USING FOOD WASTE IN CIRCULAR BIOECONOMY

Dominika Alexa Teigiserova
PHD BACKGROUND

→ BC and MSc in Environmental Engineering
→ 3rd PhD fellow, Aarhus University:
Circular Bioeconomy: Increasing the Value in Food Waste Based Biorefineries

→ collect and valorize high-value products from food waste
→ assessing environmental and economic feasibility
→ update frameworks to further carbon neutral production

Main Supervisor: Prof. Marianne Thomsen, mth@

Co-supervisor: Lorie Hamel, hamelin@insa-toulouse.fr
Collaboration with Cambioscope:


Exchange: February-April 2020

2. Teigiserova, D.A Tiruta-Barna, L. Ahmadi, A. Hamelin, L. Thomsen, M. *A step closer to circular bioeconomy for citrus peel waste: a review of yields and technologies for green extraction of essential oils and limonene* *(submitted)*.

3. Teigiserova, D.A Tiruta-Barna, L. Ahmadi, A. Hamelin, L. Thomsen, M. *How to create local circular bioeconomy: integrating scale-up process design into the life cycle and economic assessment for cascading biorefinery of orange juice residues*. *(in preparation)*
THE NEED FOR NEW FRAMEWORK

• Global: 1.3 billion tonnes of edible food is lost or wasted (FAO, 2011)
• EU-28: 88 ± 14 million tonnes (FUSIONS, 2016)
• Over 8% GHG are cause by food waste
• 25% of all water used by agriculture
• 23% of all cropland
• SDG 12.3 “half food waste and losses”

No specific guidelines

1.1x10^9 times

8713 times
# UPDATED FOOD WASTE PYRAMID

<table>
<thead>
<tr>
<th>Surplus food</th>
<th>Prevention</th>
<th>Reuse - H</th>
<th>Reuse - A</th>
<th>Material Recycling</th>
<th>Nutrient Recovery</th>
<th>Energy Recovery</th>
<th>Disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>All edible food</td>
<td>Prevention and minimization at the source</td>
<td>Redistribution for human consumption</td>
<td>Used as animal feed</td>
<td>Material recovery e.g. keeping the value bound to the material (sauce, acids, bioplastics...)</td>
<td>Degradation of material value: anaerobic digestion, compost, land application</td>
<td>Degradation of material value: anaerobic digestion, transesterification, incineration with energy recovery</td>
<td>Landfill, incineration without energy recovery</td>
</tr>
<tr>
<td>Canned food, restaurants leftovers, misshaped FFV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inedible parts, food after expiration date, defected food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food that lost its nutritional value, inedible such as peels, processing</td>
<td>Material Recycling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotten food, inedible such as cooking oil, dead animals, mixed household</td>
<td>Nutrient Recovery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotten food, inedible such as cooking oil, dead animals, mixed household waste</td>
<td>Energy Recovery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**1st publication: New frameworks**

### NEW COMPREHENSIBLE CATEGORIES

<table>
<thead>
<tr>
<th>Edible</th>
<th>Inedible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoidable</td>
<td>Unavoidable</td>
</tr>
<tr>
<td>I. All edible food i.e. surplus food</td>
<td>II. Naturally inedible (ex. bones, pits, leaves)</td>
</tr>
<tr>
<td>→ Keep in the food supply chain</td>
<td>→ Material recycling</td>
</tr>
<tr>
<td></td>
<td>III. Processing waste residues (ex. apple pomace, tea leaves)</td>
</tr>
<tr>
<td></td>
<td>→ Material recycling</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CIRCULAR ECONOMY FRAMEWORK

dat@evs.au.dk
DOMINIKA ALEXA TEIGISEROVA
CASE STUDY

WHAT SUSTAINABLE FEED UNEXPLORED BIOMASS WE CAN USE?
ORANGE PEEL CASE STUDY

500 million litres/year

Consumption & Service

Retail & Wholesale

Processing & Manufacturing

Primary production post-harvest

Primary production pre-harvest

Inedible

Edible

Recovery (energy, fertilizer)

Mixed food waste

Reuse

Material Recycling

Coffee grounds

FFV, bread

Pomace

Peels and husks

Dead animals and not mature crops

Dead animals, leaves, stems

Food banks

FFV

FFV

Residues for animal feed
ENSURING SUSTAINABLE BIOECONOMY

→ 66 quantified examples with harmonized data by 9 green technologies
→ Economies of scope

Results:
Cold press
→ establish at plant level
→ low yields

Solvent-free microwave extraction → novel technology
→ “easy” scale-up
→ high yields
SCALE-UP

→ We need more detailed technology data for: Environmental and Economic Assessment
CASCADING PRODUCTION

Orange Peel Waste → Microwave assisted extraction → Condensation → Limonene

Calcium hydroxide → Precipitation → Mycelium → Animal Feed

Sulphuric acid → Acidification → Gypsum

Crystallization → Citric acid

 avoided hexane

 avoided soybean meal

 avoided maize

 avoided gypsum

 avoided citric acid

3rd publication: Assessment
PRELIMINARY RESULTS
ENVIRONMENTAL
THANK YOU.

Any questions later ➔ d.tgsrv@gmail.com