GROWING KENT & MEDWAY

Fruit Crop Waste and Valorisation

Report: The potential of fruit by-products for a biobased circular economy






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The Kent and Medway region generates substantial crop waste from various sectors, including wine, hops, fruit, cereals, and vegetables. Each type contributes specific by-products such as grape pomace, hop stems, apple pomace, and cereal straw. This report examines the potential of fruit crop waste and by-products to contribute to a biobased circular economy.

This report is an extract from a wider publication looking at the potential for agricultural and horticultural waste and crop by-products to contribute to a biobased circular economy across South East England. The full Growing Kent & Medway report explores the opportunities for fruit, vegetable, hop, cereal and mushroom waste valorisation.

Fruit waste valorisation

Kent has extensive fruit orchards and fruit waste, such as apple pomace, can be generated during fruit processing or after the harvest. During fruit and vegetable processing or preparation, peelings, trimmings, and other non-edible parts can be generated as by-products.

Fruit waste is abundant in Kent, where their management includes composting, anaerobic digestion, and sometimes landfill. However, valuable compounds like polyphenols, pectin, and carotenoids in fruit waste, and proteins, polyphenols, and essential oils in vegetable waste can support the development of food additives, antioxidants, natural dyes, and biofuels.

Industrial applications and pre-treatment requirements

For effective valorisation, pre-treatment processes for all waste types include grinding, drying, acid or enzyme treatment, and innovative extraction methods like ultrasound and microwave-assisted extraction.

How much waste is produced in the region?

South East England, a key region for fruit production, faces challenges in minimising fruit waste. Across the UK, an estimated £60 million worth of fruit and vegetables was wasted in 2022 due to labour shortages, with 40% of growers reporting crop losses as they struggled to harvest on time. This issue is particularly relevant to South East England, where large-scale farms like Hugh Lowe Farms strive to balance production with sustainability.

Hugh Lowe Farms exemplifies both the scale of fruit growing in the region and the efforts to address waste. The farm employs robotic pickers for strawberries, which help reduce losses caused by labour constraints, but inefficiencies persist, particularly during peak harvest seasons. These challenges highlight the need for regional collaboration and innovation to better utilise surplus produce and minimise waste.

What is currently done with this waste?

Here's a breakdown of what is currently done with this waste and its potential for sorting and treatment:

- **Food waste recycling**

Many households in South East England participate in food waste recycling programs, where fruit and vegetable waste is collected separately and sent to composting facilities. This transforms organic waste into valuable compost for agriculture.

- **Anaerobic digestion**

Some fruit waste is processed through anaerobic digestion, a biological process that breaks down organic matter in the absence of oxygen to produce biogas, which can be used for energy generation.

- **Animal feed**

Certain types of fruit waste, such as overripe or blemished fruit, may be suitable for animal feed, providing a valuable source of nutrients for livestock.

- **Landfill**

Unfortunately, some fruit waste still ends up in landfills, contributing to environmental problems like methane emissions and soil contamination.

How easily can this waste be sorted and/or treated for transportation?

Fruit waste can be relatively easy to sort and treat for transportation, depending on its specific type and condition:

- **Sorting**

Fruit waste can be sorted based on its composition (e.g., peelings, cores, whole fruit) and potential uses (e.g., composting, animal feed, anaerobic digestion). This sorting can be done manually or using automated sorting technologies.

- **Treatment**
  - Composting
    - Fruit waste can be directly composted or mixed with other organic materials to accelerate the composting process.
  - Anaerobic digestion
    - Fruit waste can be pre-treated to improve its digestibility and then fed into anaerobic digestion systems.
  - Drying
    - Fruit waste can be dried to reduce its weight and volume, making it easier to transport.

Challenges and opportunities

While there are opportunities to improve the management of fruit waste in South East England, some challenges remain:

- Inconsistent collection
  - Food waste collection systems can vary between different local authorities, leading to inconsistencies in the amount and type of fruit waste collected.
- Contamination
  - Contamination of fruit waste with non-organic materials can reduce its value for composting or anaerobic digestion.
- Infrastructure
  - A lack of sufficient composting and anaerobic digestion facilities can limit the options for processing fruit waste.

To address these challenges, increased investment in waste infrastructure, improved public education on food waste reduction and recycling, and stronger collaboration between stakeholders are essential. By optimising the management of fruit waste, we can reduce its environmental impact and contribute to a more sustainable future.

High-value compounds in fruit waste

Fruit waste is a rich source of high-value compounds with various applications in the food, pharmaceutical, and cosmetic industries.

Here are some of the most prominent compounds:

- **Polyphenols**
  - Phenolic acids: These compounds possess strong antioxidant properties, protecting cells from oxidative damage. They are found in abundance in fruit peels and seeds.
  - Flavonoids: This group includes anthocyanins, flavonols, and flavanols, which are known for their anti-inflammatory and anticancer properties. They are often concentrated in the skin and flesh of fruits.

- **Pectin**

A complex carbohydrate found in the cell walls of fruits, pectin is used as a gelling agent in jams and jellies. It also has potential applications in the pharmaceutical industry as a drug delivery carrier.

- **Vitamins and minerals**

Fruit waste, particularly peels and seeds, contains essential vitamins like vitamin C and minerals such as potassium and magnesium. These nutrients can be extracted and used in dietary supplements or fortified foods.

- **Carotenoids**

These pigments contribute to the vibrant colours of fruits and vegetables. Carotenoids, such as beta-carotene and lycopene, possess antioxidant properties and can be converted into vitamin A in the body.

- **Fibres**

Fruit waste is a good source of dietary fibre, which promotes digestive health and can help regulate blood sugar levels. Fibre can be extracted and used as a functional ingredient in food products.

- **Oils**

Some fruit seeds, like those from citrus fruits and avocados, contain valuable oils that can be used in cooking, cosmetics, and as a source of biofuel.

By extracting and utilising these high-value compounds from fruit waste, we can reduce waste disposal and create sustainable, value-added products.

What industrial applications might they be used for?

The high-value compounds extracted from fruit waste have a wide range of industrial applications:

Food industry

- Natural flavourings
  - Fruit waste, particularly the peels and seeds, can be used to extract natural flavourings for food and beverage products. These natural flavours can replace synthetic additives and provide a more authentic taste.
- Dietary fibre
  - Fruit waste is a rich source of dietary fibre, which can be extracted and added to food products to improve their nutritional profile. This can help address the growing demand for high-fibre foods.
- Fermentation
  - Fruit waste can be used as a substrate for fermentation processes to produce various products, such as alcohol, vinegar, and fermented foods like kimchi and sauerkraut.

Pharmaceutical industry

- Drug delivery systems
  - Pectin and other polysaccharides extracted from fruit waste can be used as carriers for drug delivery, improving the bioavailability and efficacy of medications.
- Antimicrobial agents
  - Some compounds found in fruit waste, such as polyphenols, have antimicrobial properties and can be used to develop natural preservatives and disinfectants.
- Neuroprotective agents
  - Certain compounds, like anthocyanins, have been shown to have neuroprotective effects and may be beneficial in preventing neurodegenerative diseases.

Cosmetic industry

- Skin-lightening agents
  - Some compounds extracted from fruits, such as arbutin, have skin-lightening properties and can be used in cosmetic products to reduce hyperpigmentation.
- Hair care products
  - Fruit extracts can be used to improve hair health and condition, providing benefits like moisture, shine, and reduced hair loss.
- Sun protection
  - Carotenoids, particularly lycopene, have antioxidant properties that can help protect the skin from UV damage.

Other industries

- Textile industry
  - Fruit extracts can be used as natural dyes for textiles, reducing the environmental impact of synthetic dyes.
- Bioenergy
  - Fruit waste can be converted into biofuels, such as ethanol and biogas, through processes like fermentation and anaerobic digestion.
- Water treatment
  - Fruit waste can be used to remove pollutants from wastewater, such as heavy metals and organic dyes.

It is important to note that further research is needed to fully explore the potential of fruit waste as a source of high-value compounds. By investing in research and development, we can unlock the full potential of this valuable resource and contribute to a more sustainable future.

What initial pre-treatment would be required?

The initial pre-treatment of fruit waste will depend on the specific compounds you want to extract and the extraction method you choose. However, some common pre-treatment steps include:

1. **Washing and sorting**
   - Washing: Removes dirt, debris, and microorganisms.
   - Sorting: Separates different types of fruit waste and removes any foreign materials.
2. **Size reduction**
   - Cutting or grinding: Reduces the size of the waste material to increase the surface area for extraction.
3. **Drying**
   - Drying: Removes moisture to improve the efficiency of extraction and storage. This can be done through methods like air drying, oven drying, or freeze-drying.
4. **Heat treatment**
   - Blanching: Involves heating the waste material in hot water or steam to inactivate enzymes and improve the extraction yield.
   - Microwaving: Can be used to quickly and efficiently dry or extract compounds from fruit waste.

The specific pre-treatment steps will vary depending on the desired outcome. For example, if you want to extract heat-sensitive compounds like vitamins, you may need to use gentler methods like drying at low temperatures or using solvent extraction.

A case study: University of Kent and Rent a Cherry Tree

Rent a Cherry Tree offers individuals the opportunity to rent a cherry tree annually, allowing them to experience the tree's growth throughout the season and harvest their own cherries. In collaboration with the University of Kent, they are researching the health benefits of Kent cherry products, focusing on anthocyanin levels and prebiotic properties, to provide scientific insights for local growers.

The challenge

Reducing food waste and maximising nutritional potential

The University of Kent, renowned for its scientific research, partnered with Rent a Cherry Tree, a local Kent cherry grower, to address a pressing issue: food waste in the cherry industry. Despite being a high-value crop, a significant portion of cherries is deemed unsuitable for sale due to factors like bruising, discolouration, or minor blemishes. This wasted fruit not only represents a loss of resources but also a missed opportunity to harness its nutritional benefits.

The solution

Upcycling cherry waste into nutrient-rich foods

The collaborative project, titled "Upcycled Food: Getting the Goodness out of Kent Cherries," aimed to transform this waste into valuable, nutrient-rich products.

Researchers from the University of Kent's School of Biosciences, led by Dr. Marina Ezcurra and Dr. Jenny Tullet, worked closely with Michael Dallaway, the owner of Rent a Cherry Tree, to:

- Identify health benefits
  - The team analysed different cherry products, including fresh fruit, juice, and dried cherries, to determine their specific health benefits. Research focused on the potential of cherries to combat inflammation, improve cognitive function, and support heart health.
- Develop new foods
  - By extracting valuable compounds from cherry waste, such as anthocyanins and fibre, researchers were able to create innovative food products. These included:
    - Cherry-infused snacks: Healthy snacks like energy bars and fruit leather were developed, incorporating cherry powder and fibre to enhance their nutritional profile.
    - Functional beverages: Cherry-based beverages, such as juices and smoothies, were formulated to target specific health benefits, like antioxidant and anti-inflammatory properties.
    - Prebiotic foods: The team explored the prebiotic potential of cherry fibre, which can promote gut health by nourishing beneficial bacteria.

University of Kent

Rent a CherryTree
Grown with a personal touch

A case study: University of Kent and Rent a Cherry Tree (cont.)

The impact

A more sustainable and nutritious future

The successful collaboration between the University of Kent and Rent a Cherry Tree has had a significant impact on the local food industry and beyond: [1]

- **Reduced food waste**
  - By finding innovative uses for previously wasted cherries, the project has contributed to a more sustainable food system.
- **Enhanced nutritional value**
  - The development of new, nutrient-rich foods has provided consumers with healthier options.
- **Economic benefits**
  - The project has the potential to create new business opportunities and boost the local economy.
- **Scientific advancement**
- The research has advanced our understanding of the health benefits of cherries and the potential of upcycling food waste.

This case study highlights the power of collaboration between academia and industry to address real-world challenges and create a more sustainable and nutritious future.

By harnessing the potential of food waste, we can reduce our environmental impact and improve public health.

Dr Marina Ezcurra and Dr Jenny Tullet, University of Kent, are working with Rent a Cherry Tree

1. Upcycled Foods: Getting the goodness out of Kent cherries: https://www.growingkentandmedway.com/research-project-directory/details/19427

This table provides a summary of industrial application for fruit waste:

	Type of waste produced	High-value compounds	Industrial applications
Fruit waste	Apple pomace	Polyphenols, pectin, dietary fibre	Nutraceuticals, natural food colourants, animal feed, antioxidants, thickening agents (pectin), biofuels
	Peelings and trimmings	Vitamins, polyphenols, carotenoids	Cosmetic ingredients (antioxidants), food supplements, natural colourants, biofuels
	Cores and seeds	Polyphenols, oils	Food flavourings, antioxidants, dietary supplements, animal feed

Valuable chemicals derived from agricultural waste

Agricultural waste, often considered a mere by-product, is emerging as a treasure trove of valuable compounds with immense potential for various industries. From pharmaceuticals to food and energy, these underutilised resources hold the key to a more sustainable and circular economy. By harnessing the power of these natural resources, we can reduce our reliance on non-renewable sources and create a greener future.

- **Fruit waste (e.g., apple pomace)**
  - Pectin
    - Extracted from fruit peels, pectin serves as a thickening agent in food products and is used in pharmaceuticals as a drug carrier.
  - Polyphenols and carotenoids
    - Carotenoids offer antioxidant benefits for skincare and dietary supplements, while polyphenols provide food colourants, cosmetics ingredients, and biofuels.
  - Oils
    - Certain seeds (like those from apples) yield oils used in cosmetics and biofuels, enhancing sustainability in these industries.
- **Fibres**
  - Residues like stalks and leaves contain cellulose, which can be transformed into bioplastics, bioethanol, and other biodegradable products.

Tensei's 'Second Harvest' approach creates new biomaterials from raspberry crop waste

High-value compounds sought by industry

In the push toward sustainable practices, several high-value compounds derived from agricultural waste are increasingly sought after by the chemical manufacturing sector and other industries.

- **Polyphenols (from grape, hop, and fruit waste)**
  - Sectors
    - Cosmetics, pharmaceuticals, food, and nutraceuticals.[1]
  - Uses
    - Known for antioxidant and anti-inflammatory properties, polyphenols like resveratrol, anthocyanins, and other phenolic acids are in high demand for natural skincare products, dietary supplements, and as natural preservatives in food products.
  - Sustainable benefits
    - Polyphenols offer greener, plant-based alternatives to synthetic antioxidants and preservatives.

- **Pectin (from fruit waste)**
  - Sectors
    - Food, pharmaceuticals, and personal care.
  - Uses
    - Commonly used as a gelling agent in food products, pectin also has applications in drug delivery systems and as a thickener in cosmetics.
  - Sustainable benefits
    - Pectin provides a plant-based, biodegradable alternative to synthetic thickeners and emulsifiers.

- **Bioethanol and biogas (from various agricultural residues)**
  - Sectors
    - Energy, transportation, and manufacturing.
  - Uses
    - Produced from grape, fruit, and cereal wastes, bioethanol and biogas are alternative fuels that reduce dependency on fossil fuels.
  - Sustainable benefits
    - These renewable energy sources lower greenhouse gas emissions, particularly when used to offset traditional fossil fuel consumption in transport and manufacturing.

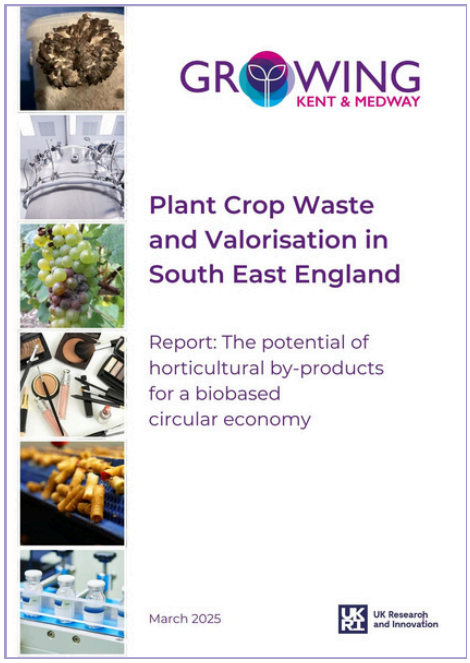
Conclusion

The agricultural waste in Kent and Medway holds immense potential for sustainable and profitable reuse. By focusing on high-value compounds and innovative industrial applications, these by-products could be transformed from environmental burdens into resources supporting diverse sectors, from pharmaceuticals to biofuels.

Sustainable practices like anaerobic digestion, composting, and nutrient recovery, coupled with advanced extraction techniques, are central to maximising the value of agricultural waste while minimising its environmental footprint. This approach aligns with a circular economy model, positioning the region as a leader in resource-efficient agricultural waste management.

The transformation of agricultural waste into high-value chemicals and materials marks a significant step towards a sustainable future. By leveraging the untapped potential of these resources, industries can reduce their environmental footprint, minimise waste, and create innovative products that benefit society.

From polyphenols with potent antioxidant properties to cellulose for biodegradable plastics, the possibilities are vast. As research and technology continue to advance, we can expect to see even more innovative applications for agricultural waste, driving a circular economy that prioritises resource efficiency and environmental responsibility.



This report is an extract from Growing Kent & Medway's report: Plant Crop Waste and Valorisation in South East England.

Read the full report at growingkentandmedway.com

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