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Closing the loop

Bringing waste materials back to life in fresh applications

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44

Closing the loop – Bringing waste materials back to life in fresh applications

Up to one third of all food is lost or wasted in the supply chain, having significant environmental, social and economic repercussions. So, the race is on to find creative solutions to stretch the use of future waste beyond animal feed and biogas. In this white paper, Karen Burgos describes food waste sources and their association with high added-value ingredients.

What is food waste?

The Food and Agriculture Organization (FAO) reports that food waste relates to food being lost from parts of the food supply chain, otherwise intended for human consumption'. The decrease may be accidental or intentional but ultimately it means less food is available.

With the global population expected to reach 9 billion by 2050 and agricultural land becoming increasingly scarce, ingredients created from food waste are expected to gain currency in the food industry[1].

Table 1: Food waste sources, corresponding target ingredients and their applications

Waste source	Target ingredient	Application
Citrus peel	Sugar syrup	Food natural sweetener
Cheese whey	α – lactalbumin, β –lactoglobulin containing whey protein & de-flavoured proteins	Food supplements & additives
Olive mill waste	Hydroxytyrosol Olive phenols & dietary fibers containing poweders	Food supplements & cosmetics Natural antioxidant in foodstuff & fat replacement in meatballs
Tomato waste	Lycopene	Food antioxidant and supplement
Soy protein isolate wastewater	Soybean albumin	Food additive & supplement
Shrimp & crab shell	Chitosan	Food thickener & fruit anti-staling agent
De-pectinated apple pomace	Apple dietary fibers	Dietary supplement
Grape & cranberry seed	Proanthocyanidin	Coloring additive in soy sauce
Pomegranite rind & seedcase residues	Ellagic acid & punicalagin	Food antioxidants & cosmetics

[1] FAO (2017), Food Loss and Food Waste. Accessed: http://www.fao.org/food-loss-and-food-waste/en/

New generation of ingredients

In the past few years, a series of cutting-edge industrial extraction techniques and processing methods, to apply to food waste sources, have been developed. A new wave of ingredients are thus emerging, finding creative applications in foods, nutraceuticals and personal care products[2].

Sourcing food-chain side-streams

The increasing recognition of low-value industry side-streams as raw materials is generating a wider range of product options. By characterising food-chain side-streams and developing methods for their fractionation or separation, new products have been or can be created, which are cost-effective and sustainable. The classic example is the by-product whey (or milk serum), which is the source of well-known ingredients such as protein concentrates and saccharide mixtures to name a few[3].

However a more recent example is potato pulp, which is produced in large quantities as a by-product in the potato starch industry and it has been suggested that rhamnogalacturonan I, a polysaccharide extracted from potato starch, could be put to use as a new source of

Table 2: Established and emerging compound recovery methodologies

Established methodologies	Emerging metholologies
A. Macroscopic Pre-treatment	A. Macroscopic Pre-treatment
Wet Milling, Thermal and/or Vacuum Concentration, Mechanical Pressing, Freeze Drying, Centrifugation & Microfiltration	Foam-Mat Drying, Electro-Osmotic Dewatering, Low-Temperature Plasma Treatment
B. Macro- & Micro- Molecules Separation	B. Macro- & Micro- Molecules Separation
Alcohol Precipitation, Ultrafiltration, Isoelectric Solubilization-Precipitation, Extrusion	Colloidal Gas Aphrons, Ultrasound-Assisted Crystallization, Pressurized Microwave-Assisted Extraction
C. Extraction	C. Extraction
Solvent, Acid, Alkali, Microwave-Assisted, Steam Diffusion, Hydrodistillation, Supercritical Fluid	Ultrasonics, Laser Ablation, Pulsed Electric Field, High Voltage Electrical Discharge, Liquid Membranes, Pervaporation
D. Isolation & Purification	D. Isolation & Purification
Adsorption, Chromatography, Nanofiltration, Electrodialysis	Magnetic Fishing, Aqueous Two-Phase Separation, Membrane Ion Exchange Chromatography
E. Product Formation	E. Product Formation
Spray- & Freeze-Drying, Emulsions, Extrusion	Nanotechnology, Pulsed Fluid Bed Agglomeration

[2] Food Ingredients First (2016), Sustainable Ingredients Emerging from Food Waste. Accessed: http://www.foodingredientsfirst.com/news/Sustainable-Ingredients-Emerging-from-Food-Waste.html?section=Business%20News&tracking=Packaging%20&%20Technology%20News%20-%20Related%20Articles

[3] Charis M. Galankis (2012), Recovery of high-added value components from food wastes; conventional, emerging technologies and commercialized applications, *Trends in Food Science & Technology*, **26**, 68-87.

pectin-like fibres[4]. Recent research, has also suggested that a novel protein derived from food waste and originally intended for animal feed, could find use in food and drink manufacture in the future. The protein in question is produced from a bacteria grown in a range of food manufacturing waste streams. If approval is gained, the novel protein could function as an effective protein booster across a range of product platforms or be used as a meat alternative[5].

The existing number of high-potential food-chain side-streams are vast and more are yet to be identified. Table 1 shows a selected range of recognised food waste sources, corresponding target ingredients for recovery and their applications[3].

Recovery technologies – A brief history

Food wastes are complex substrates and require careful handling. Normally, the recovery stages exploit the principles of analytical chemistry and processing normally occurs as depicted in Table 2, from the macroscopic to the macromolecular level, followed by extraction of specific micro-molecules and ultimately purification and encapsulation of the target compounds. The challenging goal, however, is to design a process, which will:

- Maximize the yield of the target ingredient
- Suit the demands of industrial processing
- Generate target ingredients free from impurities and toxic compounds
- Minimize or eliminate the deterioration and loss of functionality during processing and
- Ensure the food grade nature of the final product[3].

Ingredients derived from food waste – Challenge or opportunity?

Bringing an idea to market is complex. The use of food waste to produce novel ingredients is yet to reach its full commercial potential but it is undoubtedly an area that is gaining attention by key players in the industry.

Having expertise in ingredient behaviour, product formulation, food structure, food safety, sensory testing and food regulation, Leatherhead is ideally placed to help companies identify high-value food-chain side-streams to generate sustainable ingredients and help the industry better implement circular economy strategies.

[4] Nathan Gray (2011), Potato waste could provide 'new generation' of food ingredients, say researchers. Accessed: http://www.foodnavigator.com/Science/Potato-waste-could-provide-new-generation-of-food-ingredients-say-researchers
[5] Nicholas Robinson (2015), Novel protein from food waste streams. Accessed: http://www.foodmanufacture.co.uk/Manufacturing/Animal-feed-protein-could-be-used-in-food-manufacture

How Leatherhead can help

With strong links to various ingredient manufacturers/suppliers and emerging technology hubs, Leatherhead can work with you to ensure successful product development with the latest ingredients and technologies. Confidence in the product deliverables can be validated with designed product analysis on ingredient efficacy, product characteristics and shelf life stability, all of which Leatherhead can assist with. Furthermore, an understanding of the global regulatory landscape can be provided, ensuring that the products you develop comply with the local restrictions. With such a strong and increasing consumer demand for these products, the opportunities are great, and we can help you uncover them.

About the author

Karen Burgos is a Principal Scientist at Leatherhead Food Research and has comprehensive knowledge in product development; from ideation to product launch. Currently, she provides NPD consultancy, focussing on the area of functional beverages, to a wide range of food industry clients. Karen joined Leatherhead Food Research in 2014 and has an MSc degree in Engineering (Biotechnology) awarded by Lund University, Sweden.

About Leatherhead Food Research

Leatherhead Food Research provides expertise and support to the global food and drinks sector with practical solutions that cover all stages of a product's life cycle from consumer insight, ingredient innovation and sensory testing to food safety consultancy and global regulatory advice. Leatherhead operates a membership programme which represents a who's who of the global food and drinks industry. Supporting all members and clients, large or small, Leatherhead provides consultancy and advice, as well as training, market news, published reports and bespoke projects. Alongside member support and project work, our world-renowned experts deliver cutting-edge research in areas that drive long-term commercial benefit for the food and drinks industry. Leatherhead Food Research is a trading name of Leatherhead Research Ltd, a Science Group (AIM:SAG) company.

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