Meeting the challenges: role of food processing to improve food security
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Outline

- Food Security – Framing the solutions
- Food processing - Traditional and emerging
- The Farm-Factory Interface
- Food loss and waste
- Transdisciplinary practice

Food Security: Sustainability - Problems, Perspectives and Solutions

“Growing population of people need to be fed better, with less environmental impact”

How? - Conceptual Framework:
- Production Challenge – change how food is produced and efficiency
- Consumption challenge – dietary drivers that determine food production
- Socio-economic challenge – governance of the food system
Feeding the World Sustainably

Food security:

• A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

• Food security dimensions: food availability, economic and physical access to food, food utilisation and stability over time.

A LESS PREDICTABLE PLANET

• Limited and decreasing amount and quality of natural resources
• Increasingly unpredictable and severe weather events
• Decreasing biodiversity
• Increasing incidence of microorganisms and parasites, and increased antimicrobial resistance
• Increasing consumer demand for environmental and social credentials

SMARTER FOOD CHAINS

• Rising global food demand
• Food security concerns
• Rise of big data and data analysis
• Increasing digital connectivity and use of e-commerce solutions
• Verticality, decentralisation, non-linear and more agile value chains

ONE WORLD

• Increasingly interconnected global value chains
• Greater exposure to food and beverages from other regions and cultures
• Greater international competition
• Increased biosecurity risks
• Greater susceptibility to supply shocks

HEALTH ON THE MIND

• Aging population
• Rise in chronic illness
• Increasing social awareness for improved health and well-being
• Rising importance of food safety
• Increasing demand for food products that target holistic (mind + body) health and well-being outcomes

CHOOSEY CUSTOMERS

• Rises wealth and Asian middle class
• Urbanisation
• Greater demand for convenience, out-of-home consumption, food-based experiences and customised offerings
• Increasing demand for provenance information and accurate vendor claims
• Greater consumer rating intensity

Global Megatrends in Food and Agriculture

The Grand Challenge – Feeding the World

Food processing - Traditional and emerging
Food Processing:
• Any deliberate change in food before it is available for people to eat
• Converts perishable raw materials into useful, shelf-stable and palatable foods

(IFICF 2012)

Food Processing “FOR” Food Safety & Security, Efficiency & Sustainability

Efficient conversion of agri-food materials into value-added Ingredients and products

Foods
• Consumable
• Nutritious
• Safe
• Sustainable

Food Structure & Chemistry Process Engineering Science

Consumer values

Source: Deloitte food value equation survey 2015, Deloitte analysis


Food Processing

• Traditional Food Processes
  • Heat, Drying, Extrusion, Fermentation, Separation

• Innovative Technologies
  • High pressure processing, Microwave, Ultrasound, Pulsed electric field, Novel separation technologies

• Modelling & Optimisation of Food Processes
  • Modelling, Process design & control, Heat & mass transfer, Fluid dynamics

Ethical application of food processing for production of safe foods and ingredients that meet specifications of composition and quality
Food Preservation – For Safety & Stability

<table>
<thead>
<tr>
<th>Processes</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Treatment</td>
<td>Minimize pathogens</td>
</tr>
<tr>
<td>Canning (Retorting)</td>
<td>Improve food safety</td>
</tr>
<tr>
<td>Microwave</td>
<td>Improve food stability</td>
</tr>
<tr>
<td>Drying</td>
<td>Longer shelf life</td>
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<tr>
<td>Refrigeration</td>
<td>Convenience</td>
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<tr>
<td>Fermentation</td>
<td>Increased availability</td>
</tr>
<tr>
<td>Acidification/Salting</td>
<td>Enables transport</td>
</tr>
<tr>
<td>High Pressure Processing</td>
<td>Improve food quality</td>
</tr>
<tr>
<td></td>
<td>Less waste / improve utilisation</td>
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</tbody>
</table>

Food Processing – For Nutrient Quality

<table>
<thead>
<tr>
<th>Processes</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blanching/ Heat</td>
<td>Inactivation of enzymes</td>
</tr>
<tr>
<td>High Pressure</td>
<td>Retention of nutrient</td>
</tr>
<tr>
<td>Fortification</td>
<td>Restore nutrient losses</td>
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<tr>
<td></td>
<td>• Vit D in milk</td>
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<tr>
<td>Encapsulation</td>
<td>Enrichment of nutrients - bioavailability</td>
</tr>
<tr>
<td></td>
<td>• Omega-3, probiotics</td>
</tr>
<tr>
<td>Food re-formulation</td>
<td>For healthy food products</td>
</tr>
<tr>
<td></td>
<td>• High protein bars</td>
</tr>
</tbody>
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The Farm-Food Interface

The Farm-Factor Interface – Processing for a Sustainable Agri-Food Industry

- Climate change
- Environmental footprints
- Seasonality
- Land availability
- Methane mitigation
- Water availability

Altered On-farm Practices

- Animal/Plant Genetics
- Availability of conventional feeds/fertilizers
- Increased supplement/fertilizer costs
- New on-farm practices (calving & planting patterns)

Primary Produce from New Sustainable Production Systems

- Energy cost
- Water usage
- Efficiency
- Effective utilisation
- Waste minimisation

Getting the most out of agri-food primary produce with altered composition

Making consistent products from a variable production supply

Food Processing – For Sustainable Food Supply Chain (E.g. Dairy)

- Increasing yields
- Reducing environmental impacts
- Acceptable, nutritious, affordable consumer foods

Food Processing – Sustainable Factory of the Future

- Green house gases
- Distribution
- Process 1
- Process 2
- Process 3

Resources
- Energy
- Water

Raw materials
- Produce (Meat, Dairy, Grains, Pulses, Fruits, Vegetables)

Food and Feed for human and animal consumption
- Safe
- Nutritious
- High quality
- Consumer acceptance

An integrated approach to making ‘more from less’
Protein is one of the world’s major challenges

System Boundary
- Farm
- Distribution
- Resources
- Raw materials
- Waste material

Food loss and waste

UN Development Goal 12.3: By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses
Food waste occurs along the supply chain

Global volume of Food Wastage = 1.6 Gtonnes
Edible Portion = 1.3 Gtonnes

Food Loss – Greater problem in underdeveloped countries
Food Waste – Higher in developed countries

Food Loss Impact Across the Value Chain

Food Wastage = Food Loss + Food Waste
Valuing our Lost Biomass Resources

http://www.foodwastealliance.org/about-work/solutions-best-practices/

Real-time food safety management system

RFID-based Food Operations Assessment System with Case-based Reasoning (CBR)
Facilitates food safety control activities with Reduced Decision making time

TECHNOLOGY ENABLERS: RFID and wireless sensor networks (WSNs)

Megasonics-Assisted Oil Separation for Oil Bearing Materials

Less oil loss in Waste Water (Less $5 for disposal, Environmental Benefit)
Higher oil yield (More $5, Efficient extraction, quality oil)
Increased income for Factory/Small holders ($ Food Security)

Food Processing / Post-harvest Preservation/Fermentation
Acceptable consumer Appeal

Food Processing / Concentration/ Separation

Concentrate/ Separation

New products

CONSUMER PRODUCTS
FOOD & BEVERAGES
DIETARY SUPPLEMENTS

CONSUMER PRODUCTS
FOOD & BEVERAGES
DIETARY SUPPLEMENTS

FOOD & BEVERAGES
DIETARY SUPPLEMENTS

Food Processing Concentration/ Separation

Bioprocessing/ Biorefining Concentration/ Separation

Value added BIO-PRODUCTS BIOACTIVES, FUNCTIONAL INGREDIENTS, ANIMAL FEED, CHEMICALS, BIOFUEL

RBIO-PRODUCTS BIOACTIVES, FUNCTIONAL INGREDIENTS, ANIMAL FEED, CHEMICALS, BIOFUEL

Bioprocessing/ Biorefining Concentration/ Separation

Non-food Grade Biomass Products, Stems, Leaves, Cuttings etc.

RECOVERABLE LOSS
FOOD & FOOD INGREDIENTS, DIETARY SUPPLEMENTS

RECOVERABLE LOSS
FOOD & FOOD INGREDIENTS, DIETARY SUPPLEMENTS

Revegetable Component
FOOD INGREDIENTS/DIETARY SUPPLEMENT

PROCESSING TECHNOLOGIES

PROCESSING TECHNOLOGIES

Megasonics-Assisted Oil Separation for Oil Bearing Materials

High Frequency (400-3000 kHz)

Faster oil separation (time / energy)

Augustin et al. (2012) Vegetable Oil Extraction WO 2012/167315 A1


Augustin & Sanguansri, ILSII-AACC, 31 August 2017, Sydney, Australia
Extracting Value from Underutilised Biomass

Optimising Food Resources – Role of Food Processing

Improved Efficiency
Stabilisation/Conversion into Food and Ingredients
Extraction of High-value components (e.g. nutraceuticals)

Edible Biomass Recovery & Transformation

Australia has $5bn food loss problem

Bioactives and functional ingredients market is expected to reach $33.6bn by 2018

Luz Sanguansri, CSIRO
The Future FOOD LOSS BANK™

“To divert and transform edible food loss and make this our new food ingredient supply by 2030”

Prototype Products from Broccoli & Carrot made at CSIRO

• Powders
  • Broccoli and Carrot powders

• Juice Concentrates
  • Forward Osmosis

• Extruded Snacks
  • 3% vegetable
  • 100% vegetable

• Fermented Products

Processing for Value Adding

Bioactives, Food Ingredients, Foods & Beverage Products, Feed

New Bio-Economy
New Industries and Employment
Zero Waste
Food & Feed Security
Reduced Environmental Impacts
Sustainability

Use of residues from the wine industry

• Grape skins and seeds
  • Gluten-free flour (and cookies)
    http://www.wholevine.com/

• Grape marc
  • Tannins, tartaric acid, extracts
New Science/technology solutions to reduce food loss and generate customer value

Intelligent Decisions Making Tools
• Mapping the food loss and location
• Informed decision making for centralised / decentralised processing
• Address practical problems in logistics

New Sensors
• Advanced sensing technologies
• Decisions to be made on fitness for purpose of raw material for edible use

New Processing Technologies for Stabilisation of Food Loss Materials and Conversion
• Development of efficient processing and preservation

Underutilised edible biomass: Our new raw ingredient for food / supplement industries

Partners & Stakeholders Map

Transdisciplinary Practice
Collaborative Network for Enhancing Food Security

Various Sectors

- Government
- Post-harvest / Distribution
- Industry & Business
- Scientists
- Consumer

Setting Targets / Policies

Economic incentives

Internet of Things

New Business Models

Transdisciplinary Research – Science in Society

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Thank you

CSIRO Food & Nutrition Flagship
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