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Not all upcycled food is created equal: What is sustainable?

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Summary

Upcycled food has been promoted as providing an environmentally, socially, and economically sustainable use of food that would otherwise be wasted. Our review of existing research examines whether upcycling food supports these three pillars of sustainability and, if so, how. While research is still limited, it suggests that upcycling food can be both environmentally friendly and cost-effective, depending on the type of food, the methods used, and what ingredients it replaces. Social benefits include job creation, increased incomes for growers, and improved job security. While not well studied, there may also be unintended negative consequences on food security from the upcycled food industry. To ensure the most sustainable use of otherwise wasted food, assessments should consider environmental, social, and economic impacts together.

Reducing food waste helps reduce the carbon footprint of the food supply chain, address resource insufficiencies, and improve food security. While preventing food waste is best, when waste is created, it ideally remains within the food supply chain rather than being disposed of .[1] Upcycling food is one way of repurposing surplus food and by-products. For example, converting unsold bread into bread flour .[2] Globally, about 40% of all food produced is wasted,[3] but the amount of upcycled surplus food or by-products is unknown. Nevertheless, upcycling food is promoted as an economical way of improving the environment and food security. Our recently published research[4] explored whether upcycling food is environmentally, socially, and economically sustainable and, if so, how. We reviewed 76 papers referring to one or more pillars of sustainability. Several positive and potentially negative sustainability themes emerged (Figure 1).

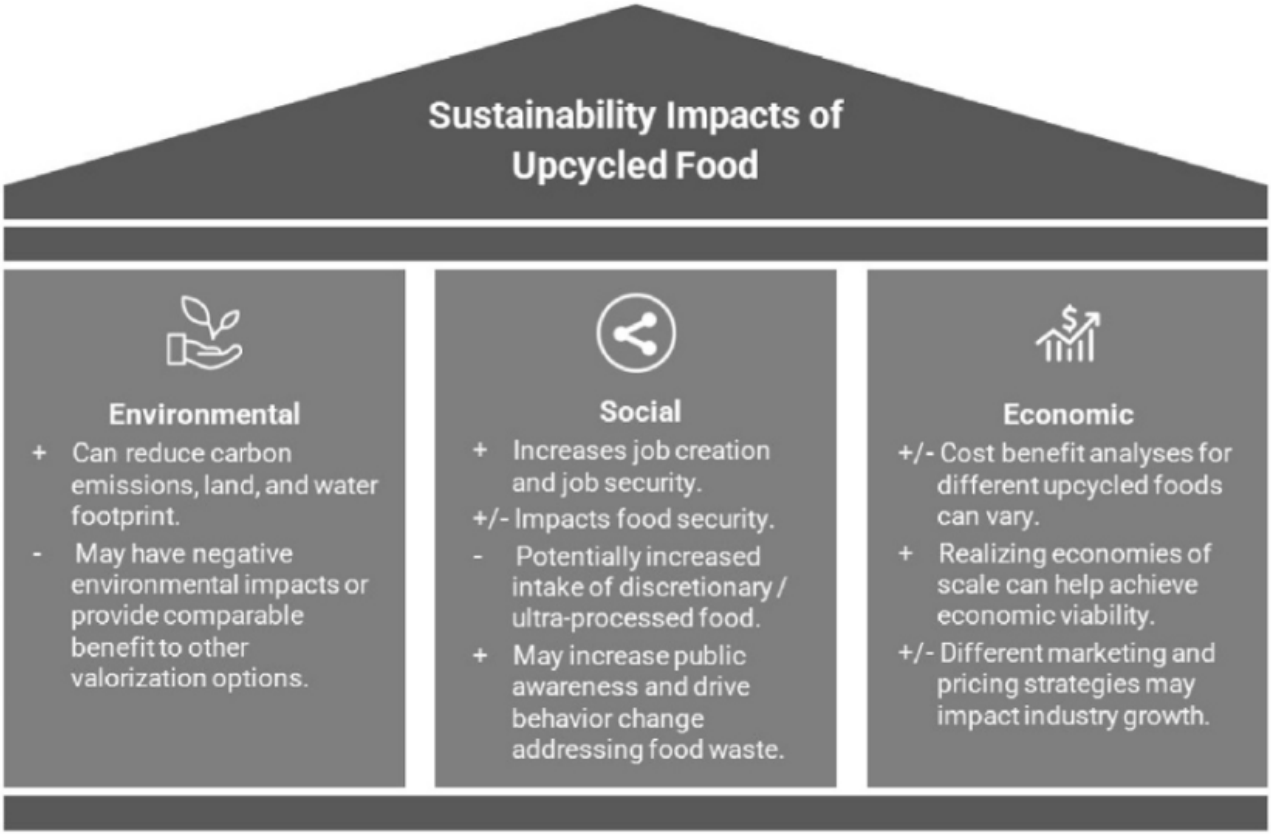

Figure 1: Positive and negative sustainability impacts of the upcycled food industry.

Environmental pillar

Upcycled food can have a lower carbon footprint than a similar conventional product. Whether there is a lower carbon footprint depends on the surplus food or by-product being upcycled, the waste destination, the ingredients being replaced, and the processing required to ensure the by-product is safe for human consumption.[5-7] For example, if a by-product needs to be dehydrated to be safe, and uses an energy source with a high carbon footprint, the upcycling process may not be environmentally beneficial.[8] In contrast, if an energy source with a lower carbon footprint is used,[9] or if the upcycled by-product replaces an imported ingredient with a higher carbon footprint, there may be environmental advantages.[10] The costs and benefits of upcycled food should also be compared with other potential uses. For instance, research shows that with the currently available processing, brewer's spent grain used as stock feed had a lower environmental impact than upcycling the grain for human consumption.[5]

Social pillar

Social equity typically refers to health, education, culture, social protection, employment, working conditions, and quality of life. The environmental benefits of upcycling food may also support society.[11] Research on social equity in the upcycled food industry is limited,[12] but when evidence does exist, it suggests that a compromise between the environmental, social, and economic benefits is required to ensure the optimal outcome for all three pillars.[6-13]

In general, upcycling food is often promoted as a way to improve food security. ‘Novel

upcycled foods' produced from ingredients previously considered unsuitable for human consumption[11] may increase the quantity of food available globally. These foods can also be financially accessible if they are not sold as premium products. However, many upcycled foods such as biscuits, chippies, and other snack foods may not meet the nutritional component of food security. Recently proposed recommendations outline how the upcycled food industry can work towards producing healthier products.[14]

Upcycled food may increase income for growers, create new jobs, and improve job security if the profits from upcycled food production are distributed fairly among food manufacturers, growers, and employees. Hypothetically, upcycled food may also serve as an educational tool by raising public awareness about food waste. By changing food waste behaviours at the individual, household, and wider community level, upcycled food may contribute to improved food security.

Upcycled food could also potentially reduce social equity. Premium-priced upcycled foods may be inaccessible to lower-income families. Upcycling edible but unmarketable fresh produce may limit efforts to reduce food waste.[15] Furthermore, upcycled food may compromise access to fresh fruit and vegetables for food banks, thus causing unintended negative impacts for people already experiencing food insecurity.[16] More sustainable and equitable uses for surplus food and by-products may be overlooked if the social impacts of upcycled food are not considered.

Economic pillar

Growing evidence supports the economic viability of the upcycled food industry.[17] However, the financial viability of individual upcycled foods varies depending on the research and development required, the cost of ensuring the proposed food or by-product is fit for purpose, and the current waste disposal costs.[18] The sustainability of upcycled food requires a reliable supply of any upcycled ingredients[19] and the economies of scale achieved by larger organisations. Customers are willing to pay for upcycled food with clear nutritional and environmental labelling.[20] Nevertheless, higher prices for environmentally sustainable products can reduce sales and product expansion. If consumers are unwilling or unable to pay for upcycled food then ultimately, upcycling food will be an unviable option.

Conclusion

Some upcycled food can be environmentally and economically viable. Evidence supporting the social benefits of upcycled food is limited and in some situations, the upcycled food industry may have an unintended negative impact on food security. Therefore, sustainability assessment tools, including social factors, are required to identify optimal outcomes. Collaboration between all stakeholders is critical to developing commercially viable technology that sustainably upcycles food.

What is new in this briefing?

- Brings together evidence about how upcycled food supports the three pillars of sustainability.
- Upcycled foods can be environmentally and economically viable depending on the product upcycled, the processes used, and the conventional ingredients replaced.
- To date, limited research has focused on the social impacts of upcycled food. However, the literature suggests that in some situations upcycled food may have unintended negative impacts on food security.

Implications for public health policy?

- Include environmental, social, and economic impacts when assessing new policies to manage food that would otherwise be wasted.
- Consider the impact that creating demand for food biomass has on food waste prevention efforts and food security.
- Focus on policies that prioritise the use of by-products in the upcycled food industry rather than foods that are edible but unmarketable.
- Support policies that help develop and commercialise environmentally friendly industrial processes that stabilise food by-products for human consumption.

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References

1. Moshtaghian H, Bolton K, Rousta K. Challenges for Upcycled Foods: Definition, Inclusion in the Food Waste Management Hierarchy and Public Acceptability. Foods. 2021;10(11):2874.
2. Kitchen R. Home Page NZ2024 [7/11/2024]. Available from: https://www.rescued.co.nz/.
3. Advisor OotPMsCS. The scale of our food waste problem. NZ: OPMCSA; 2021 [7/11/2024]. Available from: https://www.pmcsa.ac.nz/topics/food-rescue-food-waste/what-can-i-do-with-my-food-waste/why-food-waste-matters/#:~:text=Globally%2C%20an%20estimated%202.5%20billion,of%20all%20food%20that's%20produced.
4. Thorsen M, Mirosa M, Skeaff S, Goodman-Smith F, Bremer P. Upcycled food: How does it support the three pillars of sustainability? Trends in Food Science & Technology. 2024;143:104269.
5. Petit G, Korbel E, Jury V, Aider M, Rousselière S, Audebrand LK, et al. Environmental Evaluation of New Brewer's Spent Grain Preservation Pathways for Further Valorization in Human Nutrition. ACS Sustainable Chemistry & Engineering. 2020;8(47):17335-44.
6. Paraskevopoulou C, Vlachos D, Bechtsis D, Tsolakis N. An assessment of circular economy interventions in the peach canning industry. International Journal of Production Economics. 2022;249:108533.
7. Rao M, Bast A, de Boer A. Valorized Food Processing By-Products in the EU: Finding the Balance between Safety, Nutrition, and Sustainability. Sustainability. 2021;13(8):4428.
8. Scherhaufer S, Davis J, Metcalfe P, Gollnow S, Colin F, De Menna F, et al. Environmental assessment of the valorisation and recycling of selected food production side flows. Resources, Conservation and Recycling. 2020;161:104921.
9. Jain S, Gualandris J. When does upcycling mitigate climate change? The case of wet spent grains and fruit and vegetable residues in Canada. Journal of Industrial Ecology. 2023;27(2):522-34.
10. Eriksson M, Bartek L, Löfkvist K, Malefors C, Olsson ME. Environmental Assessment of Upgrading Horticultural Side Streams—The Case of Unharvested Broccoli Leaves. Sustainability. 2021;13(10):5327.
11. Aschemann-Witzel J, Asioli D, Banovic M, Perito MA, Peschel AO, Stancu V. Defining upcycled food: The dual role of upcycling in reducing food loss and waste. Trends in Food Science & Technology. 2023;132:132-7.
12. Moshtaghian H, Bolton K, Rousta K. Upcycled food choice motives and their association with hesitancy towards consumption of this type of food: a Swedish study. British Food Journal. 2024;126(1):48-63.
13. Krishnan R, Arshinder K, Agarwal R. Robust optimization of sustainable food supply chain network considering food waste valorization and supply uncertainty. Computers & Industrial Engineering. 2022;171:108499.
14. Thorsen M, Skeaff S, Goodman-Smith F, Thong B, Bremer P, Mirosa M. Upcycled foods: A nudge toward nutrition. Frontiers in Nutrition. 2022;9.
15. Leipold S, Weldner K, Hohl M. Do we need a 'circular society'? Competing narratives of the circular economy in the French food sector. Ecological Economics. 2021;187:107086.
16. Johansson N. Why is biogas production and not food donation the Swedish political priority for food waste management? Environmental Science & Policy. 2021;126:60-4.

17. Foundation EM. Cities and circular economy for food. UK: Ellen Macarthur Foundation; 2023.
18. Long TB, Looijen A, Blok V. Critical success factors for the transition to business models for sustainability in the food and beverage industry in the Netherlands. Journal of Cleaner Production. 2018;175:82-95.
19. Thorsen M, Nyhof F, Goodman-Smith F, Deutsch J, Mirosa M. Accessing Supermarket Shelves: Retail Category Managers Advice to Upcycled Food Manufacturers. Journal of Food Products Marketing. 2022;28(4):179-92.
20. Taufik D, Rood R, Dagevos H, Bouwman EP, Reinders MJ. Effects of abstract and concrete communication on moral signalling and purchase intention of upcycled food products. Cleaner and Responsible Consumption. 2023;8:100110.

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