Food and Beverage Waste Upcycling

Turning Waste Into Profits

PRESCOUTER

Billions of dollars in residual profits are thrown away annually along with food waste.

Upcycling is the next revolution and it has already started. Going from a linear- to a renewable-based world requires a major shift in the way we think about every aspect of life. Ingredients, chemicals, and materials in this new world need to be thoughtfully designed, keeping in mind that they should no longer be part of a linear model and be non-depleting (renewable). Performance will be coupled with sustainability aspects, and a product's value proposal will be linked to selling its function rather than merely the quantity.

There are already many examples of food upcycling developments, demonstrating that change is on the way.

According to the UN Food and Agriculture Organization, 1.3 billion tons of food is wasted annually across the globe — if food waste were a country, it would be the third largest emitter of greenhouse gases. To meet their individual sustainability goals, food and beverage companies need to effectively manage waste streams and upcycle in order to maximize profit.

In this Intelligence Brief, we explore innovative application-agnostic food and beverage industry waste stream upcycling opportunities.

Finding a way to upcycle all waste from food and beverage manufacturing processes could help reduce greenhouse gas emissions as well as reduce the gallons of water used in food horticulture.

ReFED, a non-profit organization working toward the reduction of food waste in the United States, estimates that an annual investment of $14 billion into food waste upcycling initiatives could reduce food waste by 45 million tons per year over the course of the next 10 years. They also indicate that such investments would lead to $73 billion in annual profits as well as reducing greenhouse gas emissions by 75 million metric tons.

Infographic: Examples of the different types of waste commonly found in F&B manufacturing processes.

Defects

Defects generated via reworking, scrap, and incorrect information

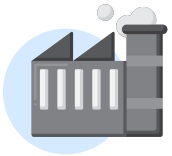
Transportation

Unnecessary movement of products and services

Motion

Unnecessary human movements

Overprocessing



Overproduction

Products produced in excess or before it is even needed

Waiting

Time wasted waiting for the next step in a process

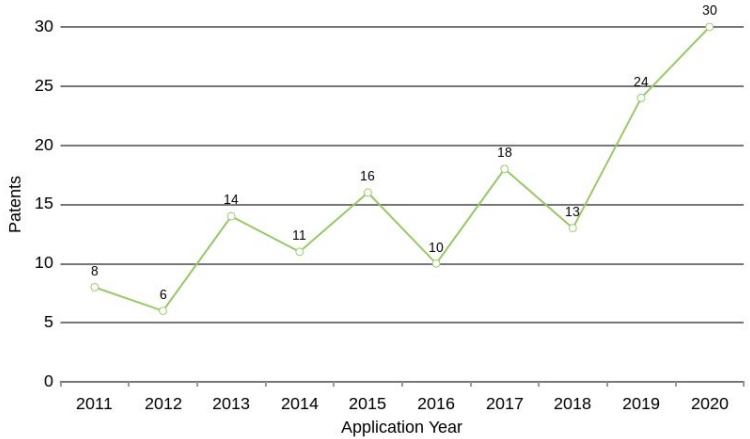
Inventory

Excess products and materials left unprocessed

Innovation in this field has been exploding in the past 10 years, with a 56.7% increase in filed patents between 2018 and 2020 alone.

More and more companies are taking advantage of the financial and environmental benefits offered by upcycling waste streams. Recent partnerships involving key players include:

- Ford partnering with McDonald's to turn coffee bean chaff into car headlamp parts.
- Kellogg's partnered with Seven Bro7hers to create limited edition beers made from cereal manufacturing waste.
- Renewal Mills has partnered with various plant-based milk companies to harvest manufacturing byproducts such as soybean pulp to make gluten-free flour for both cooking and baking.



Food Waste Upcycling Patent Application Trends

Figure. Food waste upcycling patent application trends show increased innovation over the past decade.

SUMMARY OF THE COMPANIES PROFILED

	# of Employees	Country	Product Name	Composition / Source	Aims to Replace / Function	End Industry Application
Renmatix	11-50	USA	Plantrose process	Nonfood, unused, and under-used plant materials	Supercritical crystalline cellulose (SC3), cellulosic sugars (primary building blocks for biochemicals and advanced biofuels), Omno Polymers	Personal care, beauty, spa, biofuel markets as well as health and nutrition products
Fooditive sweetener	2-10	Netherlands	Fooditive sweetener	Apple & pear side streams	Sweeteners, preservatives, thickening agents, emulsifiers	Nutrition and health products, personal care, beauty and spa markets
ubq	11-50	Israel	UBQ	Food waste and other mixed waste (banana peels, chicken bones, and other food leftovers; cardboard and paper; diapers and mixed plastics)	Conventional thermoplastics	Various, including food tray production, furniture, and flooring
BioPOWDER.com	11-50	Malta	Biopowder	Powders of olive pits, fruit shells and stones	Polyethylene, polypropylene, and polyurethane microplastics	Paints and coatings, consumer goods

MONOMERS FOR BIOCHEMICALS AND ADVANCED BIOFUELS

Derived from biomass

Personal care, beauty, spa, biofuels as well as health and nutrition products

Renmatix

SWEETENERS, PRESERVATIVES, THICKENING AGENTS, EMULSIFIERS

Derived from apple & pear side streams

Nutrition and health products, personal care, beauty products

BIOPLASTIC

Derived from food waste and other mixed waste

Conventional thermoplastic replacements

ubq

NATURAL ADDITIVE FOR VARIOUS APPLICATIONS

Derived from olive pits, fruit shells and stones

As an alternative to industrial abrasives or fillers used in plastics

BioPOWDER.com

4 UPCYCLED ALTERNATIVES

Supplementary Information | Select Technologies

This is a select sampling of potential technologies across material waste stream inputs and potential applications for the upcycled product.

RENMATIX – Plantrose Process

At A Glance
https://renmatix.com
+1 678 401 7732
HQ Pennsylvania, USA
11-50 employees

Tech Overview:

The Plantrose process is a water-based technology that converts non-food, unused, and under-used plant materials into the building blocks for creating biochemicals and biofuels. Renmatix's supercritical hydrolysis technology is claimed to deconstruct non-food biomass an order of a magnitude faster than other processes and enhance its cost advantage by using no significant consumables.

SUMMARY

MATERIAL INPUT
Non-food, unused, and under-used plant materials

SCALE OF OPERATIONS
Large-scale mass production

APPLICATIONS
Personal care, beauty, spa markets as well as health and nutrition products

APPLICABLE INDUSTRIES
Food & Beverage, CPG, Cosmetics, Construction

RENMATIX – Plantrose Process

Technical Details:

The Plantrose process is a water-based technology platform developed to convert raw plants into biobased ingredients and sustainable products. It uses water as the medium to break down diverse plant materials (sometimes called “biomass”) ranging from agricultural residues like sugar cane bagasse and corn stover to grasses like sweet sorghum and switchgrass to feedstocks from other industries, such as trees once destined for paper.

And how does this process work?

Water left in its normal states (ice – liquid – steam) alone does not dissolve plant structures or reduce them to the point where they can be separated into their most basic parts.

Using a combination of heat and pressure (around 373°C and 220 bars), the company is able to use water in a unique supercritical state in their reactor system.

In essence, water in this state dissolves biomass into simpler components. Their current focus is on making cellulose particles, but the process can also produce fiber, oligomers, sugars, lignin, and other naturally occurring plant substances.

RENMATIX – Plantrose Process

Technical Details (Cont'd):

Plant feedstock is mixed with water into a slurry that is pumped to the supercritical water reactor. It is in this reactor where the slurry is mixed with supercritical water that causes the plant matter to break down into its building blocks. Upon exiting the reactor, the building blocks are separated, washed, and finished to become different ingredient products.

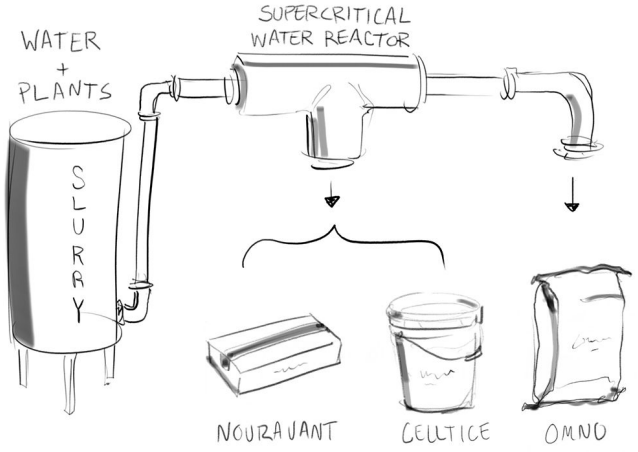


Figure: Plantose Process. Source: Renmatix

Plantrose process and the main end products/brands:

- **Nouravant:** A multi-functional food ingredient. This plant-based and clean-label ingredient has shown utility across a range of food products, from baked goods, to soup and sauces, to dairy applications and meat products. Nouravant can add texture to food or boost the moisture content.
- **Celltice:** A plant-based personal care ingredient that is a self-emulsifying active. It serves as an anti-inflammatory and antioxidant shield for the skin while offering texture and promoting skin health. Celltice is used in skincare, cleansers, and hair care formulations.
- **OMNO:** A lignin polymer that can be used as sustainable material for foams, polyurethanes, and coatings.

RENMATIX – Plantrose Process

Technical Details (Cont'd):

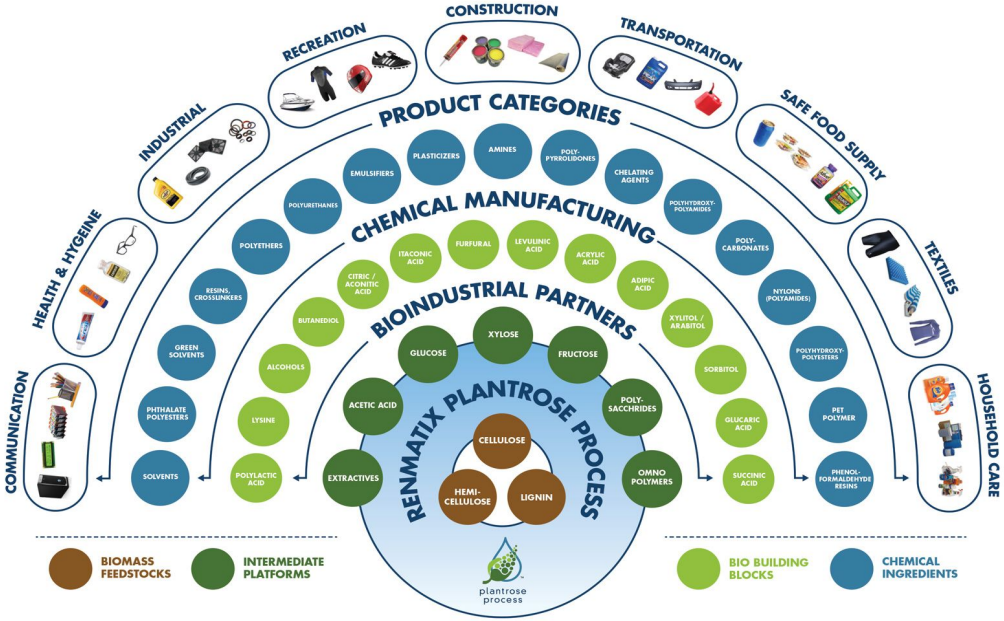


Figure: Representative example of products that can be derived from biobased building blocks generated via the Plantrose process. Source: Renamtix

FOODITIVE – Fooditive Sweetener

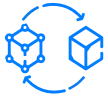
At A Glance
https://www.fooditive.nl
+31 1 07 98 62 72
HQ Rotterdam, Netherlands
2-10 employees

Tech Overview:

Fooditive products are made from fruit and vegetable leftovers or third grade produce, including sweeteners, preservatives (carrot waste), thickeners (banana skin) and emulsifiers (potato extract). The sweetener is developed through recycling apple and pear waste.

SUMMARY

MATERIAL INPUT
Food waste and under-used plant materials



SCALE OF OPERATIONS
Large-scale mass production

APPLICATIONS
Nutrition and health products, personal care, beauty and spa markets

APPLICABLE INDUSTRIES
Food & Beverage, Pharmaceutical

FOODITIVE – Fooditive Sweetener

Technical Details:

Fooditive uses fruit and vegetable leftovers as upcycled ingredients. Their process is based on continuous fermentation through the extraction of raw materials. It is a fast, high-definition process resulting in products with a purity that reaches up to 99.8% while being efficient and scalable. The company claims that during the process, they produce zero waste via the reuse of excess waste and turning it into soil. Their final products are sweeteners, thickening agents, preserving agents, emulsifiers, fat replacers, and vegan casein.

Figure: Fooditive sweetener, thickener agent, and emulsifier agent.
Source: Fooditive

FOODITIVE – Fooditive Sweetener

Technical Details (Cont'd):

- Fooditive sweetener, developed through recycling apple and pear waste, is a sugar alternative to replace the functionalities of sugar toward texturizing/bulking and sweetening. The product can mask bitter flavors, has high processing stability, and extends the shelf life of final end products.
- The thickening agent is made exclusively from banana skin but does not have color, starch, sweetness, or odor. The product has moderate viscosity and adhesive properties and is water soluble. Additionally, the thickening agent prevents sugar crystallization and stabilizes foam, meaning it helps maintain form through adjusting the tissue structure of the contained ingredients.
- The preserving agent is composed of carrot waste and is only effective at low pH levels. The active ingredient dissolves better in water than does sorbic acid. The preservative is particularly effective in actively preventing mold, is less active against yeast, and is not active against bacteria. It is suitable for products such as bakery items, dairy, sauces soups, and frozen desserts.
- The emulsifiers use potato extracts in order to create a surface-active agent between two immiscible liquids. The product reduces stickiness as well as providing controlled crystallization and guaranteed coalescence.

UBQ Materials – UBQ

At A Glance
https://www.ubqmaterials.com
+972-52-303-3099
HQ Tel Aviv, Israel
11-50 employees

Tech Overview:

UBQ Materials has created a biobased thermoplastic raw material made of waste. With this technology, they create a way to divert residual household waste from landfills and transform it into an effective, valuable, climate-positive substitute for plastic. **McDonald's** is using food trays in Latin America and the Caribbean made from food waste by UBQ Materials. The company claims that for every ton of UBQ material used, up to **15 tons of CO_2eq is saved.**

SUMMARY

MATERIAL INPUT

Unsorted household waste – including all organic materials, dirty cardboard, and unrecyclable plastic

APPLICATIONS

From food tray production to flooring and furniture

SCALE OF OPERATIONS

Large-scale mass production

APPLICABLE INDUSTRIES

Their technology is applicable in nearly every industry. Examples include Food & Beverage as well as Furniture.

UBQ Materials – UBQ

Technical Details:

UBQ Materials developed a process that converts residual municipal solid waste (RMSW) that is destined for landfills into UB material. Through a proprietary process, the mixed waste stream – containing everything from food waste and garden trimmings to paper, cardboard, diapers, dirty plastics, and packaging materials – is converted into an entirely homogeneous composite material (UBQ) that can be utilized by industry. (Metals and minerals are removed for recycling).

During the UBQ conversion process, the organic portion of the unsorted residual waste stream, which makes up the vast majority of household waste, is reduced into its more basic natural components as cellulose, sugars, fibers, and lignin. These natural particulates are reassembled into a matrix, into which the remaining plastic materials are bound to create the biobased composite thermoplastic material UBQ. This biobased material can be used in existing industries for the manufacturing of several products.

Figure. Representative image of products that can be made using UBQ material. Source: UBQ Materials

UBQ Materials – UBQ

Technical Details (Cont'd):

The modular conversion system can be effectively implemented regardless of the specific composition, volume, or origin of the RMSW. The UBQ process is: Patented worldwide; closed-loop; climate-positive; energy efficient; zero residual waste, zero emissions and zero water consumption.

The thermoplastic material is compatible with all major polymers and manufacturing processes and is also recyclable.

Figure: Representative image of UBQ material. Source: UBQ Materials

BioPowder

BioPOWDER.com

At A Glance
www.bio-powder.com
info@bio-powder.com
HQ Birkirkara, Malta
11-50 employees

Tech Overview:

BioPowder products are natural additives with high quality to be used in various industries. The company converts excess organic material from the fruit industry into fully biodegradable ingredients that can be reused in other industries. The main proposal is not to produce the raw materials of its products, but to process agricultural byproducts without competing with the food chain.

SUMMARY

MATERIAL INPUT

Powders of olive pits, fruit shells and stones

SCALE OF OPERATIONS

Commercial pilot scale

APPLICATIONS

Filler to replace polyethylene, polypropylene, and polyurethane microplastics; preserve and maintain equipment

APPLICABLE INDUSTRIES

Paints, varnishes, coatings; sandblasting, polishing, cleaning of hard materials; personal care scrubs

BioPowder

Technical Details:

Olive pits, almond, pistachio, argan, and walnut shells, and peach, avocado, and apricot stones are examples of raw materials used for applications in personal care ingredients, household product and detergent additives, food and feed ingredients, innovative biomaterials, fillers, binders, industrial abrasives, and other items. These materials are milled to the desired grain size, from 1,000 up to 50 µm. Blends of different fruit stone powders are also possible.

OLIVE PIT POWDER

Olive pit powder is a biobased hydrophobic powder used as filler to **replace polyethylene, polypropylene, and polyurethane microplastics in formulations**.

It can be used in paints, varnishes, and coatings as **matting agents** replacing the conventional polyethylene as an effective texturizer for both solvent-based and solvent-free formulations. This product can also be used as an **epoxy resin filler** (fiber-reinforced composites, biobased coatings, and ecological adhesives).

The products are suitable for food packaging as well as high-performance plastics in the medical, automotive, aerospace, nautical, and consumer item industries.

Source: BioPowder

BioPowder

Technical Details (Cont'd):

WALNUT SHELL

Their hardness of 3.5-4.00 on the Mohs scale makes walnut shells an **effective natural abrasive** in sandblasting, polishing, and cleaning of hard materials such as metal, carbon fiber, concrete, and hard plastic. This helps preserve and maintain industrial, medical, and automotive equipment.

Common examples of use can be found in **aviation**, where walnut shell granules are used for the cleanout of engines and turbines in an air jet blasting process.

Beyond the biodegradable aspect, walnut shell grit reliably removes corrosion or any chemical coating from boats, planes, and buildings without the need for additives. It is also a bio-ingredient for **hygiene products** — especially in surface cleaners .

PEACH STONE

The relatively high hardness (approx. 3.5 on the Mohs scale) makes granulated peach kernels a suitable biobased abrasive for polishing, cleaning, and sandblasting applications.

In contrast to walnut shells, peach stone powders do not contain any nut-related allergens, which makes them safe for personal care products. The relatively homogeneous shape of peach stone granules ensures a soft but effective natural skin abrasion without the risk of causing micro-lesions.

Source: BioPowder

BioPowder

Applications:

In view of the natural powders with different grain sizes made available, several applications are indicated, depending on the required composition. Among them are applications in:

- Ultra hydrophobic material: Hydrophobic paint texture and additive, epoxy resin fillers, anti-slip additives for paints and coatings, paint bonding agent additives, and hydrophobic ceramic coating
- Additives for biobased composites: Wood, plastic, and textile composites, bio-additives for rubber composites, additives for biodegradable composites
- Artificial turf infill: Infill material for artificial grass, pet turf infill, landscaping, and leisure turf
- Personal care ingredients: Abrasives for hand cleaners, natural exfoliating beads and scrubs, natural base materials for cosmetics
- Industrial abrasives: Biobased abrasives as drying media, natural abrasive blasting media
- Food and feed ingredients: Spice mix extenders of food ingredients, natural thickening agents for food, smoke chips for sustainable food flavoring
- Architecture, design, and construction: Biobased insulation materials, biobased colors for decorative design, bio-additives for building materials
- Innovative biomaterials: Innovative sustainable polymers
- Household and detergent additives
- Fillers, binders, and carriers

Source: BioPowder

The strategies and information provided in this report are an example of the insights clients rely on PreScouter for.

PreScouter is helping companies implement more sustainable practices throughout the entire product lifecycle, while ensuring the safety of products for consumer health, through the services listed on the right.

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5000+
Challenges Conquered

150K+
Hours of Research

"Working with PreScouter is like having a secret information drawer. When you need perspective and insight you can open the drawer and, presto, you have what you need."

Rowena Pullan, Strategic Innovation Leader, VP Wellness R&D at Pfizer

PreScouter's research consultancy has helped drive strategic planning and specific solution development decisions for some of the most sustainable and prominent companies in the world, for years.

1. Identifying novel biobased and/or natural sources with similar or better efficacy compared to currently sourced ingredients
2. Assessing actionable technologies that enable consumers to tailor the use of active ingredients to their specific needs
3. Reviewing and ranking competitor activity to determine areas of opportunity and differentiation

Potential Next Steps

- ✔ PreScouter can help conduct a thorough and comprehensive search for upcycling opportunities on your technical and business parameters. This can be done for products that are already on the market, those close to commercialization and/or those in development.
- ✔ PreScouter can provide best-fit recommendations and down select top candidates from a landscape custom to your application.
- ✔ PreScouter can perform anonymous interviews with companies and researchers to glean additional insights regarding the development pipeline.

SOME POSSIBILITIES THAT PRESCOUTER CAN OFFER FOR CONTINUATION OF OUR RELATIONSHIP

Authors

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PreScouter Technical Director

Gareth has been with PreScouter since 2015, and specializes in the Food & Beverage and Life Sciences industries. Since joining the the PreScouter team, he has worked across multiple topics ranging from product and process improvement and development, and sustainability throughout the food and beverage industry as well as healthcare. Gareth's research background at the University of Alberta is in the biochemistry of membrane proteins in health and disease. Prior to joining the PreScouter team, he was a project coordinator for the Cancer Research Institute of Northern Alberta (CRINA).

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Gloria is a microbiologist and science writer with 6+ years of collaborative interdisciplinary drug discovery research experience designing and modifying assays to determine the antifungal effects of plant extracts on fungal physiology. She has developed and optimized various microbiological assays and analytical chemistry lab protocols for the separation of plant products via HPLC and flash chromatography. She also has previous environmental toxicology and molecular biology research experience.

Ane Catarine Tosi Costa

PreScouter Researcher

Ane is a biologist with 5+ years of experience in scientific research. She has been working on microbiology, molecular biology, biotechnology, fermentation, and recently next-generation sequencing analysis.

Research gave Ane skills such as critical and analytical thinking, data analysis, literature review, project design and management, teamwork, and a constant desire for knowledge.

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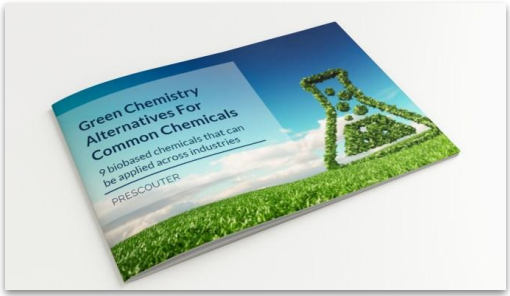

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