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Peel to Plate: A Study on the Culinary Applications of Fruit and Vegetable Peels

[1]Ms. Hazra Sunasara **[2]Dr. Rekha Battalwar**

[1]Post Graduate Student - Master's in Specialised Dietetics, Diabetes & Cardiac Nutrition, Sir Vithaldas Thackersey College of Home Science (Empowered Autonomous Status), SNDT Women's University, Juhu, Mumbai, India, 400049

[2]Professor, Director - Administration & Planning, Sir Vithaldas Thackersey College of Home Science (Empowered Autonomous Status), SNDT Women's University, Juhu, Mumbai, India, 400049

Abstract

In a country like India, where widespread malnutrition coexists with substantial food waste, fruit and vegetable peels represent an overlooked opportunity for nutritional enhancement and sustainable cooking practices. The present study aimed to explore the culinary potential of commonly discarded fruit and vegetable peels by developing innovative recipes and evaluating them for sensory acceptability and consumer attitudes. A mixed-method design was employed, involving sensory evaluation of 15 peel-based recipes by a semi-trained panel (n=15) using a 9-point hedonic scale, and a structured survey conducted among 100 adults (52 students, 48 non-students) to assess knowledge, attitudes, and practices.

Onion Peel Powder Dahi (8.10 ± 0.93) and Ridge Gourd Stir Fry (8.03 ± 0.77) achieved the highest mean scores in taste, texture, colour, and overall acceptability, while Potato Stir Fry scored the lowest (5.73 ± 1.28). Ranking tests further validated these preferences. Survey findings showed that while 91% of participants were concerned about food waste and 55% were aware of the nutritional benefits of peels, only 23% had prior experience using them. However, 70% expressed willingness to adopt peel-based cooking practices, particularly if taste and ease of preparation were addressed.

The study concludes that peel-based culinary interventions are nutritionally viable and well-accepted, offering a practical strategy to reduce household food waste while enhancing dietary quality. With greater awareness, education, and recipe-based solutions, peels can be successfully repositioned from waste to wellness in sustainable food systems.

Key words: Fruit and vegetable peels, Food waste reduction, Sensory evaluation, Sustainable cooking, Culinary innovation, Consumer attitudes

Introduction

India grapples with a growing paradox—while millions face hunger and undernutrition, food worth billions is wasted annually across the supply chain. A major contributor to this waste is the disposal of fruit and vegetable peels, which are typically discarded despite being nutrient-dense and rich in functional compounds (Times of Agriculture, n.d.). These by-products are often overlooked in conventional cooking, even though studies have proven their potential as sources of bioactive compounds, including antioxidants, dietary fibre, polyphenols, flavonoids, and essential vitamins (Kumar & Sharma, 2022).

The nutritional value of fruit and vegetable peels is significant. For instance, citrus peels are high in flavonoids and vitamin C, while pomegranate and onion peels have demonstrated antimicrobial and anti-inflammatory properties (Ahmad, Hussain, & Gupta, 2023). Despite their benefits, these peels are excluded from diets largely due to sensory perceptions, lack of culinary awareness, and limited cultural acceptance (Mohite, Patil, & Pandit, 2020). Reimagining these peels not as waste but as valuable culinary resources is essential for bridging nutrition gaps and minimising preventable food loss.

From a sustainability perspective, utilising peels aligns with global efforts to reduce food waste and improve environmental resilience. Waste valorisation strategies such as converting edible peels into functional food components are increasingly recognised as essential to ensuring long-term food security (Wani et al., 2024). India's diverse agricultural output, if utilised fully—including edible by-products—can enhance nutritional adequacy and minimise ecological footprints (Ritchie, Reay, & Higgins, 2018).

Sensory acceptability remains a critical barrier in the adoption of peel-based foods. Consumers often judge food quality based on taste, appearance, and texture, making it necessary to validate such recipes through consumer research and sensory evaluation (Ruiz-Capillas & Herrero, 2021). Moreover, behavioural studies reveal that even nutritionally sound innovations are unlikely to succeed unless supported by positive consumer attitudes and readiness to adopt new habits (Abeliotis, Lasaridi, & Chroni, 2014). Social stigma, perceived inconvenience, and aesthetic preferences play a large role in why nutritious peels end up as waste (Aktas et al., 2018).

In this context, the present study, titled "Peel to Plate: A Study on Culinary Applications of Fruit and Vegetable Peels, " assessed the nutritional and behavioural dimensions of peel utilisation. The research focused on developing fifteen innovative recipes using commonly discarded peels, conducting sensory evaluations to assess their palatability, and evaluating public attitudes through surveys. This study builds on the idea that small shifts in kitchen practices—when informed by science and guided by sustainability—can collectively contribute to a more resilient, nutritionally sound, and waste-conscious food system (Kumar, Meena, & Jha, 2021).

Methodology

The present study followed a mixed-method research design, integrating both quantitative and qualitative approaches to explore the culinary, nutritional, and perceptual aspects of using fruit and vegetable peels. Conducted in Mumbai, Maharashtra, the study targeted adults aged 18–40 years, representing a key demographic responsible for food decisions in urban households. Primary data included the development and sensory evaluation of fifteen peel-based recipes, assessed by a semi-trained panel of 15 evaluators. Sensory evaluation was performed using a 9-point hedonic scale to analyse taste, texture, appearance, and overall acceptability, with panellists selected based on availability and interest. Exclusion criteria included individuals with food allergies, pregnant women, and smokers to prevent confounding bias in taste and safety perception.

Additionally, a structured survey was administered to 100 participants (52 students and 48 non-students) to gather insights into their knowledge, attitudes, and willingness to adopt peel-based cooking. Participants were selected via purposive sampling, and eligibility required them to be literate, aged 18–40, and from middle or upper-middle socioeconomic backgrounds. Those suffering from critical illness, bedridden individuals, and participants from upper, upper-lower, or lower socioeconomic classes were excluded to ensure homogeneity of context and comparability in food behaviour patterns. The study also relied on secondary data sources, which included peer-reviewed journal articles, nutritional databases, and reports from food and nutrition organisations. These resources provided scientific evidence regarding peels' nutritional composition, bioactive properties, and waste reduction potential, helping to guide recipe selection and frame the interpretation of findings. Data were analysed using SPSS version 25 for Windows (version 25, 2017, IBM Corporation, Armonk, New York, United States). Data presented as Mean±SD or frequency (percentage). Cross tabulations were computed when classified as students and non-students and compared using the chi-square test. The difference in the mean scores for sensory evaluation was assessed using One-way ANOVA with a post hoc Bonferroni test to adjust for multiple comparisons. $p<0.05$ was considered to be statistically significant.

Results

This section presents the findings of the study, which were derived from two core components: sensory evaluation and a structured community survey. The sensory evaluation focused on assessing the acceptability of fifteen peel-based recipes using both a 9-point hedonic scale and a ranking test conducted by a semi-trained panel. This helped determine consumer preferences in terms of taste, texture, appearance, and overall appeal. Parallelly, a survey was carried out among 100 adult participants, including students and non-students, to gather insights on demographic characteristics, food waste practices, and attitudes and behaviours related to the use of fruit and vegetable peels. The following results highlight both the sensory outcomes and the behavioural patterns associated with peel reuse, offering a comprehensive understanding of the feasibility and acceptability of peel-based culinary interventions.

Table No. 1: Mean score for Taste, Texture, Colour, and Overall Acceptability of the recipes

Recipes	Taste		Texture		Colour		Overall acceptability	
	Mean ± SD	P-value	Mean ± SD	P-value	Mean ± SD	P-value	Mean ± SD	P-value

Onion peel powder dahi	8.10 ± 0.93	1*b	8.17 ± 0.794	1.000*c	8.17 ± 0.794	1.000*b	8.10 ± 0.93	1*c
Ridge gourd stir fry	8.03 ± 0.767	0*b	8.03 ± 0.767	0.000*c	8.03 ± 0.767	0.000*b	8.03 ± 0.767	0*
Bottle gourd chutney	7.93 ± 0.961	0*	7.67 ± 1.234	0.000*	7.67 ± 1.234	0.000*b	7.93 ± 0.961	0*
Orange peel zarda	7.60 ± 1.242	0.005*	7.47 ± 0.916	1.000*	7.47 ± 0.916	1.000*	7.60 ± 1.242	0.005*
Bottle gourd stir fry	7.53 ± 0.916	0.01*	7.33 ± 1.047	0.010*	7.33 ± 1.047	0.010	7.53 ± 0.916	0.01*
Onion peel tea	7.53 ± 1.356	0.01*	7.60 ± 1.298	1.000*	7.60 ± 1.298	1.000	7.53 ± 1.356	0.01*
Watermelon rind curry	7.20 ± 1.373	1	7.27 ± 1.438	1.000	7.27 ± 1.438	1.000	7.20 ± 1.373	1
Pomegranate raita	7.13 ± 1.408	1	7.27 ± 1.223	1.000	7.27 ± 1.223	1.000*	7.13 ± 1.408	1*
Ridge gourd chutney	6.90 ± 1.671	1*	6.97 ± 1.369	1.000	6.97 ± 1.369	1.000	6.90 ± 1.671	1c
Orange peel rice	6.87 ± 0.916	1	7.37 ± 0.767	1.000*	7.37 ± 0.767	1.000	6.87 ± 0.916	1
Orange peel curry	6.80 ± 1.474	1	7.07 ± 1.033	1.000	7.07 ± 1.033	1.000	6.80 ± 1.474	1
Watermelon rind chutney	6.67 ± 1.234	1	6.87 ± 1.126	1.000	6.87 ± 1.126	1.000	6.67 ± 1.234	1
Garlic peel powder chutney	6.53 ± 0.99	1	6.33 ± 1.175	1.000#a	6.33 ± 1.175	1.000	6.53 ± 0.99	1#a

Pomegranate peel tea	6.40 ± 1.595	1#	6.90 ± 1.391	1.000	6.90 ± 1.391	1.000*ad	6.40 ± 1.595	1
Potato stir fry	5.73 ± 1.28	0.231	5.87 ± 1.126	1.000	6.10 ± 1.126	1.000	5.73 ± 1.28	0.231

** Significantly different from Potato Stir Fry, #Significantly different from Ridge gourd stir fry, a Significantly different from Onion peel powder dahi, b Significantly different from Pomegranate peel tea, c Significantly different from Garlic Peel Powder Chutney, d Significantly different from Bottle Gourd Chutney*

Table 1 presents the sensory evaluation scores of the developed recipes, revealing statistically significant differences across all attributes—taste, texture, colour, and overall acceptability ($p < 0.001$), highlighting varied consumer preferences. Onion Peel Powder Dahi (8.10 ± 0.93) and Ridge Gourd Stir Fry (8.03 ± 0.77) consistently received the highest mean scores across all parameters, indicating excellent palatability, smooth texture, vibrant colour, and outstanding overall appeal. These dishes were significantly more acceptable than both Potato Stir Fry (5.73 ± 1.28), which received the lowest scores across most attributes, and Pomegranate Peel Tea (6.40 ± 1.60), which was notably poor in taste and colour. Other peel-based preparations such as Bottle Gourd Chutney (7.93 ± 0.96), Orange Peel Zarda (7.60 ± 1.24), Bottle Gourd Stir Fry (7.53 ± 0.92), and Onion Peel Tea (7.53 ± 1.36) also demonstrated significantly better taste, texture, and overall acceptability than Potato Stir Fry, confirming their enhanced sensory appeal. In terms of texture, Garlic Peel Powder Chutney (6.33 ± 1.18) and Potato Stir Fry (5.87 ± 1.13) scored the lowest, indicating coarseness and less desirable mouthfeel, while Onion Peel Powder Dahi and Ridge Gourd Stir Fry were again rated highest for their smoothness and pleasant consistency. Colour-wise, Onion Peel Powder Dahi, Ridge Gourd Stir Fry, and Bottle Gourd Chutney stood out with significantly higher visual appeal compared to duller preparations like Pomegranate Peel Tea and Potato Stir Fry. Overall, the results strongly suggest that peel-based recipes are not only nutritionally beneficial but also excel in sensory attributes, with many outperforming traditional dishes and showing great promise for consumer acceptance and incorporation into regular diets.

Table No. 2: Ranking Test of the recipes

Recipes	Mean Score	Rank
Onion peel powder dahi	8.10	1
Ridge gourd stir fry	8.03	2
Bottle gourd chutney	7.93	3
Orange peel zarda	7.60	4
Bottle gourd stir fry	7.53	5
Onion peel tea	7.53	5
Watermelon rind curry	7.20	7
Pomegranate raita	7.13	8
Ridge gourd chutney	6.90	9
Orange peel rice	6.87	10

Orange peel curry	6.80	11
Watermelon rind chutney	6.67	12
Garlic peel powder chutney	6.53	13
Pomegranate peel tea	6.40	14
Potato stir fry	5.73	15

Table 2 validates the findings with a ranking test, which was conducted to evaluate the sensory acceptance of 15 developed recipes. Onion peel powder dahi ranked highest with a mean score of 8.10, indicating excellent acceptability among the panellists. This was closely followed by Ridge gourd stir fry (8.03) and Bottle gourd chutney (7.93), both of which were also well appreciated for their taste and texture. Recipes such as Orange peel zarda, Bottle gourd stir fry, and Onion peel tea also performed well, all scoring above 7.5, reflecting good acceptance. Mid-ranked items like Watermelon rind curry and Pomegranate raita had mean scores in the range of 7.2 to 7.1, suggesting moderate acceptability. On the lower end of the ranking were recipes such as Garlic peel powder chutney (6.53) and Pomegranate peel tea (6.40), which received comparatively lower scores. The lowest ranked item was Potato stir fry, with a mean score of 5.73, indicating limited acceptance.

Peel to Plate: A Study on Culinary Application of Fruit and Vegetable Peels- This section was divided into three main parts to ensure a comprehensive investigation of the topic. The first part collected demographic data, such as age, gender, education, and occupation, to provide context for the responses and allow for analysis across different groups. The second part focused specifically on food waste, asking respondents about the frequency, types, and reasons for wasting food to understand its prevalence and underlying causes. The third part explored respondents' attitudes and practices regarding food waste to assess their perceptions and behaviours; for analytical purposes, similar response options were combined to facilitate clearer interpretation. This structured approach enabled a thorough examination of both factual and attitudinal aspects related to food waste.

Table 3: Socio-Demographic Distribution of the study participants

Demographic Variable	**Category**	**Percentage**
Gender	Female	73%
	Male	27%
Age	18–25 years	75%
	26–35 years	18%
	36–40 years	7%
Education	Bachelor's degree	49%
	High school	27%
	Master's degree	20%

	Doctorate/Professional	4%
Employment Status	Student	52%
	Unemployed	21%
	Full-time employed	18%
	Part-time employed	4%
	Other	4%
	Retiree	1%
Occupation	Student	48%
	Other (non-student)	52%
Household Size	1-2 Members	11%
	3-4 Members	47%
	5-6 Members	27%
	More than 6 Members	15%

Table 3

presents the socio-demographic distribution of the study participants. The sample was predominantly composed of female respondents, who represented 73% of participants, compared to 27% male. A significant majority (75%) fell within the youngest age group (18–25 years), followed by those aged 26–35 years (18%), with only 7% aged 36–40 years. Educationally, nearly half (49%) held a Bachelor's degree as their highest qualification, while 27% reported a high school education. Advanced degrees were also well-represented, with 20% holding a Master's degree and 4% possessing a Doctorate or professional qualification. Reflecting the age distribution, over half (52%) identified their employment status as "Student," while 21% were unemployed and 18% worked full-time. Part-time workers and "Other" employment each accounted for 4%, with retirees comprising just 1%. Similarly, 48% listed their occupation specifically as "Student," while the remaining 52% encompassed diverse non-student occupational backgrounds. The household size of participants showed that the majority cooked for 3–4 members (47%), followed by 5–6 members (27%) and more than 6 members (15%), while only 11% reported cooking for 1–2 members. The distribution was largely similar between students and non-students, with no statistically significant differences observed ($\chi^2 = 0.590$, $p = 0.899$), indicating homogeneity in household sizes across the sample.

Table 4: Participants' Reasons for Discarding and Concerns Regarding the Consumption of Fruit and Vegetable Peels

Reasons & Concerns	Responses	Non-students (n=48)		Students (n=52)		Total (n=100)		P value
		N	%	N	%	N	%	
Reason for Discarding Fruit and Vegetable Peels	Lack of knowledge of usage	24	50.0%	19	36.5%	43	43.0%	**0.024 ***
	Perceived health risks	7	14.6%	6	11.5%	13	13.0%	
	Lack of time	12	25.0%	8	15.4%	20	20.0%	
	Unpleasant taste and texture	5	10.4%	19	36.5%	24	24.0%	
Concerns about consuming fruit and vegetable peels	Health risks	9	18.8%	14	26.9%	23	23.0%	**0.797**
	Taste	24	50.0%	24	46.2%	48	48.0%	
	Others' perception	6	12.5%	5	9.6%	11	11.0%	
	None	9	18.8%	9	17.3%	18	18.0%	

** P value less than the typical significance level of 0.05 indicates statistically significant results*

Table 4 highlights that concerns about consuming fruit and vegetable peels were dominated by taste apprehensions, cited by 48% of all participants, almost equally reported by non-students (50.0%) and students (46.2%). Health risks were the next major concern (23% overall), more frequently noted by students (26.9%) than non-students (18.8%). Social perception was minimally influential (11%), and 18% of participants expressed no concerns at all. Notably, no statistically significant difference was observed between the two groups ($\chi^2 = 1.019$, $p = 0.797$). In a related finding, the analysis also reveals a statistically significant association in the factors influencing the decision to discard peels ($\chi^2 = 9.480$, $P = 0.024$). Non-students primarily attributed their discard behaviour to a lack of knowledge about peel usage (50.0%) and insufficient time (25.0%). On the other hand, students cited a dual concern—lack of knowledge (36.5%) and the unappealing taste and texture of peels (36.5%).

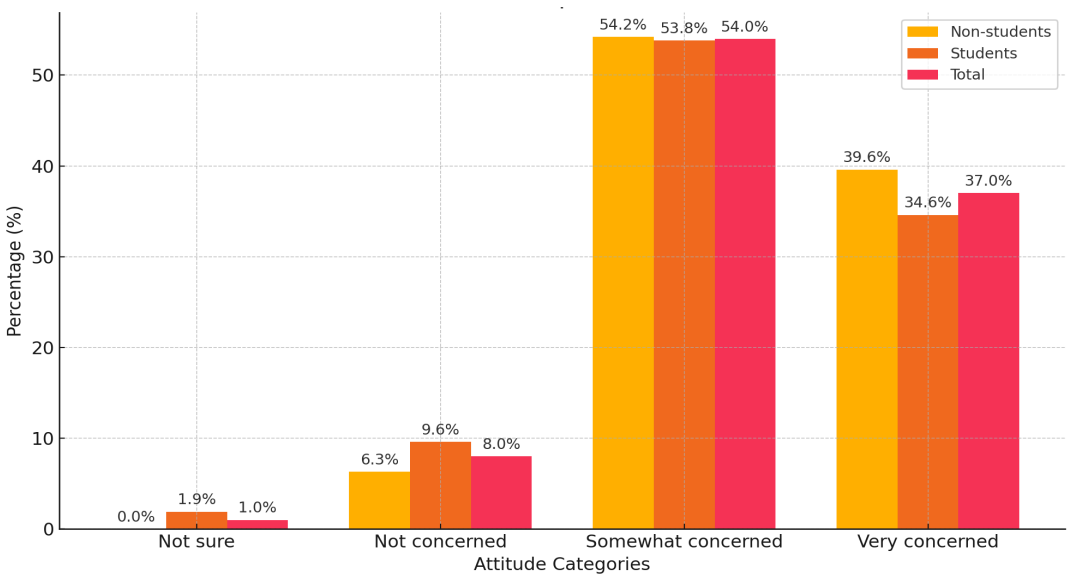

Figure 1: General attitude of participants towards food waste

Figure 1 revealed overwhelming concern, with most of them expressing awareness of the issue's severity (54% somewhat concerned + 37% very concerned). Only 8% reported being not concerned, while 1% remained uncertain. Critically, no statistically significant difference emerged between students (n=52) and non-students (n=48) ($p = 0.695 > \alpha=0.05$), as both groups showed parallel concern levels: non-students exhibited marginally higher strong concern (39.6% vs. 34.6% in students), while students had slightly more indifference (9.6% not concerned vs. 6.3%).

Table 6: Knowledge, Attitudes, and Practices(KAP) Related to Fruit and Vegetable Peel Usage among the study participants

KAP	Responses	Non-students (n=48)		Students (n=52)		Total (n=100)		P value
		N	%	N	%	N	%	
Composting practices	No	39	81.3%	38	73.1%	77	77.0%	**0.499**
	Yes	7	14.6%	9	17.3%	16	16.0%	
	Don't know	2	4.2%	5	9.6%	7	7.0%	
Opinion on peeling	No	10	20.8%	17	32.7%	27	27.0%	**0.123**
	Yes	17	35.4%	22	42.3%	39	39.0%	
	Not sure	21	43.8%	13	25.0%	34	34.0%	
Awareness of nutritional content	No	31	64.6%	21	40.4%	52	52.0%	**0.016***
	Yes	17	35.4%	31	59.6%	48	48.0%	
Thoughts on reusing peels	No	32	66.7%	29	55.8%	61	61.0%	**0.529**
	Yes	10	20.8%	15	28.8%	25	25.0%	
	Not sure	6	12.5%	8	15.4%	14	14.0%	
Willingness to use peels	No	3	6.3%	0	0.0%	3	3.0%	**0.103**
	Yes	34	70.8%	34	65.4%	68	68.0%	
	Maybe	11	22.9%	18	34.6%	29	29.0%	
Experience with using	No	37	77.1%	40	76.9%	77	77.0%	**0.998**

peels in cooking	Yes, negative experience	1	2.1%	1	1.9%	2	2.0%	
	Yes, positive experience	10	20.8%	11	21.2%	21	21.0%	

P value being less than the typical significance level of 0.05 indicates statistically significant results

Table 6 assesses knowledge, attitudes, and practices regarding fruit and vegetable peel usage between students and non-students. Regarding composting practices, a majority of both groups—81.3% of non-students and 73.1% of students—reported not engaging in composting, with no statistically significant difference between them (p = 0.499). On the topic of opinion on peeling, responses were mixed, with a substantial number of participants expressing uncertainty. Although more students (42.3%) than non-students (35.4%) believed peeling was necessary, the difference was not significant (p = 0.123). A significant difference was observed in awareness of the nutritional content of peels, where 59.6% of students reported being aware compared to only 35.4% of non-students (p = 0.016), indicating that students demonstrated greater nutritional awareness. When asked about thoughts on reusing peels, the majority of both groups responded negatively (66.7% non-students, 55.8% students), and the difference was not statistically significant (p = 0.529). Similarly, willingness to use peels showed a generally positive trend in both groups, with 70.8% of non-students and 65.4% of students answering "Yes," and 22.9% and 34.6%, respectively, responding "Maybe"; however, this difference was also not statistically significant (p = 0.103). Lastly, regarding experience with using peels in cooking, both groups had limited prior experience, with 77.1% of non-students and 76.9% of students stating they had never used peels before. A small percentage had positive experiences (around 21% in both groups), and very few reported negative experiences. There was no significant difference between groups on this aspect (p = 0.998). Overall, the only significant variation observed was in nutritional awareness.

Table 7: Perceived Health Benefits and Opinion on Consuming Peels by the Participants

Benefits and opinions	Responses	Non-students (n=48)		Students (n=52)		Total (n=100)		P value
		N	%	N	%	N	%	
Health Benefits of Consuming Peels	Fibre and nutrients	19	39.6%	36	69.2%	55	55.0%	
	Antioxidants	10	20.8%	11	21.2%	21	21.0%	
	Improved digestion	11	22.9%	4	7.7%	15	15.0%	**0.007***
	Immune function	5	10.4%	1	1.9%	6	6.0%	
	Reduced risk of chronic diseases	3	6.3%	0	0.0%	3	3.0%	
Opinions Regarding the Health Benefits	Neutral	2	4.2%	11	21.2%	13	13.0%	
	Important	20	41.7%	16	30.8%	36	36.0%	**0.038**
	Extremely important	26	54.2%	25	48.1%	51	51.0%	

Table 7 reveals statistically significant associations regarding both perceived health benefits and the importance of raising awareness about peel consumption among participants. A majority of students (69.2%) identified peels as a source of "fibre and nutrients," compared to 39.6% of non-students. Conversely, non-students were more inclined to associate peel consumption with improved digestion (22.9% vs. 7.7%) and enhanced immune function (10.4% vs. 1.9%). This divergence in perception—students focusing more on nutritional value, while non-students emphasise functional health benefits—may reflect varying levels of health literacy or wellness priorities ($\chi^2 = 14.098$, $P = 0.007$). Similarly, when asked about the importance of increasing awareness about peel utilisation, non-students showed greater concern, with 54.2% rating it as "Extremely important" compared to 48.1% of students. Students, in contrast, were more likely to be "Neutral" (21.2%) than non-students (4.2%), indicating a statistically significant difference in opinion ($\chi^2 = 6.545$, $P = 0.038$). Together, these findings highlight the need for tailored educational strategies: nutrient-based messaging for students, and functionality- and awareness-focused initiatives for non-students.

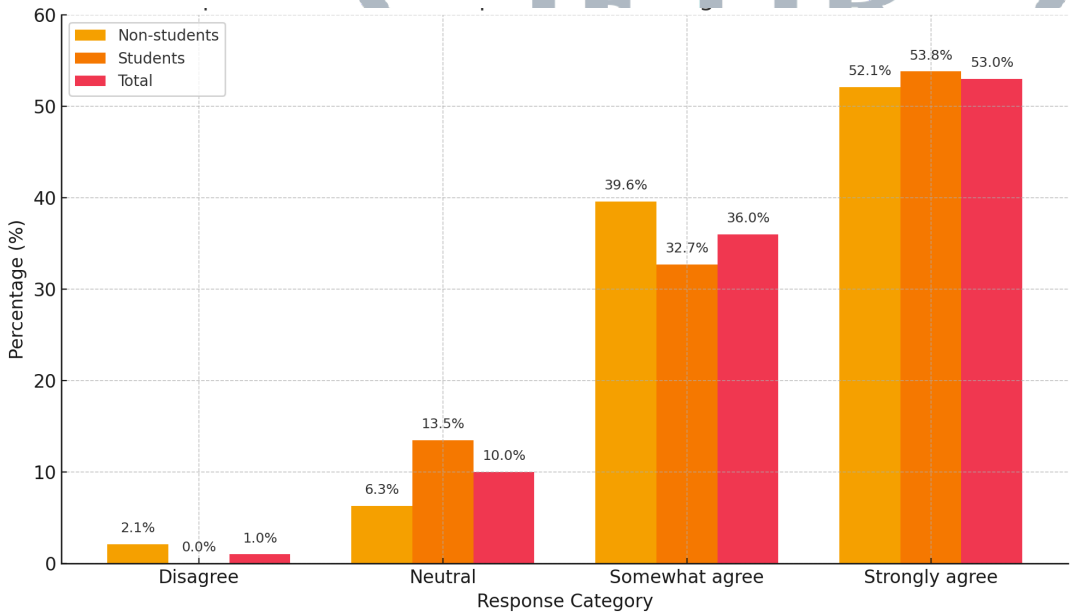

Figure 2: Participants' View on the Importance of Raising Awareness About Peels

Figure 8 reflects a strong overall agreement among participants, with 89.0% acknowledging that incorporating peels into cooking supports a more sustainable food system. Rates of "strongly agree" were nearly identical between non-students (52.1%) and students (53.8%). Pearson's chi-square test showed no statistically significant difference between the two groups ($\chi^2 = 2.725$, $P = 0.436$). Although the difference was not statistically significant, the high level of agreement across both groups underscores a shared understanding of the sustainability benefits of peel utilisation. These findings further support the study's focus on promoting peel-based culinary practices as a practical solution for reducing food waste.

Discussion

The sensory evaluation outcomes revealed that peel-based recipes can be both nutritionally innovative and organoleptically acceptable. Onion Peel Powder Dahi and Ridge Gourd Stir Fry achieved the highest mean scores across all sensory parameters, with overall acceptability scores of 8.10 ± 0.93 and 8.03 ± 0.77, respectively. These recipes outperformed the traditional Potato Stir Fry, which received the lowest acceptability score of 5.73 ± 1.28 ($p < 0.001$), indicating a significant difference in preference. Similar statistical significance was observed in taste ($p < 0.001$), texture ($p < 0.001$), and colour ($p < 0.001$), confirming that peel-based recipes maintained or enhanced palatability. These findings support prior research emphasising that food industry by-products can be transformed into desirable end-products without compromising sensory appeal (Mirabella, Castellani, & Sala, 2014).

The participant profile added further clarity to the patterns of food-related behaviour observed in the study. The sample was primarily composed of young adults aged 18–25 years (75%), with 73% identifying as female and 52% as students. Despite being a relatively well-educated and nutrition-aware demographic, 77% of participants reported never having used fruit or vegetable peels in cooking. This points to a critical knowledge-practice gap, even in an informed population segment. Students demonstrated a higher level of nutritional awareness compared to non-students (59.6% vs. 35.4%; $p = 0.016$), yet this awareness did not strongly correlate with habitual usage. These findings reinforce the idea that information alone may be insufficient to trigger behavioural change unless reinforced by experiential interventions (Mani & Thawani, 2023).

In examining food waste behaviour, taste and texture emerged as key concerns, reported by 48% of participants as reasons for discarding peels. Health risks were cited by 23%, while 43% mentioned a lack of knowledge about how to use peels. A statistically significant association was observed between participant group and reason for discard ($p = 0.024$), with students more likely to be deterred by unpleasant taste and non-students by lack of knowledge. Despite these barriers, the majority of respondents (91%) expressed moderate to high concern about food waste. This contradiction between stated values and actual practices is a well-documented phenomenon in sustainable food behaviour literature and highlights the complexity of changing food-related habits (Papargyropoulou et al., 2014).

With regard to attitudes and practices around peel consumption, 55% of participants recognised peels as being rich in fibre and nutrients, and 70% indicated willingness to use peels in cooking. However, less than 25% had any prior experience of doing so. Importantly, no significant difference was found between students and non-students in terms of willingness or previous experience ($p > 0.05$), which suggests that both groups are equally open to peel integration if barriers such as taste and ease of preparation are addressed. These findings are in alignment with the principles of circular food systems, where valorisation of food waste through consumer-friendly strategies is essential for broader adoption (Kumar & Sharma, 2021).
Altogether, the study findings suggest that peel-based culinary interventions—if supported by sensory appeal, nutritional education, and practical application—can bridge the gap between knowledge and behaviour. By addressing concerns of taste and safety while reinforcing sustainability messaging, such innovations can shift consumer behaviour toward more resource-efficient food practices. As previous literature on functional food product development notes, consumer behaviour is most likely to shift when health, sustainability, and sensory enjoyment align (Martins, Pinho, & Ferreira, 2017).

Summary and Conclusion

In the face of rising food insecurity, malnutrition, and environmental concerns, the regular disposal of fruit and vegetable peels represents a critical missed opportunity in sustainable nutrition. These peels, which are often cast aside as inedible waste, are in fact rich in dietary fibre, antioxidants, and other bioactive compounds that can contribute to both health and culinary innovation. The present study was designed to tap into this potential by developing innovative, household-friendly recipes using commonly discarded peels and assessing both their sensory acceptability and public attitudes toward their use.

Fifteen peel-based recipes were created using simple, traditional Indian culinary methods such as stir-frying, boiling, grinding, and blending. These recipes were evaluated by a semi-trained panel using a structured 9-point hedonic scale and a ranking test. The results revealed that certain preparations, particularly Onion Peel Powder Dahi and Ridge Gourd Stir Fry, stood out for their taste, texture, appearance, and overall acceptability. These recipes were consistently rated highest, reflecting their strong sensory appeal and proving that nutritional enhancement through peel integration need not compromise consumer satisfaction. Conversely, a few recipes like Potato Stir Fry scored lower, pointing to the need for better preparation techniques or improved flavour-balancing. The ranking test reinforced these findings by validating the order of preference expressed by participants. Overall, the sensory results demonstrated that peels, when processed thoughtfully, can yield dishes that are both nutritious and organoleptically acceptable.

The community survey added a behavioural lens to the findings. It revealed that while most participants expressed concern about food waste and acknowledged the potential health benefits of peels, very few had ever used them in their cooking. The primary reasons for discarding were lack of knowledge, concerns about safety or hygiene, and apprehensions about taste and texture. Interestingly, students and non-students cited different reasons—students were more sensitive to taste and texture, whereas non-students were more affected by time constraints and unfamiliarity. Despite these barriers, the majority of participants showed a willingness to try peel-based recipes, especially if they were given accessible, easy-to-follow solutions. The positive reception of the "Peel to Plate" recipe booklet indicated a strong interest in guided culinary interventions that bridge knowledge gaps and reduce perceived risks.

In conclusion, this study validates that fruit and vegetable peels, often regarded as waste, hold significant potential for contributing to sustainable nutrition. Through the development and sensory evaluation of fifteen peel-based recipes, it was established that such preparations can be both nutritionally beneficial and organoleptically acceptable, with Onion Peel Dahi and Ridge Gourd Stir Fry receiving the highest ratings. Although a majority of participants had never incorporated peels into their cooking, a substantial proportion expressed willingness to do so when supported with practical and culturally relevant guidance. The ranking test reinforced these preferences, while the positive reception of the “Peel to Plate” recipe booklet reflected openness to behaviour change. Key barriers—such as lack of awareness, concerns about taste and texture, and limited exposure—were identified, particularly among non-students. Nevertheless, the findings suggest that with appropriate education, taste-tested recipes, and accessible tools, peels can be effectively integrated into daily cooking, thereby offering a viable approach to reducing household food waste and sustainably enhancing dietary quality.

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