AGROCYCLE FACTSHEET

Fruit pomace production and value chains

This information is taken from an in-depth study; "Agricultural production systems and sustainable value chains", written by the NNFCC as part of the Agrocycle project.

What is fruit pomace?

Fruit pomace is a by-product of pressing raw fruits, after removing its juice or oil content. Fruit pomace contains the skins, seeds, pulp and stem of the fruit, constituting its non-edible parts.

- It is estimated that fruit pomace may comprise between 25% and 35% of the mass of the raw material (fresh fruit).
- Fruit pomace is a lignocellulosic material with high moisture content, which typically contains a significant volume of sugars, pectins, starch dietary fibres, and secondary plant metabolites (such as vitamins, polyphenols, anthocyanins).

Availability of Fruit Pomace

An estimated 17 million tonnes of fruit pomace are produced every year in the EU, from apples, grapes, oranges, tangerines, peaches, tomatoes, and olives.

- The largest pomace resource comes from olives and grapes, with production of 6.4 million and 4.8 million tonnes respectively, between 2010 and 2013.
- Citrus pomace (oranges and tangerines) is next largest resource of fruit pomace (1.6 million tonnes of orange solids and 856 thousand tonnes of tangerine pomace), followed by tomato pomace (1.9 million tonnes), apple pomace (over 1 million tonnes annually) and peach pomace (290 thousand tonnes).

1. Production and Management

Grape pomace left behind after pressing(left) and green olives on the tree (right)

Typical management and use

The fruit pomace generated in factories is currently collected and stored ready for utilisation or treatment. The infrastructure for collecting pomace is already in place, making this residue easy to access at low cost.

- Fruit pomaces with low value potential are mainly used wet in various applications, particularly as animal feed near to the factory. If there is low local demand, fruit pomace is either fed into AD or composted into bio-fertiliser, otherwise it sometimes discarded in open areas potentially causing soil and groundwater pollution.
- Pomaces with higher value potential can be dried and used in more niche applications such as extracts for nutraceutical markets, or biocomposites.

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2. Processing systems resulting in pomace

General schematic flowchart of fruit juice processing.

Peach processing systems

Peaches are mainly consumed fresh, however in the EU, around 0.7 million metric tonnes of peaches are processed for their juice or tinned. The main by-product from the peach processing industry is pomace/pulp. Owing to the high moisture content of fresh peaches (approximately 90wt%) and the high levels of water-soluble carbohydrates, peach pomace is difficult to preserve at ambient temperature (high risk of spoilage).

- Therefore, most peach pomace is sent to landfill, with just a small volume used for the extraction of value-added products like dietary fibres, pectin and polyphenols for example.

Apple processing systems

Apple pomace is the solid residue remaining after the milling and pressing of apples for cider, juice and puree, and represents approximately 25-30wt% of the original fruit. Fresh apple pomace contains 15-30wt% dry matter on average, but moisture content will vary significantly depending on the processing methods used.

- Currently, pomace from the apple processing industry is treated via landfill, incineration, and composting methods. Only a small proportion is utilised as animal feed for ruminants or spread on land as a fertiliser. This type of pomace is typically low in protein but rich in fibre and sugars.

Citrus processing systems

Approximately, over 40wt% of the oranges produced globally are processed to make various commercial products, such as dehydrated citrus products, marmalades, jams, fresh juices, and flavouring agents for beverages. Approximately 40–60wt% of the processed fruit winds up as citrus pomace.

- At present, citrus pomace has no economic value, despite being rich in soluble sugars, cellulose, hemicellulose, pectin, and essential oils. Possible uses include composting, as animal feed, and the extraction of value-added constituents (e.g. oils and pectin). Currently, citrus pulp is used primarily as a substitute for cereal residues in ruminant feeds, but in nonruminant animals, citrus pulp may be toxic, even at levels of just 2.5wt% of the diet.

Grape processing systems

Grapes are mainly cultivated for their edible berries which are eaten fresh or fermented to produce red and white wine. It is estimated that for each tonne of grapes processed, approx. 300kg of solid residues are produced. In both white and red wine making processes, grape pomace is produced after pressing for juice extraction. The main difference is that white grape pomace is separated from the juice before the fermentation stage, whereas red grape pomace is co-fermented together with the grape juice and is separated after the fermentation stage.

- The pomace produced in either case is commonly utilised for the production of alcoholic spirits via the fermentation and distillation of white grape pomace, or just the distillation of red grape pomace.

Olive processing systems

There are three olive oil processing methods: traditional press process; three-phase decanting process; and two-phase decanting process. Regardless of the processing scheme used, the main residue produced is olive pomace (containing the olive pulp, skin, and crushed seeds). The physicochemical properties of the crude olive pomace depend largely on the processing scheme used for olive oil extraction.

- Almost all of the olive pomace produced in Europe is forwarded to industries that dry the wet pomace and extract residual oils using organic solvents.

Pomace Extracts & Ingredients

Recently, Pomace has been considered a source of **bioactive compounds**.

- compounds like polyphenols and anthocyanins can be isolated from fruit pomace and find applications in nutraceuticals, pharmaceuticals and the cosmetic industry.

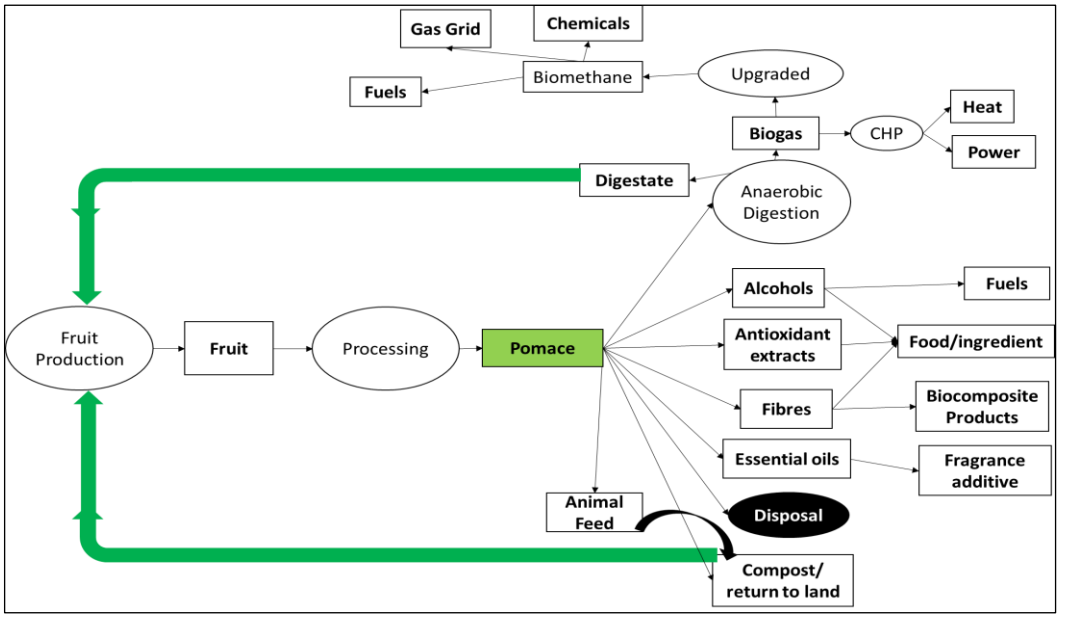
Many pomaces also contain **pectin**, a dietary fibre that cannot be absorbed by human body.

- Pectin has applications in the food, pharmaceutical, and cosmetics industries, and one of the most important uses is as a 'natural' food ingredient to form gels with sugar and acid.

Essential oils can also be extracted from pomace. Of particular interest is the oil from citrus peel which contains limonene and other compounds that give citrus fruits their characteristic aroma.

- Limonene has applications as a perfume in cleaning products, as solvent for adhesives, and in biological pest control.

3. Typical value chains



Pomace to energy

- Dried pomace has a high energy content, in particular when sourced from oil-rich fruits (e.g. olive pomace), and is sometimes **combusted** onsite to help power fruit processing and drying of the pomace, or sold as pellets for consumer heating.
- Pomace is increasingly being treated with **AD** to produce biogas, to power manufacturing operations or to export. Pomaces with more fermentable sugars, such as grape and apple pomace, obtain higher methane yields,
- Alternatively, fermentable pomace can be used to make biofuels, using microbes that ferment pomace saccharides into **ethanol**.

Animal Feed

Pomace's are nutritious, containing fibre, energy, vitamins and many types are used as animal fodder, for livestock and pets.

- Some pomaces (e.g. olive, grape) have low levels of protein and contain anti-nutritional factors such as tannins and polyphenols that decrease their value as fodder.
- Pomace can be fed to animals fresh from the factory, if used quickly before spoilage (often within days). To prolong storage up to months pomace can be dried and transported as pellets or ensiled with dry matter (e.g. straw).

Biofertilizer

Where alternative uses are not available and further processing to dry or pellet the residual material are not viable, pomace would typically be spread to land to realise its nutrient benefits. This is a low value option but is probably one of the most widespread at present due to the immaturity of other markets and value chains.

- Pomace contains nutrients useful for plant growth, making it a valuable source of mulch or compost when in combination with a carbon source, to balance the C:N ratio.

Constraints to maximise utilisation of fruit pomace

Fruit pomace has recently been regarded as a source of value constituents (e.g. polyphenols, anthocyanins, oils, and pectin) that may find applications in nutraceuticals, pharmaceuticals and the cosmetic industry.

The main issues that hinder the development of high value chains for pomace valorisation include:

- Its high moisture content and low value, which make it uneconomical to transport and process.
- the presence of highly biodegradable compounds that can be spoiled rapidly.

To reduce transportation costs and extend its shelf life, pomace can be ensiled, or dried prior to its storage. However, unless sun drying is available, dry can be an energy intensive and expensive procedure.

Given also its rather low value, it is often not worth the drying step and thus, pomace is mainly used as wet for various applications or often discarded in open areas, potentially causing environmental problems, like soil and groundwater pollution.

Grape fruits (left) and grape pomace left behind after pressing (right)

4. Constraints and actions for further exploitation

Indicative actions for more sustainable exploitation

There is a great technical potential in pomace beyond the traditional animal feed and composting. However, efficiencies in drying, storing and processing need to be improved to increase the value of products and make valorisation cost competitive compared with conventional management practices.

- To prolong storage and to make transport more viable, the use of processing technologies like biomass boilers could reduce both the economic and environmental cost of drying fruit pomace.
- Developing small-scale and flexible processing facilities for high value, low volume products can also make the subsequent transport of final products more economical.

Suitable markets need also to be identified to increase the economic potential of pomace value chains.

- Trade and knowledge platforms could help producers find solutions and markets, otherwise trade associations can help disseminate knowledge and make connections.
- Consultants can help industry develop market strategies, while industry can then respond by investing in specialised storage/processing facilities and logistics for valorisation.

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