicality for exploratory research. The sample size is 361 respondents from the Delhi NCR region. Data is analysed using Microsoft Excel and SPSS software, employing statistical tests such as chi-square tests and factor analysis to derive insights into consumer perceptions of upcycled foods. The study captures the broad spectrum of consumer attitudes, filling a research gap regarding effective marketing strategies for upcycled foods, and providing valuable insights for startups, entrepreneurs, scholars, and innovators focused on waste reduction and sustainability. However, limitations included budget constraints, time limitations, and potential bias from the convenience sampling technique

**Analysis and Interpretation**

The reliability of the scale used in this study was assessed using Cronbach’s Alpha which gave the alpha value of 0.773, that suggested that the scale has good reliability. The demographic profile includes key characteristics of the respondents. Age groups were categorized as 0-15, 15-30, 30-45, and 45+, providing insights into the age distribution. Education levels ranged from high school to Ph.D. or higher, indicating the educational background of participants. Profession categories included private sector, public sector, business, student, and retired, reflecting the occupational diversity. Locations covered were Delhi, Sonipat, Faridabad, Ghaziabad, Noida, and Gurgaon, showing the geographical distribution of the respondents. Table 2 gives a sample description of the respondents.

**Table 2: Demographic Characteristics of the Sample**

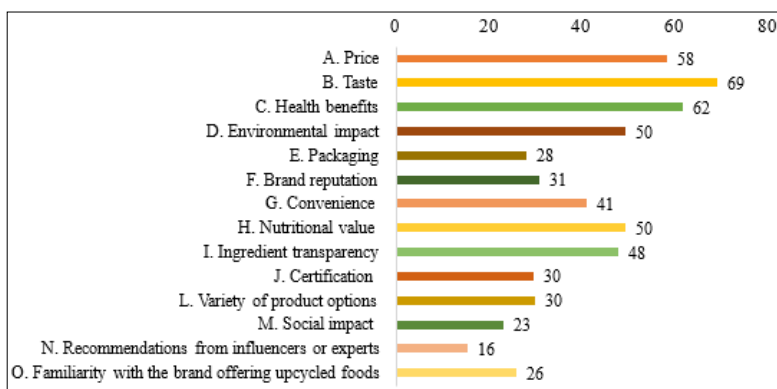
Variable	Sample Description	Percentage
Gender	Male	37%
	Female	63%
Age	Below 15 years old	1%
	16 - 30 years old	87%
	30 - 45 years old	6%
	45+ years old	7%
Education Level	A.High School	26%
	B.Bachelor’s Degree	26%
	C.Master’s Degree	42%
	D.Ph.D. or higher	5%
	E.Intermediate	1%
Profession	A.Private Sector	32%
	B.Public Sector	12%
	C.Business	2%
	D.Student	52%
	E.Retired	2%
Location	A.Delhi	46%
	B.Sonipat	12%
	C.Faridabad	5%
	D.Ghaziabad	13%
	E.Noida	17%
	F.Gurgaon	8%
Source of information	A.Social media	56%
	BTV commercials	10%
	C.Friends or family	13%
	D.Food blogs/ websites	14%
	E.Newspapers	4%
	F.Conferences	2%

To determine the baseline knowledge of the term among the survey participants, awareness regarding the term ‘Upcycled Foods’ was asked, which is crucial for understanding their subsequent perceptions and attitudes. The results showed that 54% of them were not aware whereas 46% had previously heard of upcycled foods.

Respondents were further asked to define “upcycled foods” with options such as foods made from recycled materials, leftover ingredients, organic ingredients, or expressing uncertainty, to understand consumer knowledge and perceptions of upcycled food practices. Majority (65.9%) of the respondents chose option ‘Foods made from leftover or surplus ingredients that would otherwise be wasted’, whereas 16.6% of the respondents were not sure about the definition of upcycled foods.

To understand the level of familiarity with upcycling concept, respondents were asked if they were aware that leftover rice and spent grains can be repurposed. Majority of the respondents were well aware that fruits which are undesirable in appearance were still edible and almost 50% of the respondents knew about upcycling of spent grains. Respondents were asked to identify factors that would influence their decision to try upcycled foods. Key considerations included price,

taste, and health benefits, highlighting the importance of affordability and sensory appeal. Environmental impact and packaging also played significant roles, emphasizing the growing consumer interest in sustainability. Other factors such as brand reputation, convenience, nutritional value, and ingredient transparency are crucial for building trust and meeting consumer expectations. Additionally, certifications, personal values, variety, social impact, recommendations, and brand familiarity are influential, reflecting a multifaceted decision-making process for upcycled food. Out of 361 respondents 250 (69%) of them chose ‘Taste’ as one of the major factors, followed by ‘Health benefits and ‘Price’ (Figure 1). Nutritional Value and Environmental Impact were also considered important factors by the respondents.



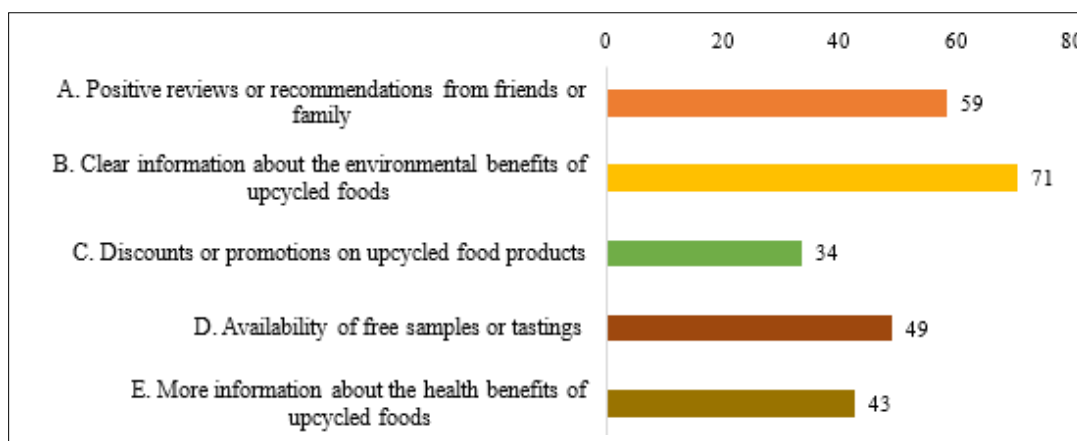
**Figure 1:** Factors Affecting Acceptability of Upcycled Foods (Percentage)

Understanding potential barriers to the adoption of upcycled foods is essential for fostering their integration into mainstream diets. This question encompassed a range of considerations, from concerns about taste and quality to issues related to trust in the ingredients or production process. Additionally, uncertainties surrounding health or safety implications, along with perceptions of upcycled foods as less appealing or desirable, influenced consumer attitudes. Furthermore, economic factors such as price competitiveness against traditional food options and the limited availability or accessibility of upcycled products were the additional challenges. However, the survey also offered respondents the option to indicate openness to trying upcycled foods without any reservations. Table 3 gives the data about the potential barriers as selected by respondents (in percentage). Uncertainty about health or safety implications was one of the major potential barriers, followed by concerns about taste or quality and Lack of trust in the ingredients or production process.

**Table 3: Potential Barriers**

Potential Barriers	Percentage
A. Concerns about taste or quality	53
B. Lack of trust in the ingredients or production process	55
C. Uncertainty about health or safety implications	61
D. Perception of upcycled foods as less appealing or desirable	30
E. Price compared to traditional food options	42
F. Limited availability or accessibility of upcycled food products	37
G. None, I am open to trying upcycled foods	10

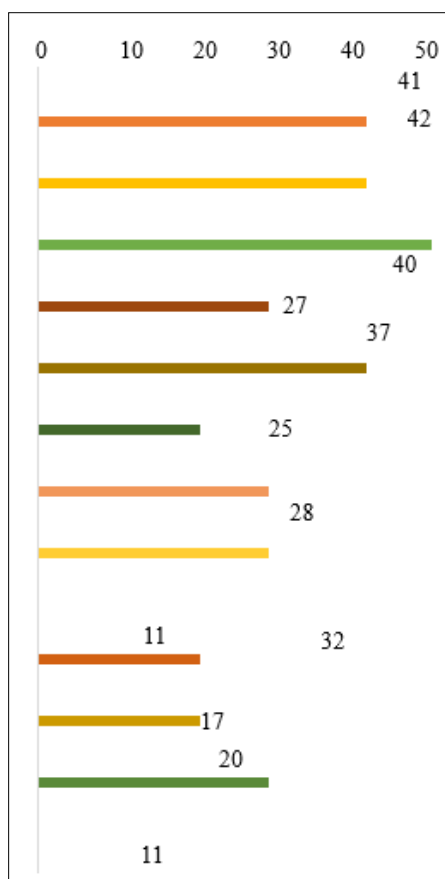
To effectively promote the adoption of upcycled foods, it is crucial to identify the factors that can encourage consumers to overcome any hesitations. The survey question, “What would encourage you to overcome any hesitations and try upcycled foods?” sought to uncover these motivating factors. Potential influences include positive reviews or recommendations from friends or family, which can significantly boost consumer confidence and interest. Additionally, providing clear information about the environmental benefits of upcycled foods can appeal to eco-conscious consumers by highlighting their role in reducing waste and promoting sustainability. Economic incentives, such as discounts or promotions, can also play a vital role in encouraging trial by making upcycled products more financially attractive. Offering free samples or tastings directly address concerns about taste and quality, allowing consumers to experience the product firsthand.



**Figure 2:** Encouraging Factors

The results (Figure 2) displayed that respondents would be encouraged to try upcycled foods if they are provided with clear information about the environmental benefits of upcycled foods, followed by positive reviews or recommendations from friends or family.

The survey further sought to understand the consumer preferences regarding the sources of upcycled foods, options included various sources such as unwanted fresh produce from grocery stores, leftover bread, juice from fruit cuttings, grains after brewing, excess dairy products, overripe grains and cereals, food processing by-products, leftover coffee grounds, unused meat or seafood portions, discarded bakery goods, surplus ingredients from restaurants, and food manufacturing or household food scraps. By identifying preferred sources, this research aims to guide strategies for enhancing consumer acceptance and adoption of upcycled foods. Fig 3 depicts the preferred sources of upcycled foods. The most preferred source was juice from cutting of fruits, followed by confectionary items like leftover bread. Unwanted or unsold fresh produce from grocery stores was also a preferred option by 41% of the respondents.



**Figure: 3** Sources for Upcycled Foods (in %)

- a) Unwanted or unsold fresh produce from grocery stores
- b) Confectionary Items (leftover bread)
- c) Juice (from cutting of fruits)
- d) Leftover grains after brewing
- e) Excess dairy products (e.g., surplus milk or cheese)
- f) Unused or overripe grains and cereals
- g) By-products from food processing (e.g., fruit peels, vegetable...)
- h) Leftover coffee grounds
- i) Unused portions of meat or seafood
- j) Discarded bakery goods (e.g., stale pastries, unsold cakes)
- k) Rescued or surplus ingredients from restaurants and catering...
- l) Excess ingredients from food manufacturing or production...
- m) Food scraps from households or community composting programs

The survey further explored consumer preferences regarding the form of upcycled foods they would like to try or consume. Participants were asked, "In which form would you like to try/consume upcycled foods?" with options including chips/puffs, beverages, Flavors, candies/bars, and an "Other" category for specifying additional preferences. Chip/puffs were the most preferred form in which respondents were eager to try upcycled food, followed by beverages whereas Flavors were the least preferred form.

The chi-square test results highlighted how demographic factors shaped consumer perceptions of upcycled foods: Table 4 summarizes Chi-Square test results examining how demographic factors (Age, Gender, Education, Profession, Location) relate to perceptions or knowledge across three topics: "Knowledge of Upcycled Foods," "Undesirable fruits are still edible," and "Spent grains can be used to make flour/chips." Awareness of upcycled foods varied significantly by gender, profession, and location; Perceptions about the edibility of "undesirable" fruits were influenced by age, gender, and education and knowledge of using spent grains in food production correlated with education levels.

**Table 4: Chi Square Test**

Dependent Factor	Independent Factor	Asymptotic Significance (2- sided)
"Knowledge of Upcycled Foods"	Age	0.224
	Gender	0.022
	Education	0.146
	Profession	0.047
	Location	0.00
Undesirable fruits are still edible"	Age	0.00
	Gender	0.00
	Education	0.001
	Profession	0.035
	Location	0.236
Spent grains can be used to make flour/chips"	Age	0.198
	Gender	0.792
	Education	0.001
	Profession	0.083
	Location	0.089

Principal component analysis and varimax rotation were used to carry out an exploratory factor analysis. The data's suitability for factor analysis is indicated by the Kaiser-Meyer-Olkin measure of sampling adequacy (MSA), which came in at 0.732. Data that have MSA values greater than

0.700 are deemed suitable for factor analysis in this sense.

**Table 5: Components**

Components	Factors	Mean	SD	%Covariance
Environmental and Quality Concerns (C1)	The environmental impact of a product will affect my buying choices.	3.88	0.512	36.93
	I am hesitant to purchase upcycled foods due to concerns about the taste or quality.	3.36		
Attitude Towards Upcycled Foods (C2)	I actively seek out products labelled as eco-friendly or sustainable.	3.79	0.569	15.99
	It is important for me to know the specific ingredients and sources used in upcycled food products.	4.1		
	I frequently make fried rice using leftover rice from previous meals.	4.17		
	I feel that upcycled foods can play a significant role in solving environmental issues	4.19		
	I am willing to try upcycled foods if they are available at my local grocery store or restaurant.	4.11		
	I am willing to pay a premium for upcycled foods compared to regular foods.	3.14		

The results of the factor analysis, as shown in Table 5 reduced the variables into two distinct components. Component 1 included items related to personal practices and attitudes towards upcycled foods, such as willingness to try, pay a premium, and the potential of upcycled foods to address environmental concerns. This factor is labelled as "Attitude Towards Upcycled Foods." Component 2 included items related to concerns about environmental impact and hesitation due to taste and quality, reflecting a more cautious and evaluative approach. This factor was labelled as "Environmental and Quality Concerns."

The correlation analysis between components C1 and C2 revealed important insights into their relationship. The Pearson correlation coefficient between C1 and C2 is 0.306. Hence, it can be inferred that there is a statistically significant positive correlation between components C1 and C2. This suggests a tendency for C2 to increase as C1 increases, although the relationship is moderate in strength. The strong statistical significance ( $p < 0.05$ ) underscored the reliability of this correlation, indicating that it is not due to random chance.

### Conclusion

The global challenge of food waste can be addressed through upcycling, which converts edible food waste into new products. The study aims to assess awareness levels, identify barriers to adoption, understand preferences. Data analysis was performed using Microsoft Excel and SPSS software, employing various statistical techniques like reliability analysis, chi-square tests, and factor analysis.

### Major Findings Included:

- **Awareness:** 54% of respondents were unaware of upcycled foods, while 46% had heard of them. Many knew that discarded food like fruits and spent grains can be repurposed.
- **Factors Influencing Acceptance:** Taste, health benefits, and price are major factors, with nutritional value and environmental impact also important.
- **Barriers:** Health and safety concerns, taste or quality doubts, and lack of trust in ingredients or production processes.
- **Preferred Sources and Forms:** Juices from fruit cuttings and confectionary items like leftover bread are preferred sources, with chips/puffs being the most preferred form.

The study concludes that a significant portion of respondents are familiar with upcycling, presenting an opportunity for the food industry to market upcycled food products. The study provides valuable insights for businesses, policymakers, and researchers aiming to promote sustainable food practices in India.

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