GROWING KENT & MEDWAY

Grape Crop Waste and Valorisation

Report: The potential of viticulture 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 grape 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.

Wine industry waste and sustainable management

The growing English wine industry produces large amounts of grape pomace, wastewater, yeast lees, and vine prunings. Key sustainable strategies for managing wine waste include composting, bioenergy production through anaerobic digestion, and nutrient recovery. Grape pomace and yeast lees offer potential in high-value applications, such as animal feed, skincare products, and bioethanol production.

Proper management of these waste products is crucial to minimise environmental impact and maximise resource utilisation.

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?

The English wine industry has experienced significant growth in recent years, with South East England emerging as a major producer. In 2022, this region boasted 1,945 hectares of vineyards, yielding a substantial 9,336 tonnes of grapes.[1]

However, this burgeoning industry also generates various waste products. One such by-product is grape pomace, which consists of the skins, seeds, and stems remaining after the juice is extracted from the grapes. In 2022, South East England's vineyards produced an estimated 2,334 tonnes of grape pomace, of which 584 tonnes were grape stems.

Another significant waste stream from winemaking is wastewater. South East England's wine industry generated approximately 9,336,000 litres of wastewater in 2022.[2] This wastewater can contain organic matter, nutrients, and other contaminants that require proper treatment to minimise environmental impact.

In addition to these primary waste products, the winemaking process also generates secondary waste streams. One such example is wine yeast lees, a by-product of the fermentation process. Wine yeast lees contain yeast cells, tartaric acid, and other inorganic compounds. While these lees can be a valuable source of nutrients for plants or animals, they also need to be managed responsibly to avoid environmental pollution.

Finally, the viticultural process itself generates waste in the form of vine prunings. These prunings can be used for various purposes, such as mulching or composting, but if not managed properly, they can contribute to soil erosion and nutrient loss.

1. Wine GB Industry Report, 2022 – 2023.
2. Sustainability of Wine Production. Sergi Maicas, Jose Juan Mateo. 11 Jan 20.20

Addressing the waste challenge

The English wine industry is increasingly recognising the importance of sustainable practices and waste reduction. By implementing innovative technologies and adopting circular economy principles, the industry can minimise its environmental footprint and maximise the value of its waste products.

Some potential strategies include:

- Composting
  - Grape pomace, vine prunings, and other organic waste can be composted to produce nutrient-rich soil amendments.
- Bioenergy
  - Certain waste streams, such as grape pomace, can be converted into biofuels or biogas through anaerobic digestion.
- Nutrient Recovery
  - Wastewater can be treated to recover valuable nutrients, such as nitrogen and phosphorus, which can be used as fertilisers.
- Product Upcycling
  - Wine yeast lees can be used to produce value-added products, such as nutritional supplements or skincare products.

By adopting these and other sustainable practices, the English wine industry can continue to grow and thrive while minimising its impact on the environment.

What is currently done with this waste?

Expanding on grape pomace and other wine by-products

While grape pomace, a by-product of winemaking consisting of skins, seeds, and stems, is often utilised as a fertiliser, its application requires careful consideration. Although it can enrich soil, excessive use can hinder crop germination due to the high concentration of polyphenols, which possess toxic properties.

Another potential use for grape pomace is as animal feed. It can be incorporated into lamb feed, with an optimal inclusion rate of 12.2%. However, excessive use, exceeding 30%, should be avoided due to the presence of polyphenols and lignin, which can negatively impact animal health. Additionally, grape pomace has shown promise in reducing methane emissions from dairy cattle by approximately 20%. This reduction is attributed to the presence of crude fat and condensed tannins in the pomace.

Wine yeast lees, a by-product of the fermentation process, and grape pomace can be further processed through distillation to produce pure ethanol.

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Grape stems and prunings

Unfortunately, grape stems and pomace are frequently disposed of in landfills. A more sustainable approach would be to utilise them as feedstock for anaerobic digestion, a process that generates biomethane or electricity. Similarly, grapevine prunings could be diverted from landfills and used for anaerobic digestion or composting.

By exploring innovative and sustainable methods for utilising these wine by-products, the industry can reduce its environmental impact and contribute to a more circular economy.

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

A significant advantage of viticultural and vinicultural waste is its inherent separability. Given that these by-products are generated at distinct stages of the winemaking process, they are often already segregated. This inherent separation simplifies the process of valorising specific waste streams, eliminating the need for labour-intensive and costly separation steps.

In terms of treatment, these wastes are generally non-hazardous and do not require specialised treatment before transportation. This simplifies logistics and reduces the associated costs. For instance, grape pomace, a common by-product, is often transported to nearby farms using tractor-trailers, a straightforward and efficient method.

By understanding the distinct characteristics of each waste stream, wine producers can effectively manage and utilise these by-products, contributing to a more sustainable and circular economy.

High-value compounds in grape waste

Grape waste, a by-product of the winemaking process, is a rich source of valuable compounds with a wide range of potential applications.

Polyphenols, a class of compounds with potent antioxidant and anti-inflammatory properties, are abundant in grape seeds and skins. These compounds, including anthocyanins, phenolic acids, resveratrol, flavonols, and flavanols, have been extensively studied for their potential health benefits.

- **Antimicrobial and antifungal properties**
  - Polyphenolic compounds derived from grape pomace have demonstrated antimicrobial and antifungal activity.
- **Antioxidant and anti-inflammatory effects**
  - These compounds have also been shown to possess antioxidant and anti-inflammatory properties.
- **Gut health**
  - Polyphenols from red wine have been found to modulate gut microbiota, which can positively impact human health.
- **Anti-cancer properties**
  - Extracts from grape waste have exhibited antitumor and anti-proliferative effects, with the specific grape variety influencing the efficacy of these extracts.

Enanthic ester, commonly known as cognac oil, is another valuable compound found in grape waste, particularly in wine yeast lees. This compound can be extracted through distillation and is used in the production of cognac and certain perfumes. Approximately 0.4 kg of enanthic ester can be obtained from one ton of wine yeast lees.

By harnessing the potential of these high-value compounds, the wine industry can reduce its environmental impact and contribute to the development of sustainable and innovative products.

What industrial applications might they be used for?

Polyphenols

In addition to their potential pharmaceutical applications, polyphenols, particularly anthocyanins, find diverse applications in various industries:

- Dye industry
  - The vibrant colours of anthocyanins make them attractive as natural dyes. By utilising these naturally derived pigments, industries can reduce reliance on synthetic, inorganic dyes, promoting more sustainable and environmentally friendly practices.
- Cosmetics industry
  - The pigmentation and antioxidant properties of anthocyanins make them valuable ingredients in the cosmetics industry. They are used in a wide range of topical skincare products, including creams, serums, and lotions, to protect the skin from oxidative stress and promote a youthful appearance.

By exploring and capitalising on the diverse applications of grape waste compounds, industries can contribute to a more sustainable and innovative future.

There are several other additional potential applications for grape waste compounds:

Food and beverage industry

- Natural food colourant
  - Anthocyanins can be used as natural food colourants, providing vibrant colours to a variety of food products, including beverages, candies, and baked goods.
- Antioxidant supplements:
  - Polyphenol-rich extracts from grape waste can be used to create antioxidant supplements, promoting overall health and well-being.
- Flavour enhancers
  - Certain compounds found in grape waste, such as terpenes, can be used to enhance the flavour of food and beverages.

Other potential applications:

- Biofuels
  - Grape waste, particularly pomace, can be converted into bioethanol or biogas through fermentation processes.
- Animal feed
  - Grape pomace can be used as a feed additive for livestock, providing additional nutrients and improving animal health.
- Biodegradable plastics
  - Some research suggests that polyphenols from grape waste could be used to develop biodegradable plastics.

By exploring these diverse applications, the wine industry can maximise the value of its waste products and contribute to a more sustainable future.

What initial pre-treatment would be required?

Pre-treatment for extracting high-value compounds from grape waste

To effectively extract high-value compounds, such as polyphenols, from grape waste, various pre-treatment techniques can be employed. These techniques aim to disrupt the plant cell walls and release the target compounds into the extraction solvent.

Common pre-treatment methods

- **Physical methods**
  - Grinding or milling
    - Reducing the particle size of the grape waste increases the surface area available for solvent contact, enhancing extraction efficiency.
  - Drying
    - Removing moisture from the waste can improve the extraction process by reducing the polarity of the solvent and preventing microbial growth.
- **Chemical methods**
  - Acid or alkali treatment
    - Adjusting the pH of the grape waste can alter the solubility of polyphenols, facilitating their extraction.
  - Enzyme treatment
    - Enzymes **c**an be used to degrade cell wall components, making it easier to extract target compounds.

Extraction techniques

Once the grape waste has been pre-treated, various extraction techniques can be employed to recover the high-value compounds

- **Solvent extraction**
  - This traditional method involves using organic solvents to dissolve the target compounds. However, the choice of solvent and extraction conditions is crucial to maximise yield and minimise environmental impact.
- **Ultrasound-Assisted Extraction (UAE)**
  - Ultrasound waves can disrupt cell walls and enhance mass transfer, leading to improved extraction efficiency.
- **Microwave-Assisted Extraction (MAE)**
  - Microwaves can rapidly heat the sample, accelerating the extraction process and reducing energy consumption.
- **Supercritical Fluid Extraction (SFE)**
  - Supercritical fluids, such as carbon dioxide, can selectively extract target compounds with high efficiency and minimal environmental impact.

It is important to note that the optimal extraction technique depends on factors such as the target compound, the desired purity, and the scale of production. Additionally, combining different techniques can often lead to synergistic effects, further improving extraction efficiency and selectivity.

Ongoing research aims to develop more efficient and sustainable methods for extracting high-value compounds from grape waste, contributing to a circular economy and reducing the environmental impact of the wine industry.

This table shows each type of waste, allowing for specific industrial applications based on the unique properties and compounds present in grape waste. By maximising the use of these high-value compounds, industries can promote sustainability and reduce reliance on raw resources.

	Type of waste produced	**High-value compounds**	**Industrial applications**
Wine/grape	Grape pomace (skins, seeds, stems)	Polyphenols (resveratrol, anthocyanins), crude fat, tannins	Nutraceuticals, animal feed (reduces methane emissions), biofuel (bioethanol), antioxidants, compost, natural dyes
	Wastewater	Nutrients (nitrogen, phosphorus)	Fertilisers (through nutrient recovery)
	Wine yeast lees	Yeast cells, tartaric acid, enanthic ester (cognac oil)	Nutritional supplements, skincare products, ethanol production, compost
	Vine prunings	Organic material	Mulching, composting, anaerobic digestion for bioenergy

Valuable chemicals derived from grape 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.

Polyphenols

- Abundant in grape seeds and skins, these compounds offer antioxidant and anti-inflammatory benefits. Uses include pharmaceuticals for supplements, nutraceuticals, cosmetics, and natural dyes. Polyphenols, like resveratrol and anthocyanins, also have health benefits relevant to gut health, anti-cancer therapies, and cardiovascular support.

Enanthic Ester (Cognac Oil)

- Found in wine yeast lees, this compound is used in perfumes and cognac production.

Biofuel potential

- Grape pomace can be transformed into bioethanol or biogas, offering renewable energy applications. Vine prunings can also serve in anaerobic digestion to produce bioenergy.

High-value compounds sought by industry

In the push toward sustainable practices, several high-value compounds derived from grape 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.
- 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.

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.

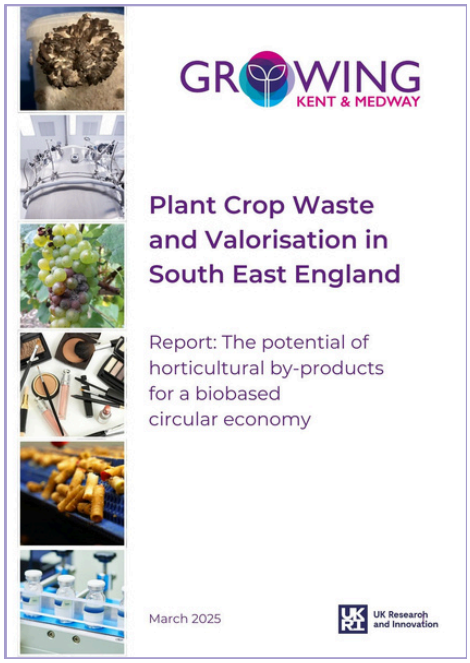
Conclusion

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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