Ex-ante LCA and cost analysis of non-thermal food technologies

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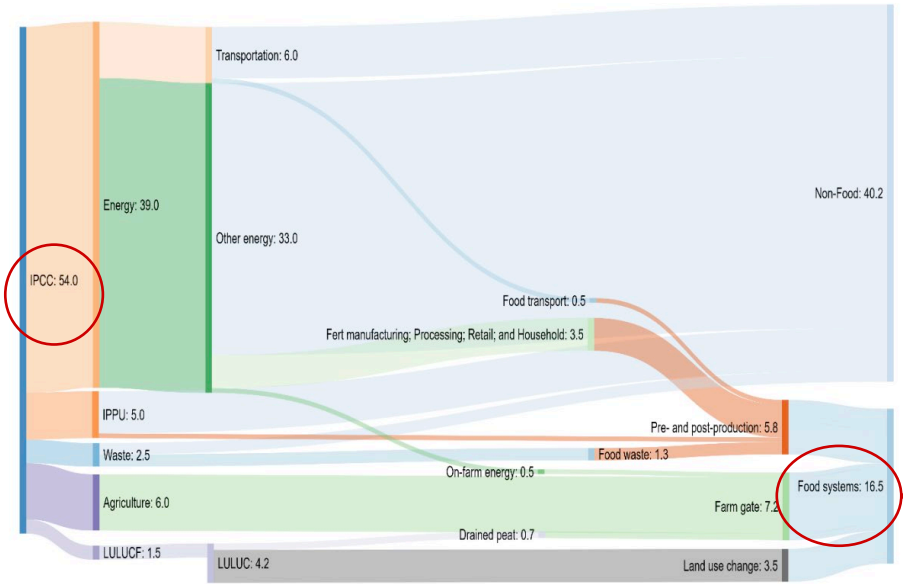
Introduction

- Food system is responsible for ~1/3 of total anthropogenic GHG emissions globally.

IPCC:
54 Gt CO_{2e}

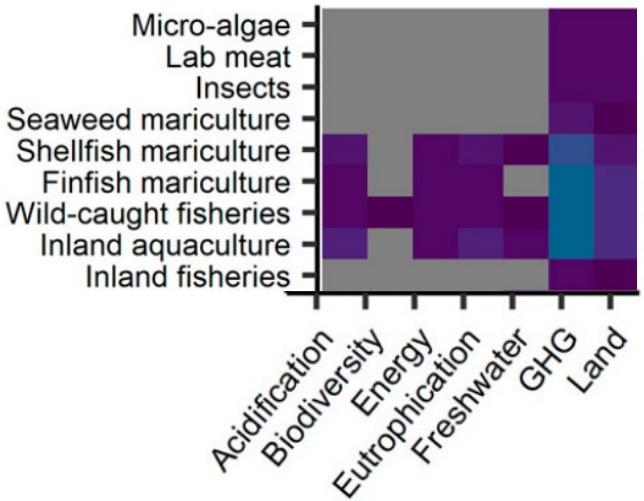


Food system:
16.5 Gt CO_{2e}

Source: FAO, 2021; IPCC, 2019

Introduction (*cont.*)

- Previous studies have focuses on only a few food products and limited environmental impact indicators.



Source: Halpern et al., 2019.

Introduction (*cont.*)

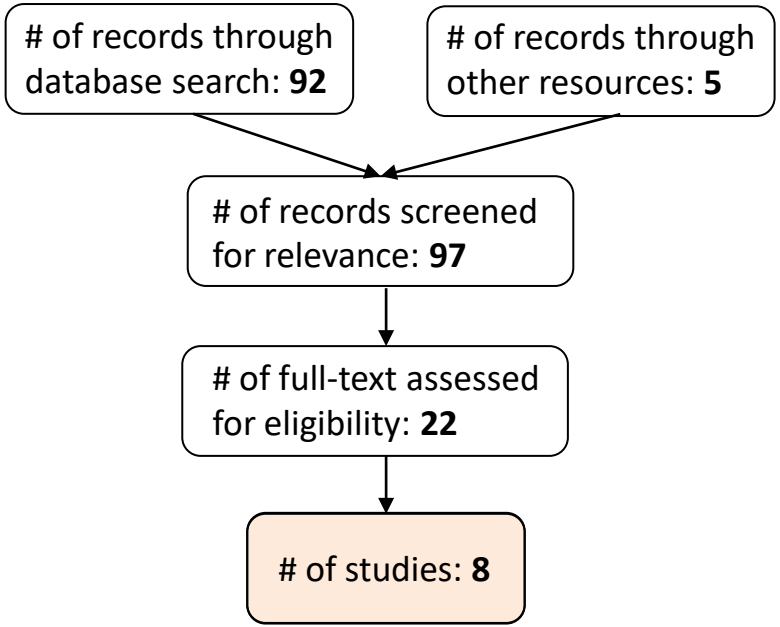
- Decarbonization in food industry requires improvements in energy- and carbon-intensive processes.

- Non-thermal technologies offer advantages including improving food quality and sustainability:
  - High Pressure Processing (HPP)
  - Pulsed Electric Field (PEF)
  - Cold Plasma (CP)
  - Ultraviolet (UV)

Source: DOE, 2022; Radhakrishnan et al., 2022

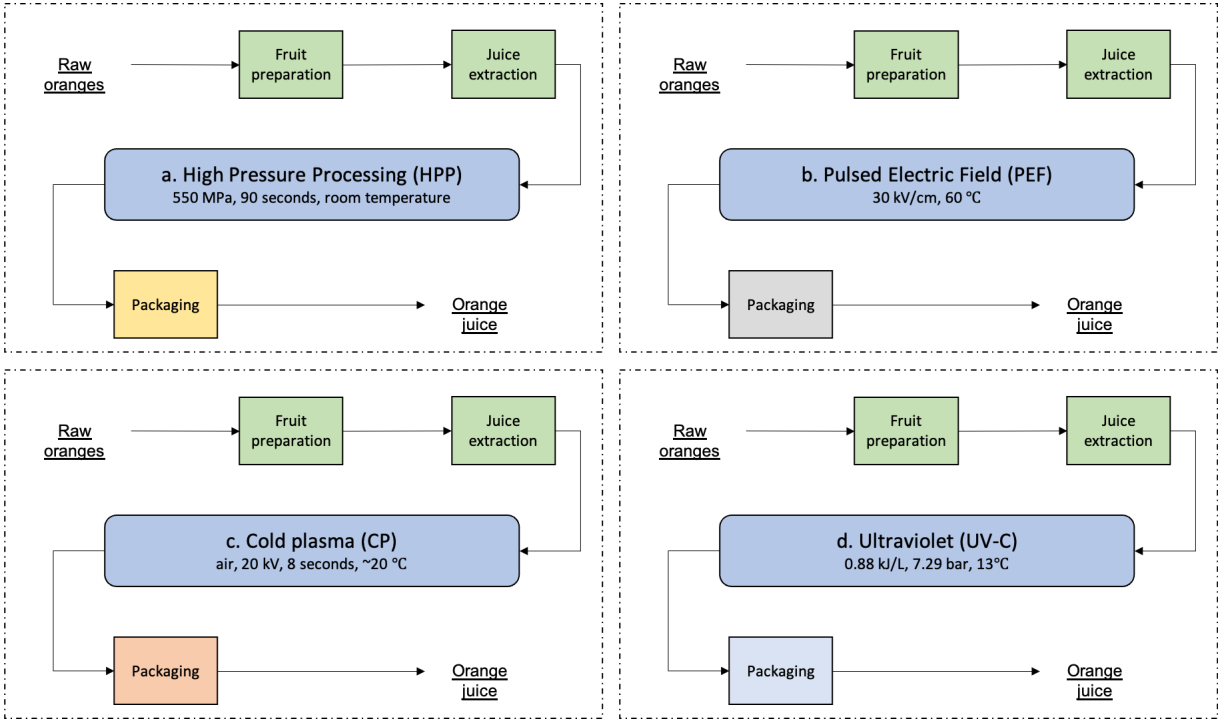
Literature review

- Limited LCA studies were conducted in non-thermal food processing.



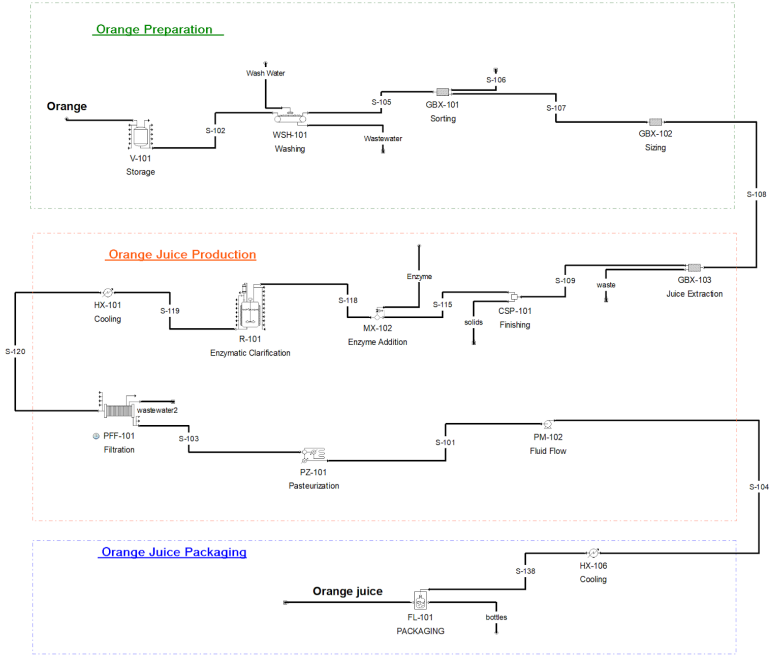
- Pulsed electric field: juice
- High pressure processing: juice
- Radio frequency: cookies & crackers
- Modified atmospheric packaging: vegetables

Case study: orange juice production



Source: Sampedro et al., 2013; Sampedro et al., 2014; Shi et al., 2011; Biancaniello et al., 2018

LCA & technoeconomic analysis (TEA)

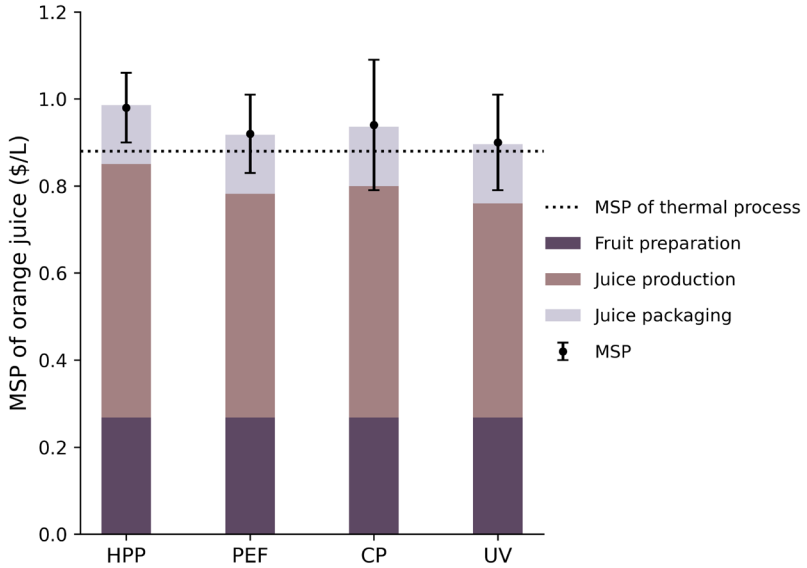


- To compare cost and GHG emissions using different non-thermal technologies in food preservation
- Functional unit: 1 L of orange juice
- System boundary: from orange plantation to juice production

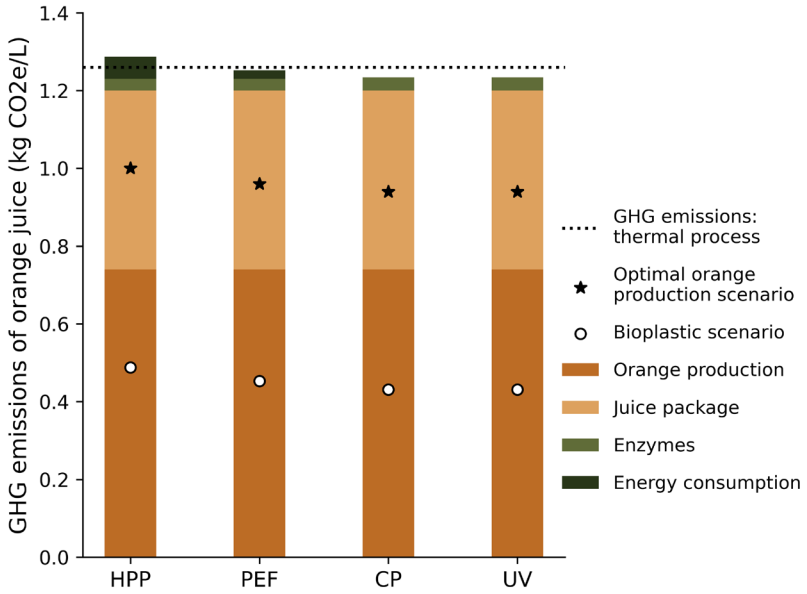
Source: Intelligen, 2023

TEA Results

- Conventional thermal process: $0.88/L
- High Pressure Processing: $0.98/L
- Pulsed Electric Field: $0.92/L
- Cold Plasma: $0.94/L
- UV-C: $0.90/L



LCA results



- Conventional thermal process: 1.26 $kgCO_{2e}/L$
- High Pressure Processing: 1.29 $kgCO_{2e}/L$
- Pulsed Electric Field: 1.25 $kgCO_{2e}/L$
- Cold Plasma: 1.23 $kgCO_{2e}/L$
- UV-C: 1.23 $kgCO_{2e}/L$

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Thank you!