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Consumer attitudes towards upcycled foods

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Background

One-third of produced food is wasted each year

- food insecurity
- financial loss
- negative environmental impacts

World's annual edible food waste: 1.3 billion tonnes

Upcycled foods contain unmarketable ingredients (e.g., damaged food produce, by-products and scraps from food preparation) that otherwise would not be directed for human consumption.



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According to UFA, upcycled foods use ingredients that otherwise would not have gone to human consumption, are procured and produced using verifiable supply chains, and have a positive impact on the environment.



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Upcycled food examples

Damaged bananas → banana chips

Brewer's spent grain (BSG) → flour → cereal-based products

Tofu and soymilk by-products → flour → chocolate chip cookies

Carrot peels → powdered soup mix



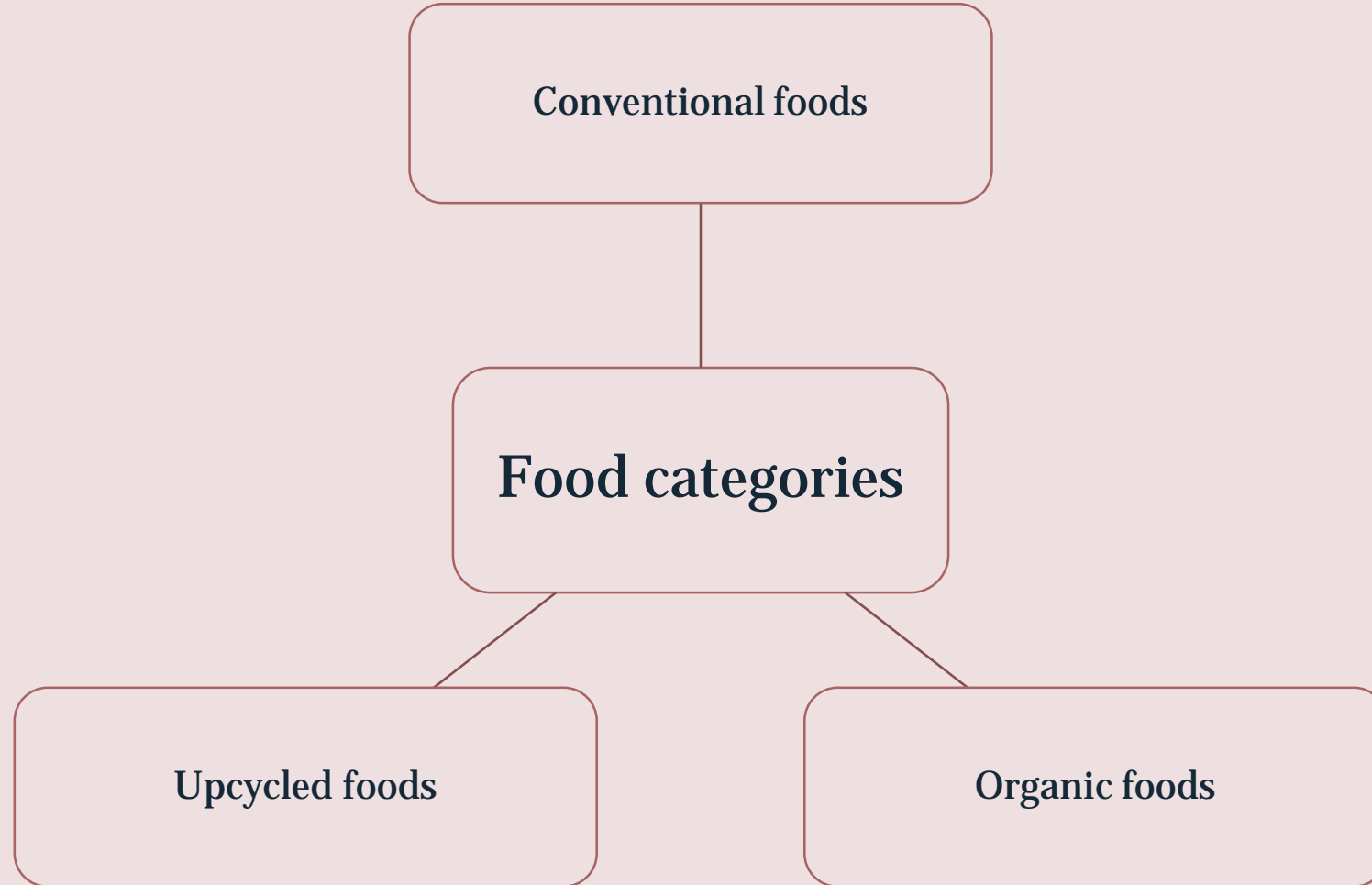
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Conventional foods

Food categories

Upcycled foods

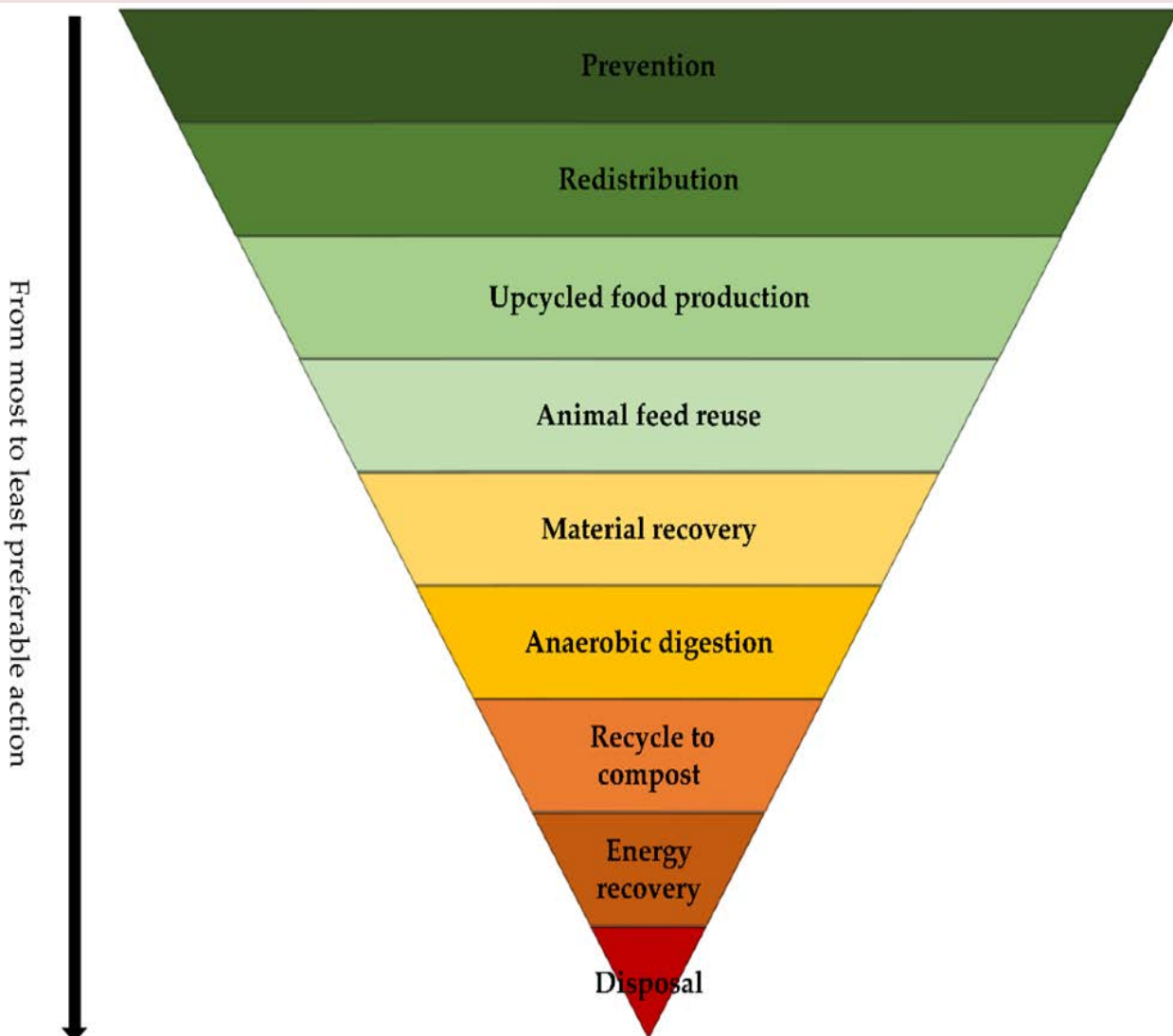
Organic foods





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Food waste management hierarchy



The hierarchy for the management of food surplus, waste, and loss has been modified to include upcycled food production as a management action (Moshtaghian et al. 2021).



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Upcycled food choices factors

Aim 1: to investigate the upcycled food choice factors among those who are inclined to consume upcycled food and those who are hesitant or reluctant

Aim 2: assesses the association between upcycled food choice factors and hesitancy or reluctance toward upcycled food consumption



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Factors influencing upcycled food choices

- Food Choice Questionnaire
- Focused on the importance of health and weight management, mood, convenience, sensory appeal, natural content, price, familiarity, ethical and environmental concern, risk perception and neophobia.
- Scored from 1 to 5 (1=not at all important, 2= a little important, 3= moderately important, 4= important, 5= very important).



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Questionnaire

- Advertised on social media (e.g., Facebook, LinkedIn and Instagram) for 3 months
- All adults aged 18 and over who lived in Sweden were eligible
- 683 participated
- 682 participants provided information on their intention to consume upcycled foods



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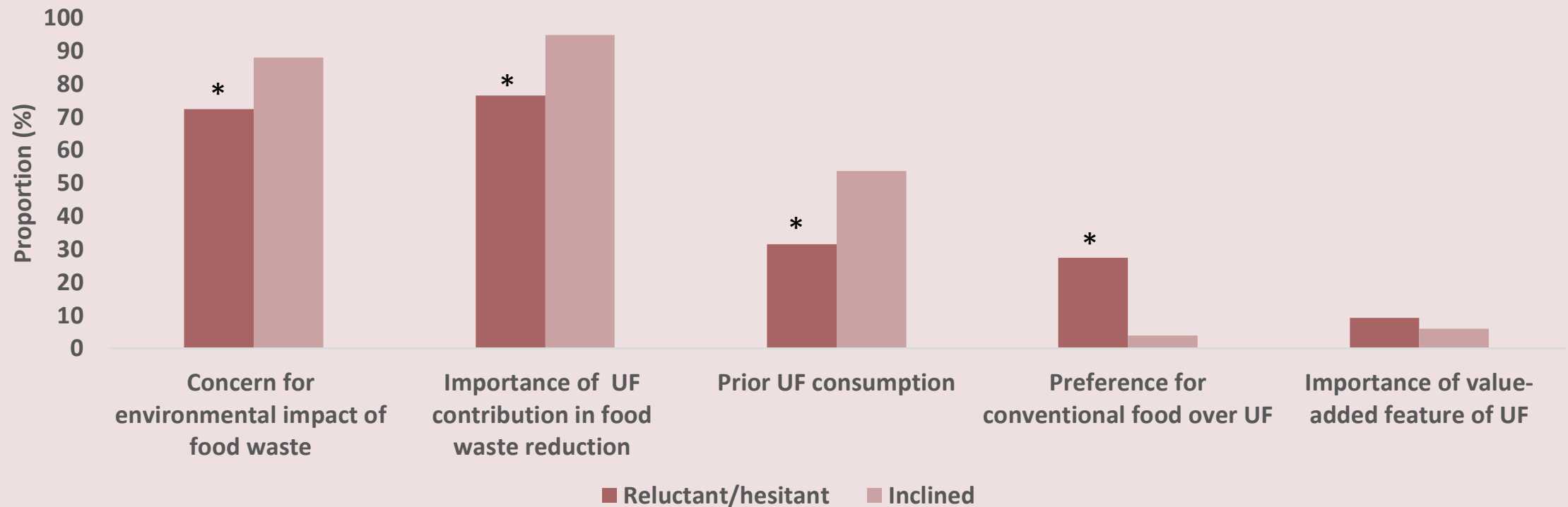
Participants' characteristics

	Reluctant/hesitant	Inclined
n	146	536
Female, n (%)	105 (71.90)	475 (88.62)
Age, mean (SD)	47.58 (16.70)	48.10 (14.55)
Postgraduate education, n (%)	59 (40.41)	136 (25.37)
Living alone, n (%)	37 (25.34)	128 (23.88)
Small household, n (%)	117 (80.14)	429 (80.04)
No children in household, n (%)	101 (69.18)	355 (66.23)
Full-time employment, n (%)	69 (47.26)	280 (52.24)
High household income, n (%)	36 (24.7)	161 (30.04)



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Attitudes towards food waste and upcycled foods



*Significant difference (P-value <0.05) between two groups assessed by Z-test for proportion (Bonferroni adjustment)
Upcycled Foods: UF



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Table 2. Comparison of importance of food choice factors in reluctant/hesitant and inclined participants.

	Reluctant/hesitant (%)	Inclined (%)	<i>F</i> -value
<i>Health and weight control</i>			
Contain vitamin and minerals	46.53	46.54	0.998
Nutritious food	61.38	68.60	0.101
High protein content	20.00	11.78	0.010
High fibre content	17.24	17.57	0.926
Low calorie content	10.34	4.48	0.007
Low fat content	13.10	7.09	0.020
<i>Mood</i>			
Helps in coping with stress	16.67	5.06	<0.001
Keeps me awake/alert	18.75	17.45	0.717
Cheers me up	31.03	28.65	0.576
<i>Convenience</i>			
Easy to prepare	30.34	21.27	0.022
Convenient to store	63.70	52.34	0.014
Easily available in shops	59.31	65.42	0.174
<i>Sensory Appeal</i>			
Nice smells	60.27	47.01	0.005
Nice Look	44.83	26.54	<0.001
Pleasant texture	68.75	56.07	0.006
Good taste	92.47	88.22	0.144
<i>Natural Content</i>			
No additives	59.72	63.43	0.414
Natural ingredients	80.00	82.84	0.428
Certified as no chemical	81.82	86.52	0.156
Unprocessed	54.23	57.94	0.426
Preserves natural goodness	69.44	69.72	0.949
<i>Price</i>			
Not expensive	52.41	32.46	<0.001
Cheap	33.10	18.27	<0.001
Value for money	66.21	60.45	0.206
<i>Familiarity</i>			
Similar to usual food	21.38	6.16	<0.001
Familiar food	23.61	6.72	<0.001
Well-known brand	9.09	1.87	<0.001
<i>Ethical Concern</i>			
Country of origin marked	77.08	84.46	0.037
Not forbidden by my religion	7.69	4.14	0.080
Respect animal rights	74.31	86.49	<0.001
Respect human rights	76.92	85.74	0.011
<i>Environment</i>			
Environmentally friendly preparation	71.53	84.08	0.001
Local production	46.15	46.25	0.983
Environmentally friendly package	66.21	85.26	<0.001
<i>Risk perception and neophobia</i>			
No genetically modified ingredients	69.44	64.67	0.284
Familiar ingredients	60.14	52.28	<0.001
No food scare	93.01	96.27	0.092
Certification from authorities	59.44	44.47	0.001
Food label	70.83	71.96	0.789
Food that I can trust	90.91	90.09	0.770

Comparison of importance of food choice factors in reluctant/hesitant and inclined participants



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Comparison of importance of food choice factors in reluctant/hesitant and inclined participants in three different age groups: young (18–39), middle-aged (40–64), and older adults (65+)

	Young n=238			Middle aged n=327			Elderly n=115		
	Reluctant/hesitant (%)	Inclined (%)	<i>B_W</i>	Reluctant/hesitant (%)	Inclined (%)	<i>B_W</i>	Reluctant/hesitant (%)	Inclined (%)	<i>B_W</i>
<i>Health and weight control</i>									
Contain vitamin and minerals	40.35	40.88	0.943	40.12	46.64	0.733	50.00	58.14	0.451
Nutritious food	56.14	64.64	0.247	60.34	67.42	0.302	71.43	80.46	0.314
High protein content	26.32	11.05	0.005	15.52	10.86	0.317	14.29	16.09	0.819
High fibre content	22.81	14.36	0.133	13.79	17.91	0.451	7.14	23.26	0.061
Low calorie content	10.53	3.31	0.030	8.62	5.60	0.384	7.14	3.45	0.404
Low fat content	12.28	4.97	0.055	12.07	7.46	0.248	14.29	10.34	0.567
<i>Mood</i>									
Helps in coping with stress	17.86	5.52	0.004	13.79	5.24	0.019	17.86	3.49	0.010
Keeps me awake/alert	17.54	13.33	0.429	15.79	17.23	0.793	25.00	26.74	0.856
Cheers me up	31.58	31.49	0.990	36.21	26.97	0.158	21.43	27.91	0.499
<i>Convenience</i>									
Easy to prepare	42.11	29.83	0.085	20.69	18.28	0.670	21.43	12.64	0.255
Convenient to store	68.42	54.14	0.057	55.93	50.75	0.471	67.86	53.49	0.182
Easily available in shops	71.93	73.48	0.818	46.55	61.05	0.042	60.71	62.07	0.898
<i>Sensory Appeal</i>									
Nice smells	47.37	43.09	0.571	72.88	46.54	<0.001	60.71	56.32	0.683
Nice Look	42.11	24.44	0.010	48.28	25.00	<0.001	39.29	35.63	0.727
Pleasant texture	71.93	60.77	0.127	73.68	55.60	0.012	50.00	47.67	0.831
Good taste	92.98	90.06	0.506	93.22	89.55	0.391	89.29	80.23	0.274
<i>Natural Content</i>									
No additives	51.79	50.28	0.843	60.34	66.79	0.349	71.43	80.46	0.314
Natural ingredients	63.16	72.38	0.185	91.38	87.31	0.387	89.29	90.80	0.812
Certified as no chemical	75.44	79.89	0.474	80.70	89.18	0.077	96.30	91.95	0.440
Unprocessed	37.50	43.09	0.458	66.07	61.80	0.548	60.71	77.01	0.091
Preserves natural goodness	57.89	61.88	0.591	75.44	70.04	0.415	78.57	85.06	0.422
<i>Price</i>									
Not expensive	63.16	37.02	0.001	44.83	30.22	0.032	42.86	29.89	0.204
Cheap	42.11	21.67	0.002	31.03	16.60	0.011	14.29	16.28	0.802
Value for money	70.18	68.51	0.813	60.34	54.85	0.445	67.86	60.92	0.509
<i>Familiarity</i>									
Similar to usual food	29.82	8.29	<0.001	13.79	4.85	0.012	21.43	5.75	0.014
Familiar food	24.56	8.84	0.002	17.54	4.48	<0.001	28.57	9.20	0.010
Well-known brand	14.29	1.66	<0.001	5.26	1.12	0.035	7.14	4.60	0.598
<i>Ethical Concerns</i>									
Country of origin marked	59.65	76.67	0.012	87.72	87.69	0.995	89.29	90.70	0.826
Not forbidden by my religion	10.53	4.44	0.090	7.14	3.77	0.262	3.57	4.60	0.817
Respect animal rights	73.68	87.85	0.010	70.18	85.66	0.005	82.14	86.21	0.598
Respect human rights	76.79	83.43	0.260	77.19	87.27	0.050	75.00	85.88	0.182
<i>Environment</i>									
Environmentally friendly preparation	70.18	82.32	0.048	70.18	84.70	0.009	75.00	85.88	0.182
Local	31.58	44.75	0.078	55.36	43.98	0.121	57.14	56.32	0.939
Environmentally friendly package	54.39	82.87	<0.001	74.14	85.45	0.036	71.43	89.66	0.018
<i>Risk perception and neophobia</i>									
Genetically modified ingredients	57.89	50.83	0.352	70.18	70.32	0.958	89.29	75.58	0.122
Familiar ingredients	57.14	32.04	0.001	59.65	31.72	<0.001	64.29	34.48	0.005
No food scare	91.23	94.48	0.379	94.64	97.01	0.373	92.86	97.70	0.224
Certification from authorities	66.67	38.89	<0.001	51.79	47.57	0.566	57.14	46.51	0.328
Food label	61.40	60.00	0.850	70.18	77.61	0.231	89.29	79.31	0.235
Food that I can trust	87.72	86.67	0.837	91.07	91.79	0.859	96.43	91.95	0.418



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Risk perception and neophobia

	Reluctant/hesitant (%)	Inclined (%)	*P _{value}
Absence of genetically modified ingredients	69.44	64.67	0.284
Familiar ingredients	60.14	32.28	<0.001
Absence of contamination	93.01	96.27	0.092
Certification from authorities	59.44	44.47	0.001
Food label	70.83	71.96	0.789
Trustable food	90.91	90.09	0.770

* Z-test for proportion comparison (Bonferroni adjustment)

- In all age groups, the importance of familiarity of ingredients differed between Reluctant/hesitant and Inclined groups.
- In young age group, the higher proportion of Reluctant/hesitant participants considered certification as important factors compared to Inclined participants.



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Sensory Appeal

	Reluctant/hesitant (%)	Inclined (%)	*P _{value}
Nice smells	60.27	47.01	0.005
Nice Look	44.83	26.54	<0.001
Pleasant texture	68.75	56.07	0.006
Good taste	92.47	88.22	0.144

* Z-test for proportion comparison (Bonferroni adjustment)

- In middle age group, the higher proportion of Reluctant/hesitant participants believed in the importance nice smell, nice look and pleasant texture compared to Inclined participants.



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Health and weight control

	Reluctant/hesitant (%)	Inclined (%)	*P _{value}
Contain vitamin and minerals	46.53	46.54	0.998
Nutritious food	61.38	68.60	0.101
High protein content	20.00	11.78	0.010
High fibre content	17.24	17.57	0.926
Low calorie content	10.34	4.48	0.007
Low fat content	13.10	7.09	0.020

* Z-test for proportion comparison (Bonferroni adjustment)

- In the young age group, there was a significant difference between Reluctant/hesitant and Inclined groups for the importance of high protein, and low-calorie content



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Environmental concern

	Reluctant/hesitant (%)	Inclined (%)	*P _{value}
Environmentally friendly preparation	71.53	84.08	0.001
Local production	46.15	46.25	0.983
Environmentally friendly package	66.21	85.26	<0.001

* Z-test for proportion comparison (Bonferroni adjustment)

- In both young and middle age groups, the proportion of those who considered environmentally friendly preparation and packaging as importance factors were different between Reluctant/hesitant and Inclined groups



Association between importance of food choice factors and reluctancy or hesitancy towards upcycled food consumption

	Model 1		Model 2	
	OR (95%CI)	P-value	OR (95%CI)	P-value
<i>Health and weight control</i>				
Contain vitamin and minerals	0.96 (0.58, 1.60)	0.880	0.97 (0.57, 1.63)	0.900
Nutritious food	0.57 (0.32, 1.01)	0.056	0.58 (0.32, 1.06)	0.075
High protein content	1.87 (1.10, 3.17)	0.021	1.89 (1.08, 3.25)	0.025
High fibre content	0.96 (0.56, 1.65)	0.886	0.96 (0.55, 1.67)	0.882
Low calorie content	2.35 (1.13, 4.89)	0.022	2.23 (1.06, 4.71)	0.035
Low fat content	1.99 (1.06, 3.72)	0.032	1.80 (0.94, 3.43)	0.075
<i>Mood</i>				
Helps in coping with stress	4.03 (2.18, 7.46)	<0.001	4.12 (2.18, 7.81)	<0.001
Keeps me awake/alert	1.23 (0.74, 2.06)	0.428	1.21 (0.71, 2.07)	0.474
Cheers me up	1.13 (0.72, 1.78)	0.593	1.22 (0.77, 1.95)	0.395
<i>Convenience</i>				
Easy to prepare	1.86 (1.12, 3.10)	0.017	1.78 (1.05, 3.02)	0.033
Convenient to store	1.39 (0.77, 2.52)	0.272	1.53 (0.83, 2.83)	0.176
Easily available in shops	0.65 (0.37, 1.17)	0.150	0.61 (0.34, 1.11)	0.106
<i>Sensory Appeal</i>				
Nice smells	2.67 (1.46, 4.89)	0.001	2.71 (1.46, 5.03)	0.002
Nice Look	3.28 (1.97, 5.48)	<0.001	3.10 (1.85, 5.22)	<0.001
Pleasant texture	2.12 (1.18, 3.83)	0.012	2.25 (1.23, 4.12)	0.009
Good taste	1.44 (0.29, 7.20)	0.658	1.24 (0.24, 6.29)	0.795
<i>Natural Content</i>				
No additives	1.05 (0.61, 1.81)	0.847	1.09 (0.63, 1.89)	0.767
Natural ingredients	0.95 (0.46, 1.97)	0.884	0.99 (0.47, 2.10)	0.987
Certified as no chemical	0.86 (0.44, 1.70)	0.667	0.90 (0.45, 1.81)	0.766
Unprocessed	0.91 (0.57, 1.46)	0.703	0.95 (0.59, 1.54)	0.841
Preserves natural goodness	1.24 (0.64, 2.40)	0.521	1.17 (0.60, 2.28)	0.648
<i>Price</i>				
Inexpensive	1.92 (1.13, 3.25)	0.015	2.02 (1.16, 3.51)	0.013
Cheap	2.26 (1.39, 3.69)	0.001	2.14 (1.29, 3.56)	0.003
Value for money	1.08 (0.53, 2.21)	0.825	1.13 (0.53, 2.37)	0.755
<i>Familiarity</i>				
Similar to usual food	4.55 (2.59, 7.99)	<0.001	4.70 (2.62, 8.45)	<0.001
Familiar food	4.66 (2.67, 8.11)	<0.001	4.82 (2.70, 8.59)	<0.001
Well-known brand	5.77 (2.41, 13.81)	<0.001	5.73 (2.33, 14.10)	<0.001
<i>Ethical Concern</i>				
Country of origin marked	0.73 (0.39, 1.40)	0.346	0.83 (0.43, 1.61)	0.586
Religion approved/permisssible by	1.69 (0.78, 3.68)	0.182	1.72 (0.78, 3.76)	0.177
Respect animal rights	0.34 (0.17, 0.67)	0.002	0.38 (0.19, 0.77)	0.007
Respect human rights	0.43 (0.20, 0.91)	0.028	0.45 (0.20, 0.97)	0.043
<i>Environment</i>				
Environmentally friendly preparation	0.34 (0.17, 0.69)	0.003	0.31 (0.15, 0.65)	0.002
Local	0.84 (0.50, 1.40)	0.503	0.84 (0.50, 1.41)	0.507
Environmentally friendly package	0.31 (0.17, 0.58)	<0.001	0.29 (0.15, 0.55)	<0.001
<i>Risk perception and neophobia</i>				
Genetically modified ingredients	1.25 (0.78, 2.01)	0.353	1.31 (0.80, 2.13)	0.281
Familiar ingredients	3.16 (1.96, 5.11)	<0.001	3.53 (2.15, 5.82)	<0.001
No food scare/contamination	0.76 (0.22, 2.63)	0.664	0.76 (0.22, 2.63)	0.664
Certification from authorities	1.63 (1.02, 2.59)	0.041	1.51 (0.94, 2.44)	0.090
Food label	0.80 (0.45, 1.40)	0.430	0.79 (0.45, 1.41)	0.429
Trustable food	0.85 (0.22, 3.31)	0.816	0.73 (0.19, 2.90)	0.659

Model 1 adjusted for age and gender

Model 2 adjusted for model 1 and education and employment status



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Association between importance of food choice factors and reluctance or hesitation towards upcycled food

	Odds ratio (95%CI)	*P _{value}
Familiar ingredients	3.53 (2.15, 5.82)	<0.001
Pleasant texture	2.25 (1.23, 4.12)	0.009
High protein content	1.88 (1.08, 3.25)	0.025
Environmentally friendly preparation	0.31 (0.15, 0.65)	0.002

* Logistic regression adjusted for age, gender, education and employment status



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In conclusion:

- **People are interested in upcycled foods, but some health, sensory and risk perception factors influence their choices**
- **Upcycled food manufacturers and researchers should consider consumer perspectives and needs to meet their expectations and achieve upcycled food acceptability**



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Thank you