

Consumer Preference Structure for Upcycled Ingredients: Do Beliefs Matter? Evidence from a Stated Preference Survey

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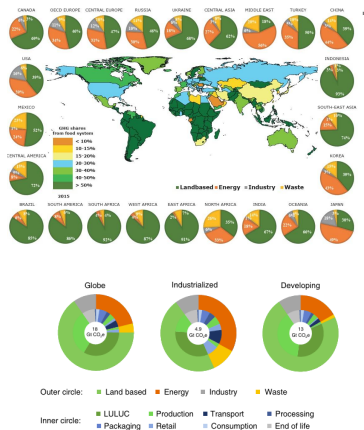


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Introduction: Current Challenges in the Agri-Food System

- Climate change and resource scarcity
- Reduction of natural resource use and food waste
- Food loss and waste and its links to food security, nutrition and food security environment sustainability (FAO, 2019)



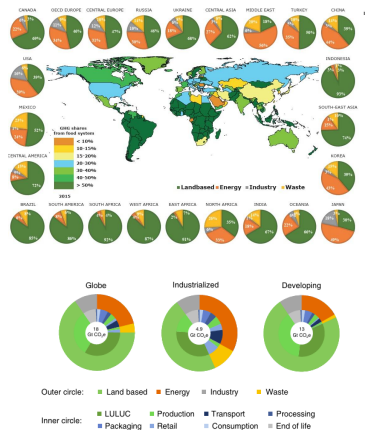
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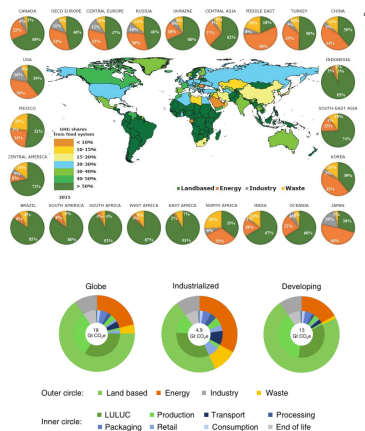
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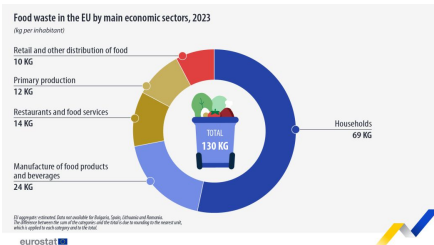
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- Sustainable Development Goal Target 12.3 "Responsible Consumption and Production" (UN Agenda 2030): to halve per capita global food waste at the retail and consumer level by 2030 and reduce food losses along the food production and supply chains



Source: Eurostat, 2025

- From linear to circular economy

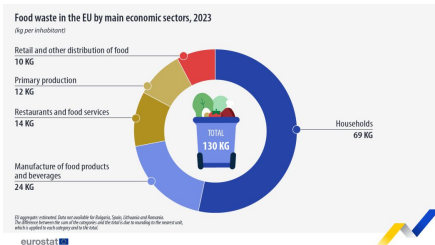


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Introduction: Upcycled foods and Upcycled ingredients

- Upcycled Foods Association (UFA)
- "Upcycled foods are defined as products made from ingredients that would otherwise not be consumed, sourced and produced through verifiable supply chains, and having a positive" impact on the environment
 - Food Ingredients
 - Food Products
 - Beverage
 - Pet Food
 - Cosmetics
 - Home and personal care products



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Introduction: Consumers and upcycled foods?

- Consumers may be sceptical about consuming upcycled foods, or they may value these products less than conventional ones (Grasso et al., 2023; Lu et al., 2024; Peschel and Aschemann-Witzel, 2020)
- Socio-demographic and attitudinal factors shift consumer preference structure for upcycled foods (Coderoni and Perito, 2020; Grasso and Asioli, 2020; Peschel and Aschemann-Witzel 2020)
- Type of upcycled ingredients, e.g. animal or vegetal origin (Edenbrandt and Lagerkvist 2024; Hellali, Korai, et al. 2023)
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- What about the same upcycled ingredient used in different products?
 - Upcycled ingredients derived from food production waste are used in other industries
 - Consumer preference for ingredients in new food technologies can vary depending on how they are consumed, es., use of insect-based foods (Giotis and Drichoutis 2021; Sogari et al. 2019)
- What about other product information?
 - Interaction of upcycled ingredient use with sustainable labels/claims?
- What about food beliefs?



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- Online survey with a Discrete Choice Experiment (DCE) in Fall 2025 on an Italian sample of 1322 individuals
- Elicitation of consumer preferences for Upcycled ingredients and product characteristics
- Between-subject approach: same upcycled ingredient for different uses
 - Direct Ingestion Treatment (DIT)
 - Topical Application Treatment (TAT)
 - Indirect Ingestion Treatment (IIT)



- European Union is the leading producer, consumer and exporter of olive oil (European Commission, 2025)
- Olive oil production generates large volumes of solid and liquid waste (Teksoy and Sen, 2025)
- Production of by-products and/or secondary raw materials
 - Vegetation waters
 - Pomace
 - Olive Pit
 - Olive leaves



Materials and Methods: case study of Olive Oil industry

- Olive Leaves: antioxidant properties
- Nutraceutical Industry
 - Multivitamin supplement (DIT)
 - Lotions (TAT)
 - Supplement of animal feed (IIT)
 - enhancing the quality of both meat and dairy products from sheeps (Bolletta et al. 2022)
- Common upcycled ingredient (Coderoni and Perito, 2020; Coderoni and Perito, 2021)



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Materials and Methods: Choice Experiment Design

- Fractional Factorial Orthogonal Design
- Twenty-four choice tasks
- Three blocks of eight choice tasks
- Cheap talk script to reduce hypothetical bias

Attribute	Levels	Logo
Ingredients	• With olive leaf extract	
	• With "upcycled" olive leaf extract	
Zero Waste to Landfill Label	• No label	
	• Zero Waste to Landfill	
Organic Certification	• Multivitamin supplement, Pecorino cheese: EU Organic Logo	
	• Body lotion: ECOCERT Cosmos Organic	
Price	• DIT: €7.50, €11.00, €14.50, €18.00 • TAT: €5.50, €9.00, €12.50, €16.00 • IIT: €5.00, €5.90, €6.80, €7.70	



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Materials and Methods: Choice Experiment Design

**Multivitamin
supplement
(Direct Ingestion)**



437 respondents

**Body lotion
(Topical
Application)**



433 respondents

**Pecorino cheese
(Indirect Ingestion
via animal feed)**



452 respondents

- Sustainability-related information is expected to positively interact with the upcycled ingredient attribute, enhancing consumer acceptance:

$$H_{01} : \beta_{\text{interaction}} \leq 0$$

$$H_{13} : \beta_{\text{interaction}} > 0$$

- Consumers will attribute a higher value to the "upcycled" ingredient attribute when it is topical applied or indirect ingest compared to directly ingest:

$$H_{02} : mWTP_{\text{upcycled, DIT}} \geq mWTP_{\text{upcycled, TAT}}$$

$$H_{12} : mWTP_{\text{upcycled, DIT}} < mWTP_{\text{upcycled, TAT}}$$

$$H_{03} : mWTP_{\text{upcycled, DIT}} \geq mWTP_{\text{upcycled, IIT}}$$

$$H_{13} : mWTP_{\text{upcycled, DIT}} < mWTP_{\text{upcycled, IIT}}$$



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- Correlated Mixed Logit Model in WTP space

$$\begin{aligned} U_{njt} = & \text{NOBUY}_{njt} + \pi_n \left(-\text{PRICE}_{njt} + \beta_{n,\text{OLIVE}} \text{OLIVE}_{njt} \right. \\ & + \beta_{n,\text{UPCYCLED}} \text{UPCYCLED}_{njt} + \beta_{n,\text{WASTE}} \text{WASTE}_{njt} \\ & + \beta_{n,\text{ORG}} \text{ORG}_{njt} \\ & + \text{int}_1(\text{UPCYCLED}_{njt} \cdot \text{WASTE}_{njt}) \\ & \left. + \text{int}_2(\text{UPCYCLED}_{njt} \cdot \text{ORG}_{njt}) \right) + \varepsilon_{njt} \end{aligned}$$

- int_1 and int_2 are used to test H_{01} .
- To test H_{02} and H_{03} :
 - Krinsky–Robb Simulation (1986) to derive bootstrapped 1000 mWTP
 - Combinatorial testing procedure of Poe et al. (2005)



Results: Model specification including socio-demographic information

- To ensure that estimated willingness-to-pay (WTP) measures are comparable across treatments, respondents are reweighted so that each product sample reflects the same population composition
- Gender and education are used to construct post-stratification weights
- Respondents are assigned post-stratification weights based on six groups defined by gender (men/women) and education (lower, secondary, higher)
- Each weight is computed as the population share of the group divided by the sample share of the group



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Correlated MXL Model Estimates (weighted)

	DIT	TAT	IIT
<i>Price</i>			
Mean	-1.281***	-1.496***	-0.141*
St. Dev.	0.741***	1.123***	0.568***
<i>Olivo</i>			
Mean	2.250***	2.760***	1.385***
St. Dev.	0.691	1.288***	0.746***
<i>Upcycled</i>			
Mean	0.222	0.494	0.812***
St. Dev.	0.950*	0.222	0.166
<i>Waste</i>			
Mean	2.757***	2.604***	0.863***
St. Dev.	3.330***	3.086***	0.928***
<i>Organic</i>			
Mean	1.827***	0.830**	0.184
St. Dev.	1.862***	2.819***	0.790***
No-buy	-6.219***	-4.307***	-8.680***
<i>Interaction terms</i>			
Upcycled × Waste	2.401***	1.498***	0.109
Upcycled × Organic	0.153	0.834	0.156

Results: Poe test (2005)

$$I(m\hat{WTP}_{upcycledolive}) = \frac{\hat{WTP}_{upcycled}^{(r)}}{\hat{WTP}_{olive}^{(r)}}$$

Comparison	p-value (two-sided)
TAT vs DIT	0.691
TAT vs IIT	0.762
DIT vs IIT	0.850



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Belief elicitation Respondents reported, on a probabilistic scale ranging from **0% (very unlikely)** to **100% (very likely)**, how likely they believed that a product containing upcycled olive leaves would:

- reduce food waste;
- promote the circular economy;
- provide nutritional benefits;
- be safe for human consumption;
- generate environmental benefits;
- support the local economy.

Outcome variables

Posterior individual WTP estimates obtained from the Mixed Logit (WTP-space) model.



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Motivation The six belief variables exhibited substantial correlation. Principal Component Analysis (PCA) with Varimax rotation was applied.

- The first two rotated components explain approximately 70% of the total variance.

Interpretation of the components

- **PC1:** Sustainability-related beliefs (food waste reduction, circular economy, environmental benefits, local economy).
- **PC2:** Health and safety beliefs (nutritional benefits and food safety).



The retained components were used as explanatory variables in linear regressions.

$$Y_i = \alpha + \beta_1 PC1_i + \beta_2 PC2_i + \varepsilon_i$$

Separate regressions were estimated for each treatment:

- DIT (food supplement);
- TAT (body lotion);
- IIT (cheese).



Results: Beliefs and Individual WTP

Main result

- No statistically significant association between beliefs and individual WTP was found for the **food supplement (DIT)** or the **cheese (IIT)** treatments.
- A significant relationship emerged only for the **body lotion (TAT)** treatment.

TAT (Body lotion)

Variable	$\hat{\beta}_{PC1}$	$\hat{\beta}_{PC2}$	Adj. R^2
upcycled iMWTP	-0.0119***	-0.0041	0.020

PC1 represents *sustainability-related beliefs* and is statistically significant across all three WTP specifications, whereas PC2 captures *health and safety beliefs* and it is not statistically significant in any specification.



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Discussion and conclusions

- We reject H_{01} in case of DIT and TAT when interacting upcycled attribute with the information about zero waste to landfill
- We fail to reject H_{01} interacting upcycled attribute with organic production
- Sustainable messaging is more effective when tailored to the product type
- We fail to reject H_{02} and H_{03}
- Positive mWTP for upcycled olive leaves in case of the IIT: consumers are more open to upcycled ingredients in non-direct ingestion contexts
- Association with beliefs
- **To be continued!!!**



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Thank you!
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Model Fit comparison

Treatment	LL w/o Int.	LL w Int.	Δ LL	LR (df=2)	p-value	Fit improvement
DIT	-1238.720	-1231.870	6.850	13.700	0.001	Yes
TAT	-1389.670	-1387.830	1.840	3.680	0.159	No
IIT	-1319.170	-1318.820	0.350	0.700	0.705	No



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