

Innovations in Food and Beverage Packaging: Edible Packaging - Opportunities and Challenges

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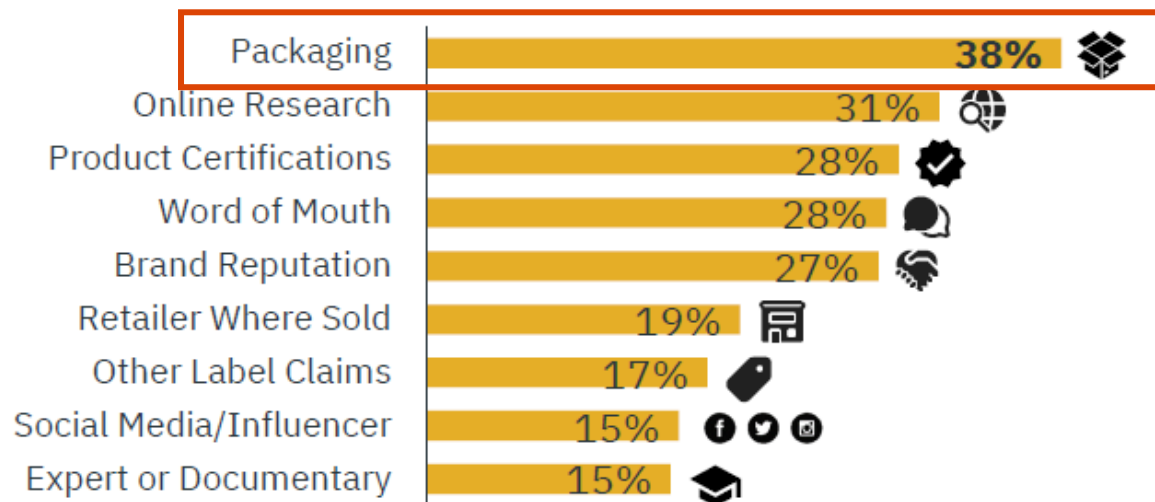
2024 Joint IEDO-AMMTO Sustainable Food and Beverage
Packaging Workshop, September 24-25, 2024, Chicago



Oregon State
University

Packaging is the most common way that shoppers do recognize sustainable products, especially among younger consumers

What factors do consumers use to recognize if products are sustainable?



Younger consumers are especially passionate about their packaging choices.

- 54%** of 18-34yo consumers always or often **base purchase decisions** on sustainable packaging
- 79%** of 18-34yo consumers are **willing to pay more** for sustainable packaging
- 68%** of 18-34yo consumers are **willing to adapt their habits/lifestyles** to accommodate a sustainable packaging purchase

2023 US Food Packaging Industry Reports

Sustainability Remains Top Concern for Packaging Products, Drives Innovations

- **Recyclable and compostable** packaging
- Incorporating **recycled and post-consumer content** into packaging
- **Light weighting and source reduction**
- **Improving shelf-life** to reduce food waste
- Increasing the performance of sustainable solutions: **aqueous barrier solutions for paper and molded fiber products** to allow wider applications while still maintaining recyclability or compostability



<https://www.freedoniagroup.com/industry-study/food-packaging-us>

Reduce



1. First, we must reduce the amount of packaging to only use what is necessary.

Reuse



2. Then, we must reuse materials whenever possible to reduce packaging waste.

Recycle



3. Once we've done those first steps to the greatest extent, there will ultimately be packaging remaining which must be recycled!

<https://recyclingpartnership.org/circular-packaging-101>

Why Edible Packaging?

Sustainable alternative to single-use plastics

- Doesn't need to be collected, processed, recycled, or disposed of
- Reduction in packaging waste

Reduce food loss and versatile

- Shelf-life extension
- Can be used in many ways: refrigerated items, single-serve products, and liquid items

Biodegradable and compostable

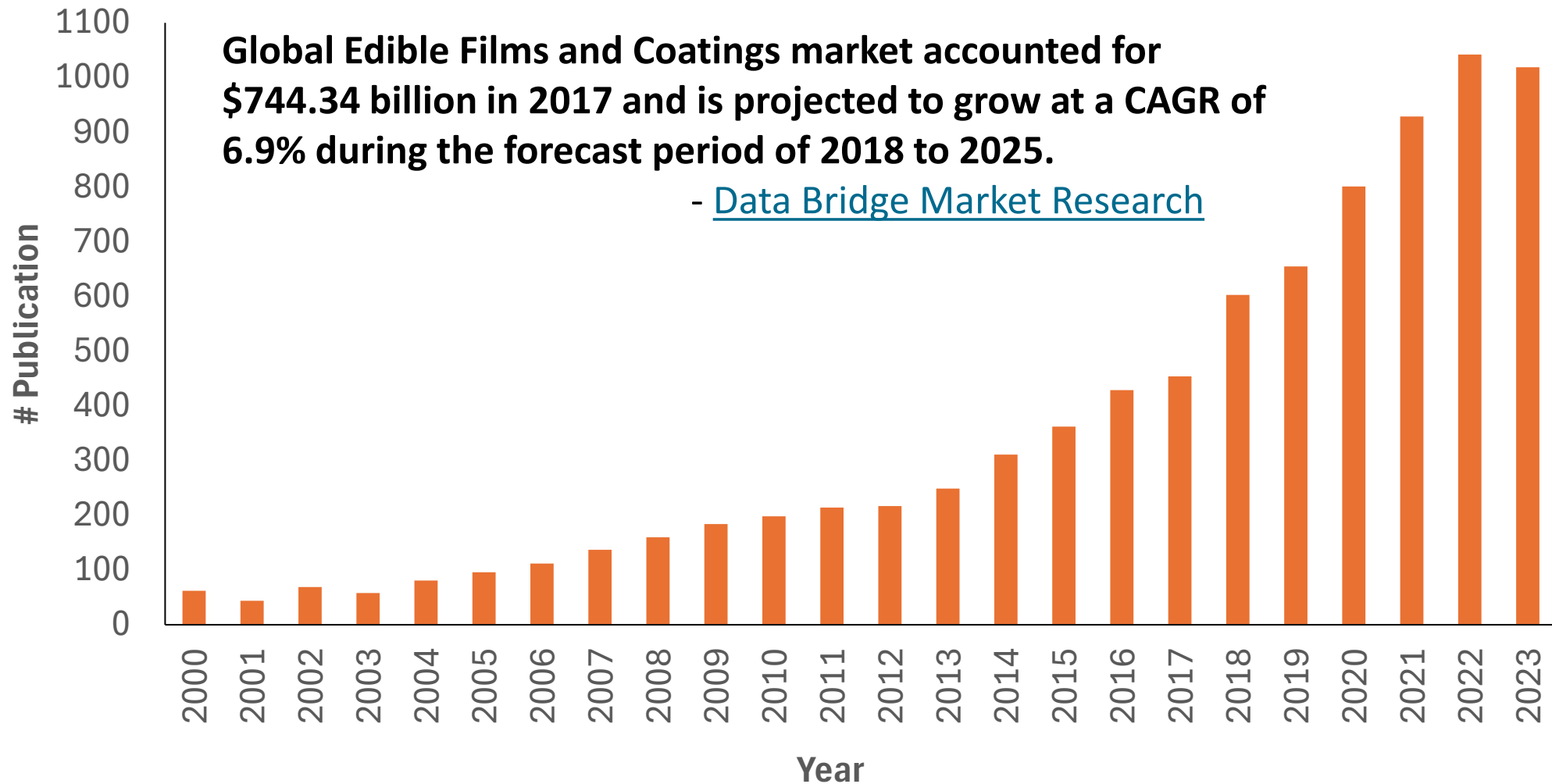
- Made from materials that can be consumed
- Same properties that make it edible also make it compostable

Benefits to food and consumer

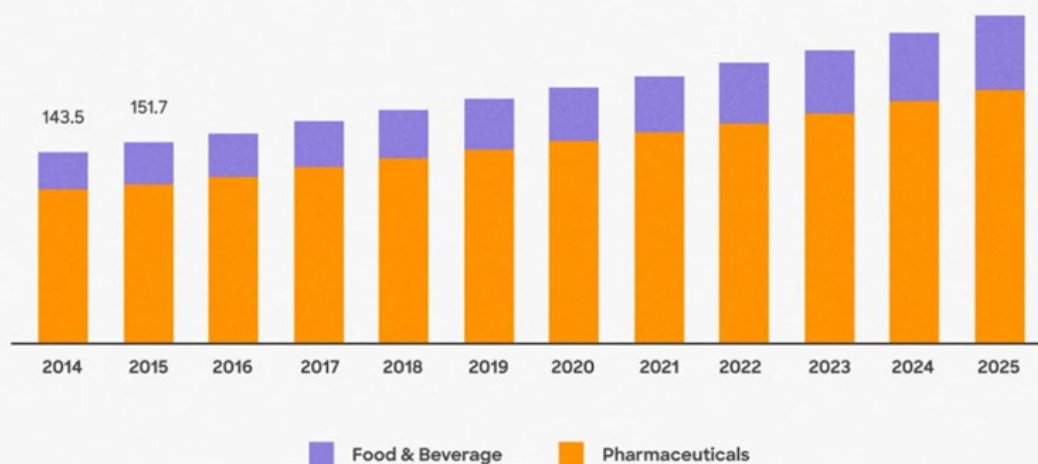
- Can carry antimicrobial and antioxidant substances, bioactive compounds, flavor and color substances
- Provide convenience to consumers



Web of Science Database Search Results - “Edible Film” from 2000 to 2023



U.S. EDIBLE PACKAGING MARKET SIZE, BY END USE, 2014 - 2025 (USD MILLION)

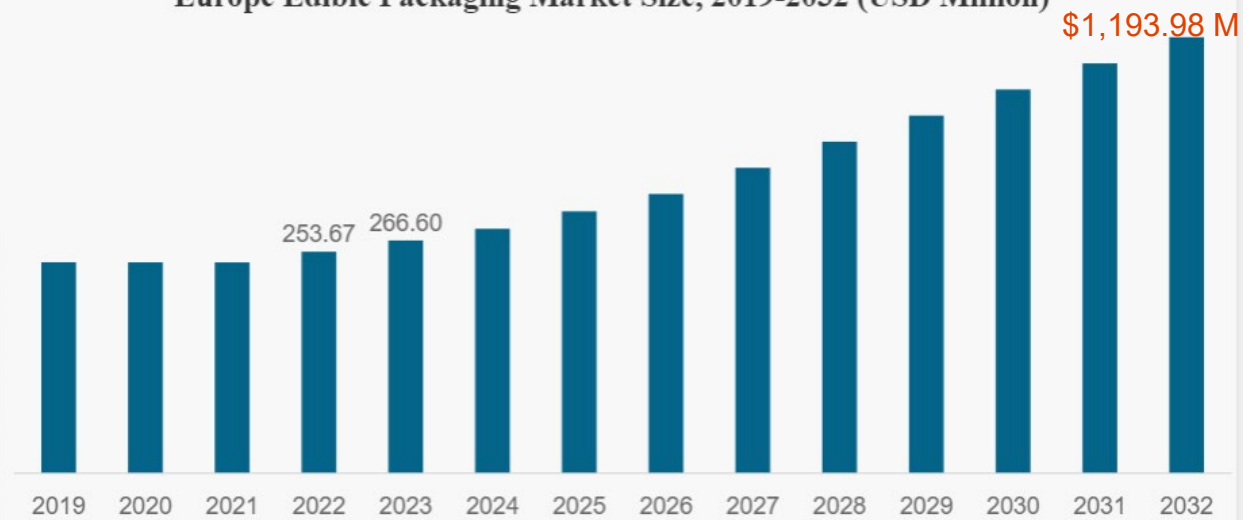


PakFactory

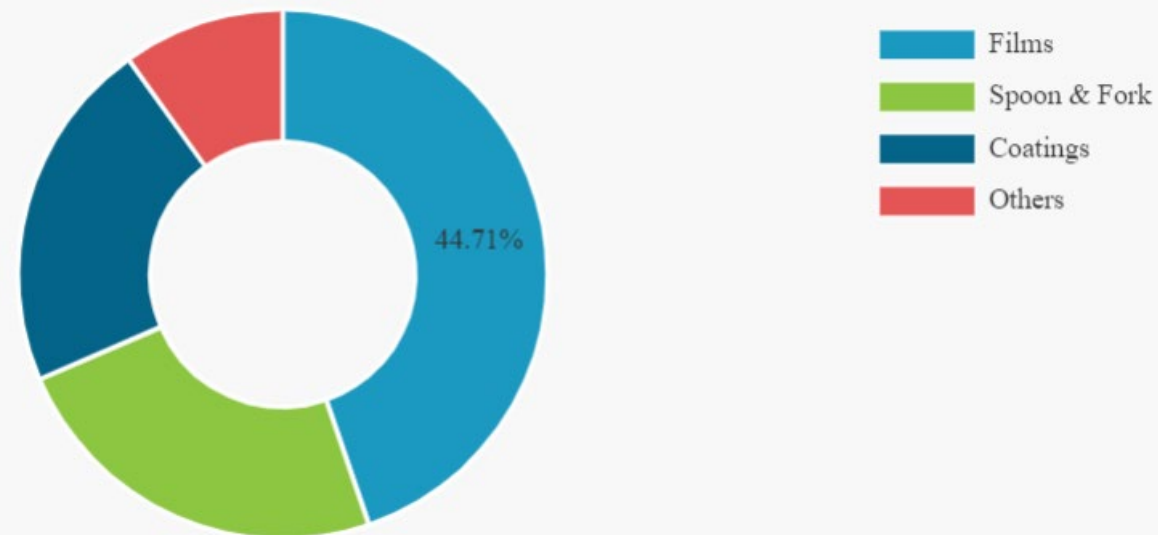
Source: [Edible Packaging Market Size, Share & Industry Analysis](#), August 2024.

[Edible Packaging – The Fast Approaching Sustainable Packaging Trend](#), June 2023

Europe Edible Packaging Market Size, 2019-2032 (USD Million)



www.fortunebusinessinsights.com

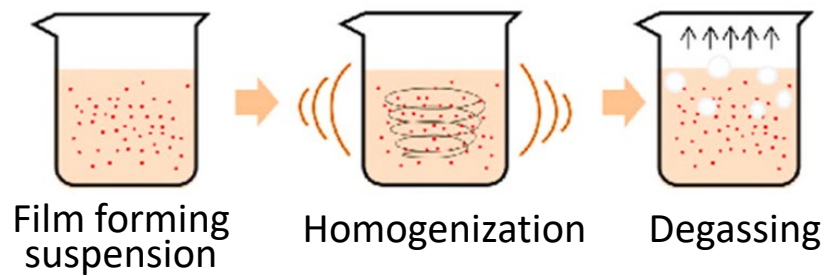


www.fortunebusinessinsights.com

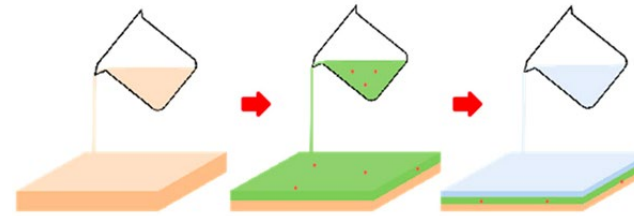
Fabrication Methods of Edible Films

Wet process

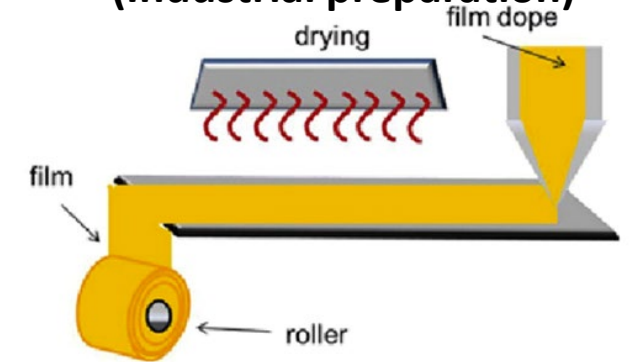
Preparation of film forming suspension



Solvent casting (Lab preparation)

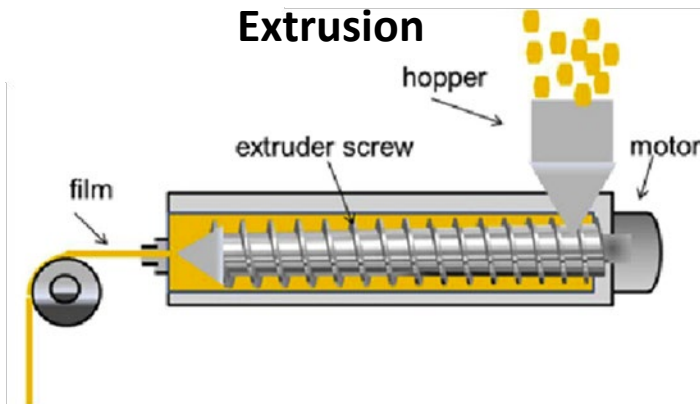


Solvent casting (Industrial preparation)

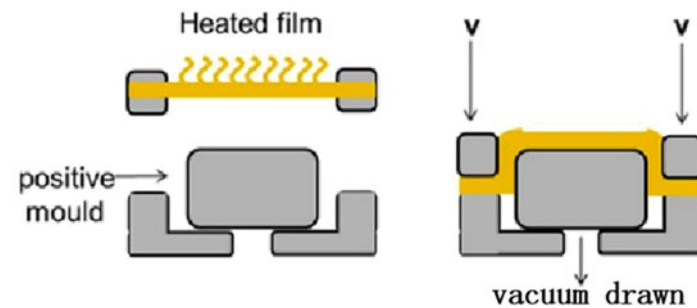


Dry process

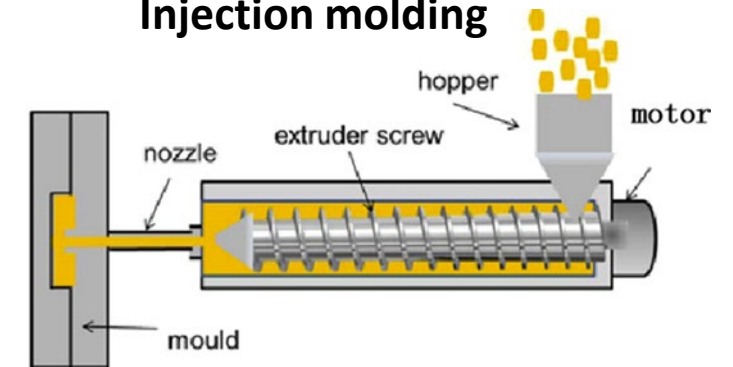
Extrusion



Thermoforming



Injection molding



Applications of Edible Films

Food

- Food wrap/pouch
- Smart and/or active packaging
- Edible oven bags
- Convenient and instant food items
- Fruit leather
- Food coatings

Biomedicine

- Wound dressing
- Tissue engineering
- Drug delivery
- Medical devices

Applications of edible films

Others

- Breath strips
- Cosmetics
- Water treatment

Edible Casings for Meat Products



Collagen casings for sausages



**Water soluble polysaccharides
films for cooked meat products**

Edible Glutinous Rice Candy Paper/Wrapper



Edible Films as Food Wrap



Fruit and Vegetable Based Films by NewGem Foods

<https://www.newgemfoods.com/>

Other Examples of Edible Packaging



Forest & Whale,
Edible and reuse container



Notpla,
Edible Sachets



Evoware,
Edible Food Wrap



Holly Grounds,
Edible noodle package



Kickstarter,
Edible utensil

Source: <https://designwanted.com/edible-packaging-four-startups>

<https://www.startus-insights.com/innovators-guide/5-top-edible-packaging-startups-out-of-300-in-packaging>

<https://meyers.com/meyers-blog/most-sustainable-food-beverage-packaging-8-examples/>

Applications of Edible Films in Non-Food Products

- Breath strips
- Neutraceutical delivery
- Pharmaceutical drug deliver
- Capsule of medicines
- Others



- The global oral thin film market is projected to expand at a CAGR of 8.9%.
- By the end of 2034, the market is forecasted to climb to a value of US \$8.7 billion.
- The market in the United States is forecasted to reach US\$ 1.07 billion in 2024.
- China is set to occupy a market share of 48.8% in East Asia in 2024.

Yahoo Finance, July 9, 2024.

Legislation on Edible Packaging

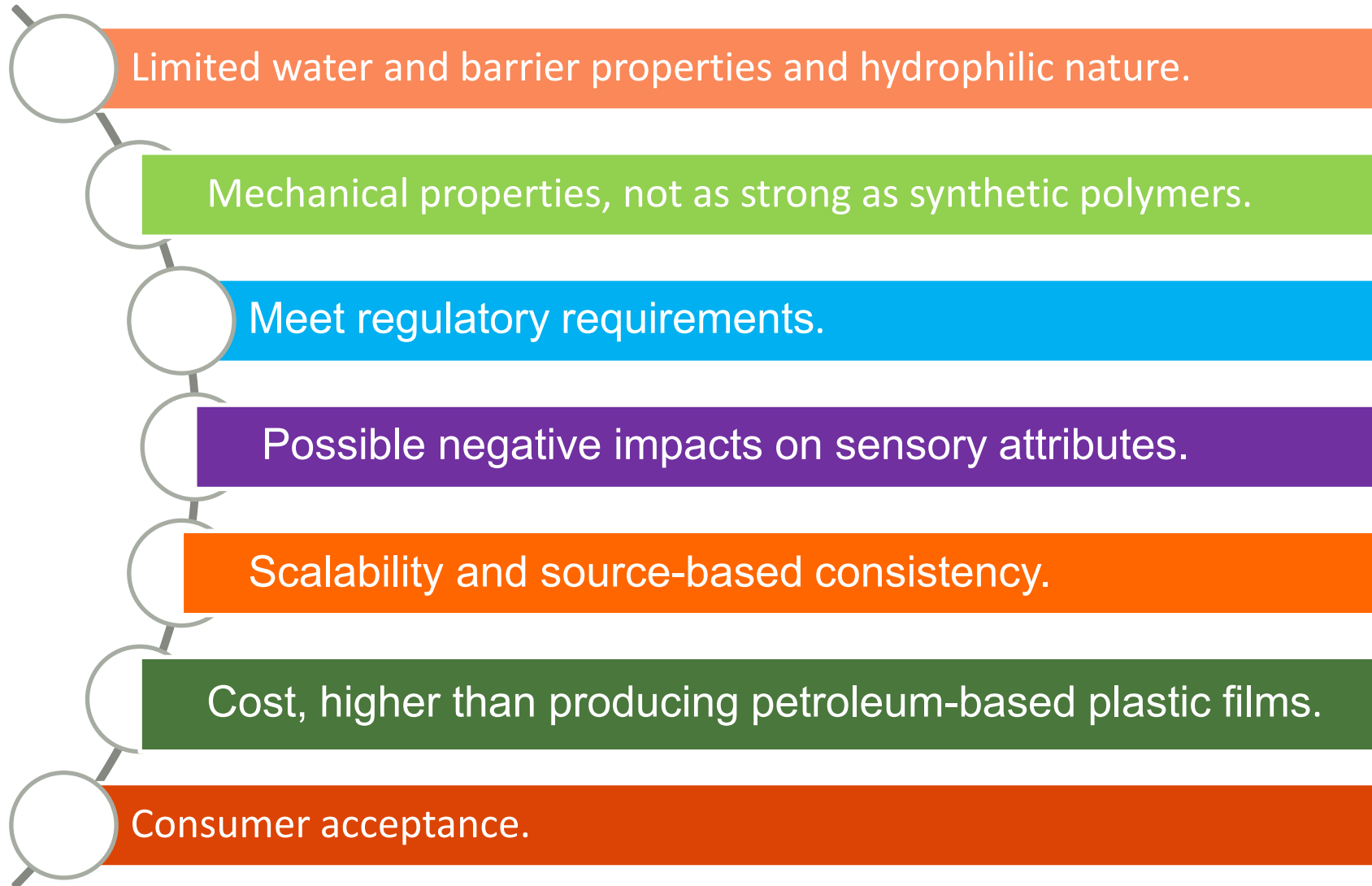
USA

- All materials are GRAS and its use in an edible film is in accordance with current GMPs and within any limitations specified by FDA.
- If the edible film material use is not currently GRAS but the manufacturer can demonstrate safety, the manufacturer may file a GRAS Affirmation Petition to FDA.

EU regulation
(EC) No.
1935/2004

- They shall not endanger human health.
- They shall not change the composition of the food in an unacceptable way.
- They shall not change taste, odor, or texture of the food.
- They shall be manufactured according to good manufacturing practice.

Challenges and Limitations in Edible Packaging



Research Efforts to Overcome the Barriers

- Improve performance of film-forming matrix to achieve desired functionality and performance for a wide range of products
- Identify novel renewable biopolymers with improved functionalities
- Reduce cost and improve manufacturing methods
- Consumer education and acceptance studies

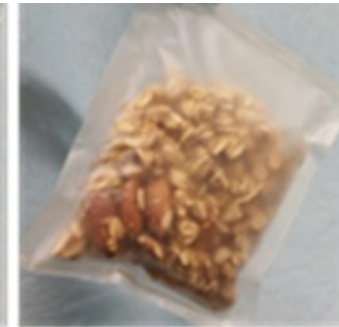
Edible & Antioxidant Single Use Oil/Condiment Pouches



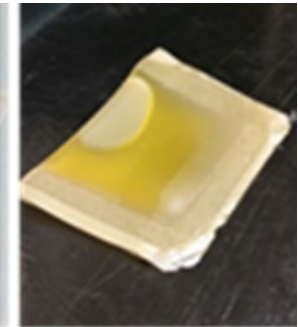
Instant noodle
seasoning



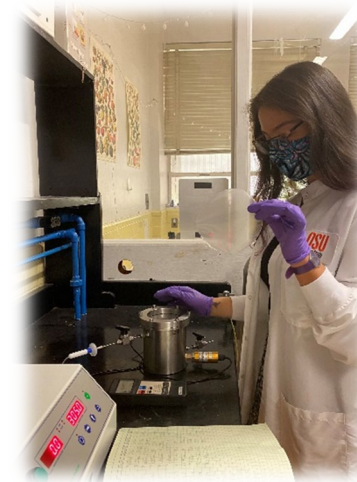
Instant coffee



Cereal

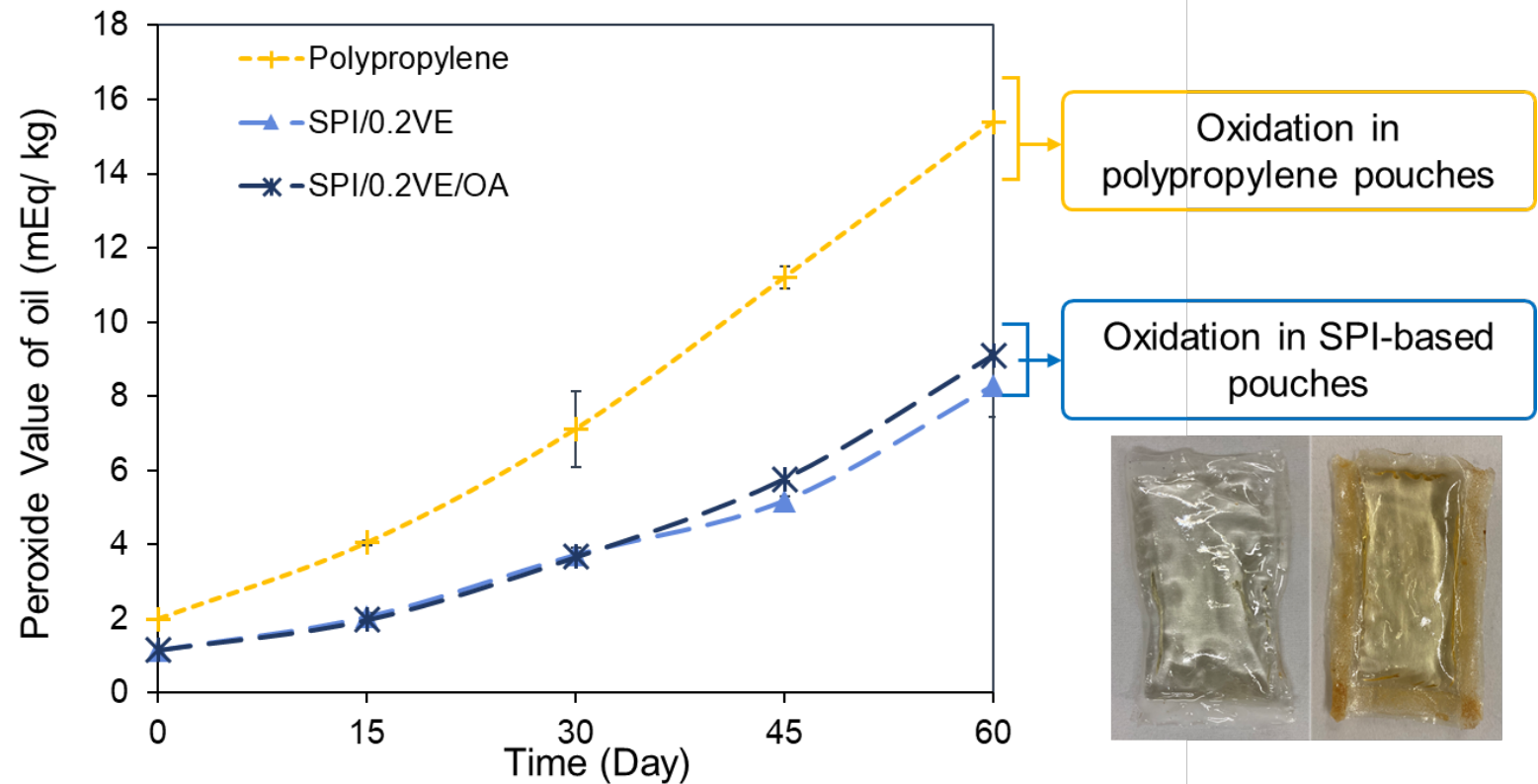


Olive oil



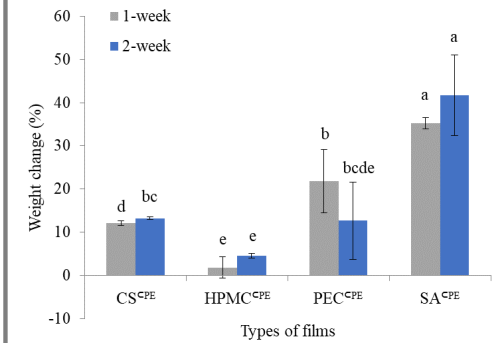
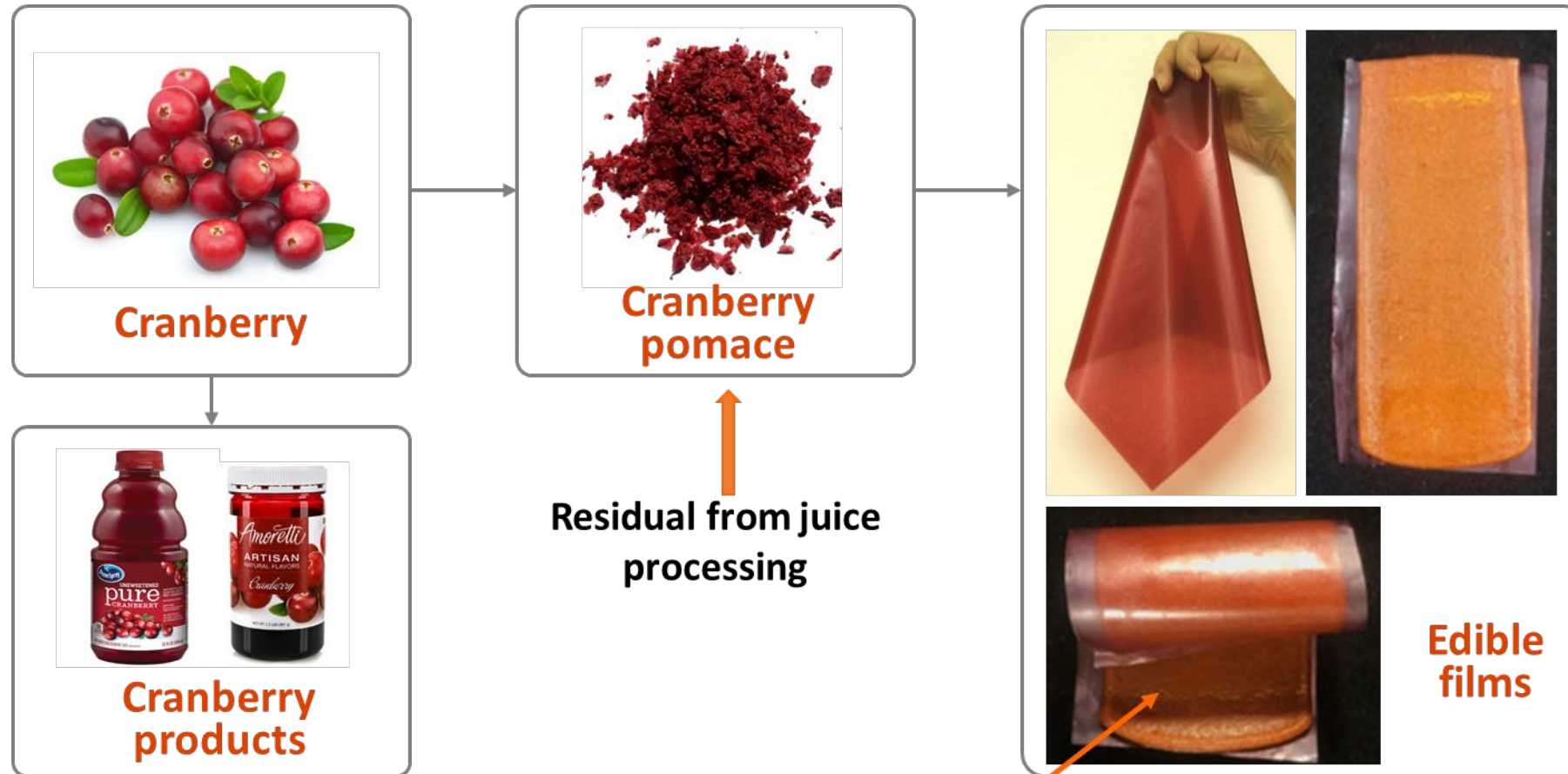
Rosenbloom & Zhao, 2021. J Food Sci. 86(1), 129-139.

Edible & Antioxidant Single Use Oil/Condiment Pouches

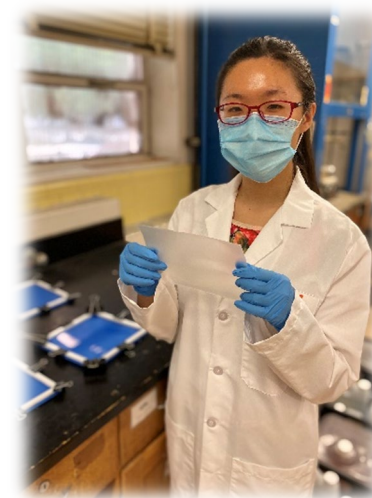


SPI = Soy protein isolate, VE = Vitamin E acetate, OA = Oleic acid

Edible Fruit Leather Wrap Produced from Pomace Extracts

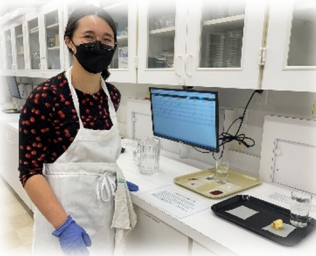


Edible Muffin/Cupcake Liners

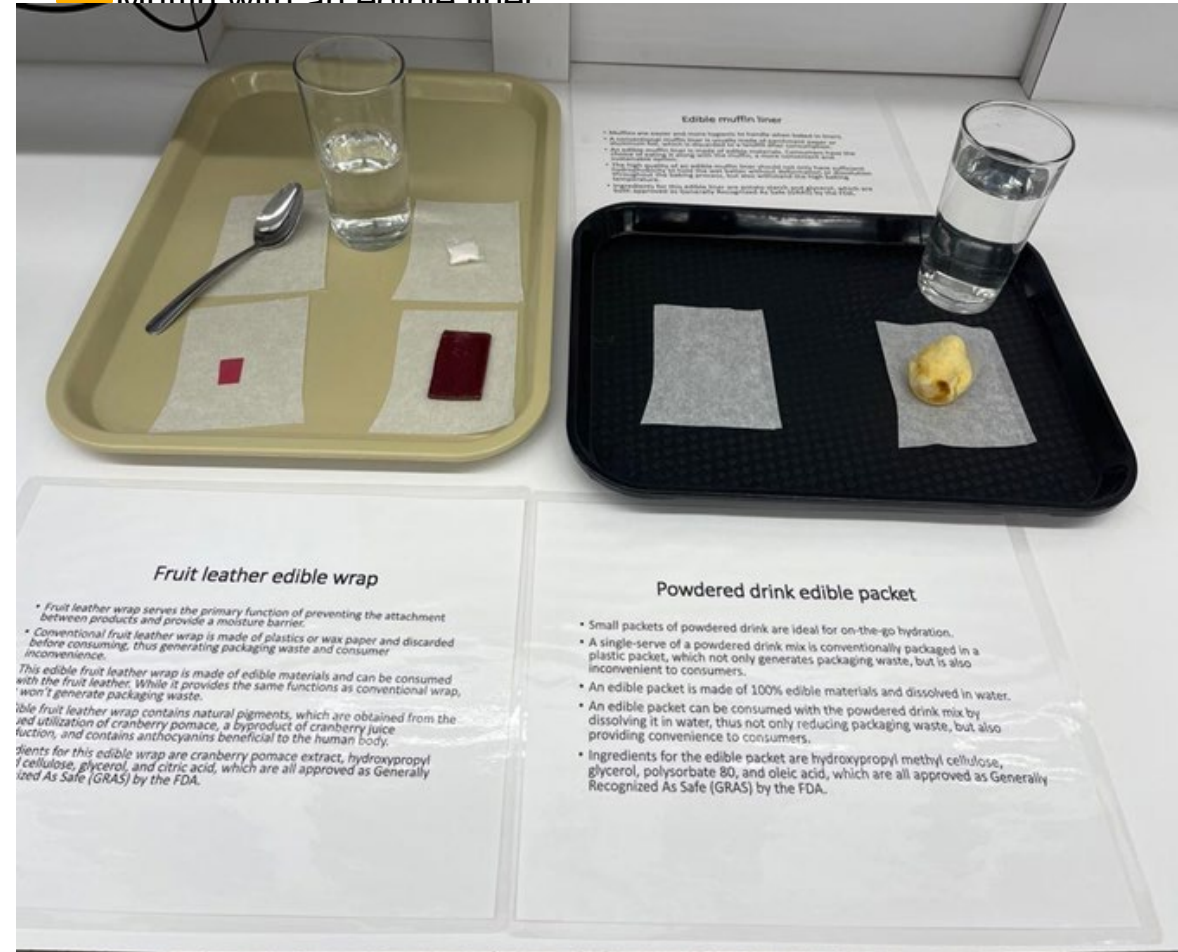


Shih & Zhao, 2021. J Food Sci. 89(4), 2423-2437. Food Packaging & Shelf Life. 28, 100655.

Consumer Response to Edible Packaging



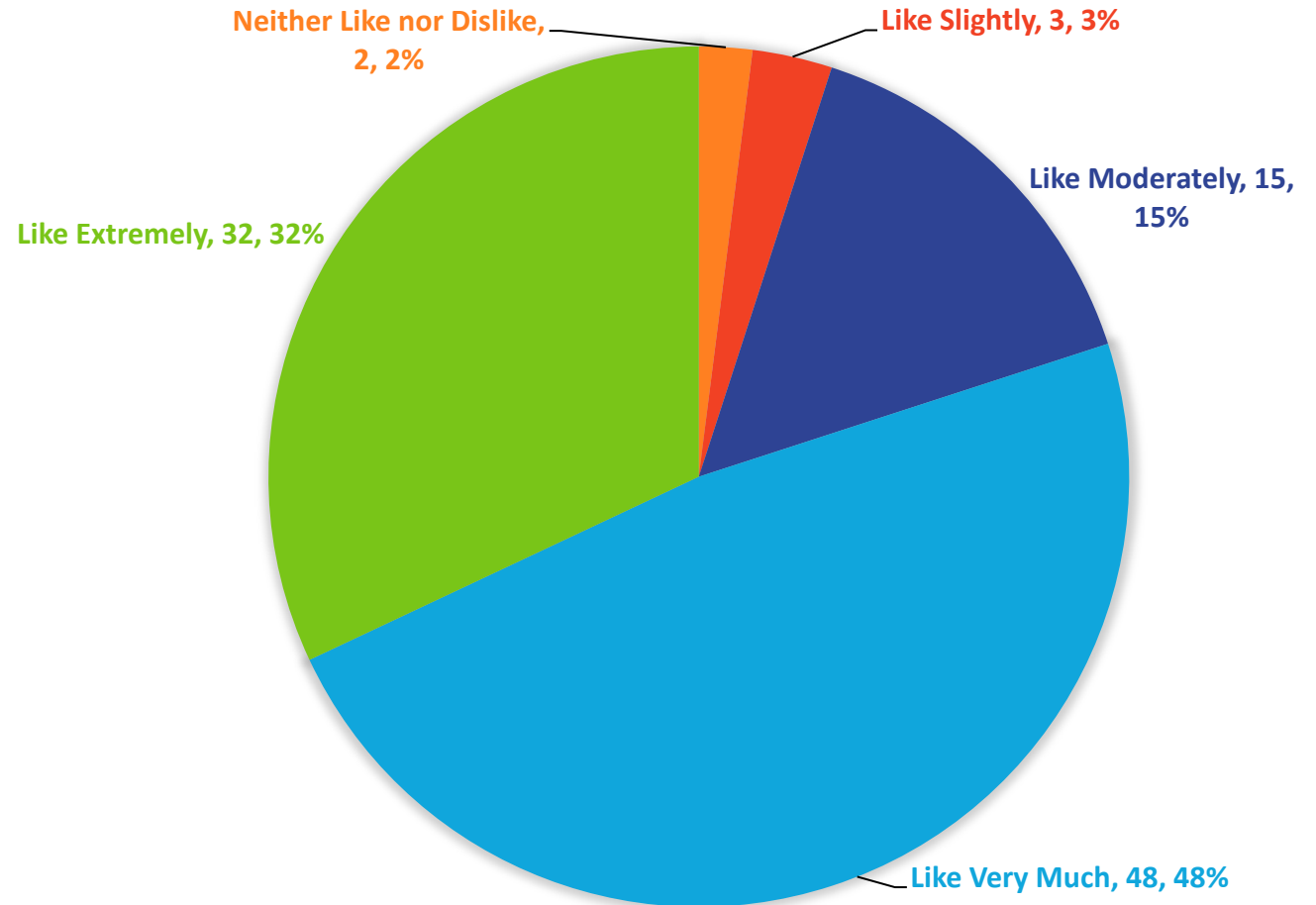
Muffin with an edible liner



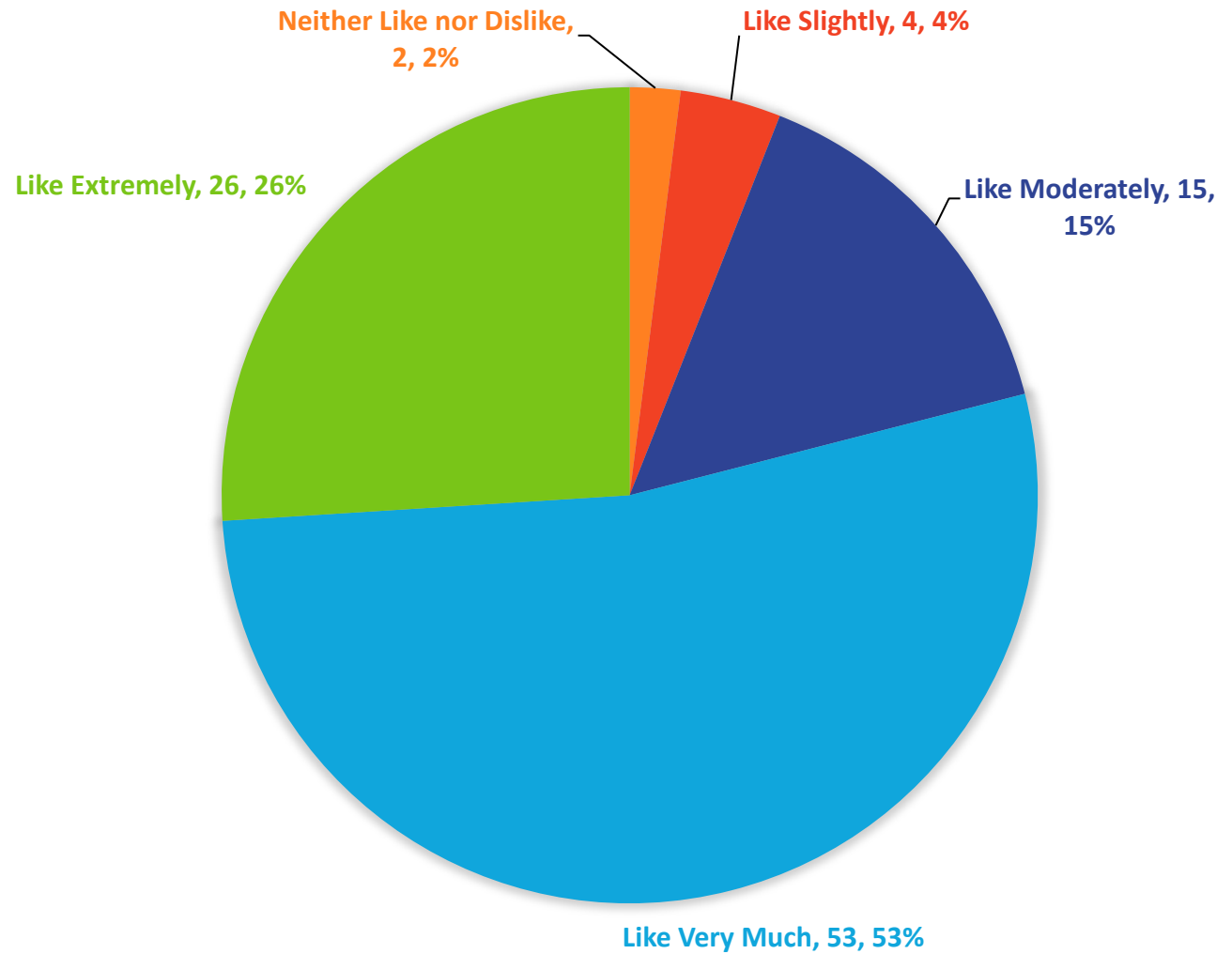
Taylor et al., 2023. J Food Sci. 89(4), 2423-2437.

le
packaging using 9-point hedonic scale: 1=dislike
extremely to 9=like extremely.

Consumer Likeness on Edible Fruit Leather Wraps



Consumer Likeness on Edible Muffin Liners



Edible, Water Resistant and Antimicrobial Film



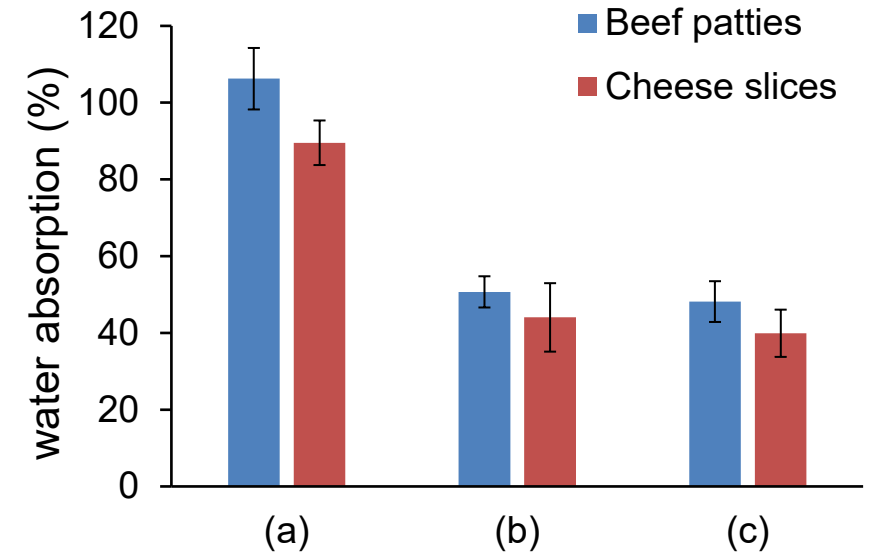
CNF only



CNF + 20% high
MW CH

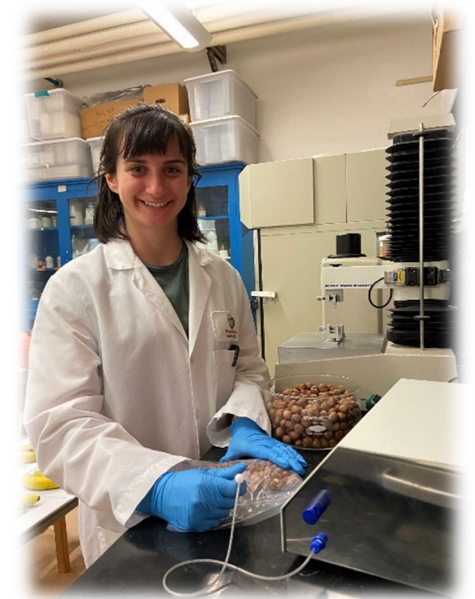


CNF + 20% low
MW CH



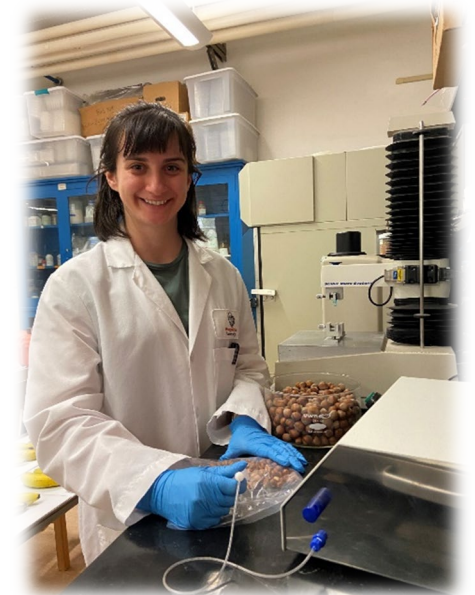
- Type of film
- (a) CNF only film
 - (b) Low Mw (68 kDa) chitosan incorporated CNF film
 - (c) High Mw (287 kDa) chitosan incorporated CNF film

Antioxidant, Printable, Heat Sealable Biodegradable Films



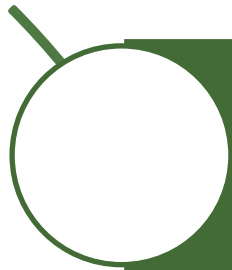
Dag, et al. 2024. Inter. J. Biological Macromolecules. 261, Part 2. 129790.
Dag et al., 2023. Food Packaging & Shelf-life. 39, 101153 .

Antioxidant, Printable, Heat Sealable Biodegradable Films

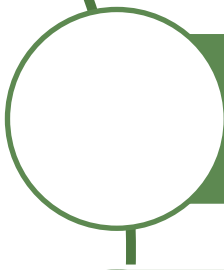


Dag, et al. 2024. Inter. J. Biological Macromolecules. 261, Part 2. 129790.
Dag et al., 2023. Food Packaging & Shelf-life. 39, 101153 .

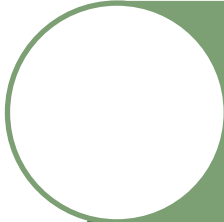
Key Takeaway Messages



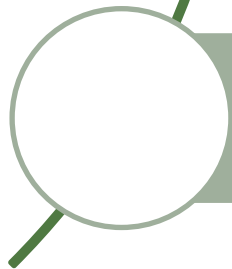
Edible packaging aligns with sustainability goals, reducing plastic pollution, carbon emissions, and food waste, making it an eco-friendly choice for replacing single use plastic packaging.



Continuous research and innovation are necessary to improve its performance and functionality for different food applications.



The hurdles (cost, large scale production, consumer acceptance, etc.) of edible packaging faces have to be overcome before its broad applications.



Require interdisciplinary team and stakeholder engagement.

Acknowledgements

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US





Thank You



Oregon State
University