

# Exploring apple processing by-products: an overview of 5 ways of valorisation for apple pomace

Apple is a fruit frequently produced and consumed in Europe. Indeed, the European Union is the second largest apple producer in the world, behind China, but ahead of the United States. The European production of apples is led by 3 countries: Poland, Italy and France. These three countries represent more than 50% of European apple production. Historically, Europe is an exporter of apples. However, the situation is very different depending on the country. Lithuania and Latvia, for instance, are very dependent on apple imports.

Apple production is economically valued in three main markets: food industry, animal feed and the health and hygiene sector. In the food industry, apples can be sold as fresh fruit, for eating raw, or can be processed, juice and cider being the main resulting products. Both procedures generate a large quantity of apple by-products: for instance, rotten apples are a by-product of harvest and storage, whilst apple pomace is a result of juice or cider production. Transformation processes can also discard out-of-size apples or generate contaminated water during cleaning stages.

As a consequence of the variety in terms of transformation process, various apple by-products are available, leading to a great diversity of raw materials. The B-Resilient partners decided to focus their attention on **apple pomace**, which is the most important by-product of apple industrial transformation. Apple pomace is made up of residues from the production process (peel, seed, stem, juice, etc.) and it represents up about 25 % of the apple mass (Zlatanovic et al. 2019a), though interviews with manufacturers indicates a very different mass depending on how apples are processed.

The B-Resilient partners made the decision to explore the valorisation of apple by-pomace in 5 European regions where the apple production and processing sector are either important at regional level or the valorisation of apple by-products is now investigated: Pays de la Loire, Normandy, Brittany and Sud-Provence Alpes Côte d'Azur, in France, and Wallonia in Belgium.

The partners conducted a market analysis aimed at exploring new business opportunities in the valorisation of apple pomace. The study included a review of scientific literature available, data gathered through Mintel, an international database of product releases as well as interviews with 13 organizations, including different types of companies (SMEs and large companies), apple producers and processing companies, solution providers (e.g., food research labs, biosolution providers, etc), as well as public and private technical centres. This work allowed to identify 5 main ways of valorisation of apple pomace in the regions covered by the study: animal feed, methane and biofuels, food, extraction of bioactive compounds and packaging.

**Animal feed** represents the oldest process of valorisation of apple pomace and is the one that allows the most important optimization in terms of quantity. Apple pomace, in this sector, is particularly used as feed supplement for ruminants. However, it has a poor economic added value. In addition, the use of apple pomace for animal feed faces limits due to its richness in ethanol and pectin. Another limit lies in the presence of pesticides, which is a major health issue for animals.

Apples are rich in sugar which can be transformed, under certain conditions, into methane or ethanol for **biofuels**. Methane and biofuels are therefore an additional way of valorisation, well explored by the literature and mentioned by industrials. However, although common, this way of valorisation also has its limits. Apples, and the relative apple pomace do not have a significant methanogenic potential and being a seasonal crop, they can only be exploited for the manufacture of biogas or biofuel for a short period of time. Thus, they cannot be exploited as a primary source of energy, but only as a complement.

Apple pomace can also be valorised in the **food sector**, notably thanks to fermentation processes. Indeed, fermentation makes it possible to exploit apple pomace in a large number of sectors: cosmetics, nutraceuticals, food processing, agriculture (by providing soil nutrients), etc. However, this way of valorisation encounters a certain number of problems: the stabilisation of apple pomace, the access to the raw material as well as a poor economic value added for industrials. End-user markets where are sold the ingredients/products resulting from apple pomace valorisation in food are small and face logistical problems. In addition, an issue raised by manufacturers is the limited application allowed by the legislation. Food processing industrials are not encouraged to valorise apple pomace through fermentation processes because they have often already adopted more rentable valorisation processes (such as biogas, methane, or feed) which are costly to change, and the demand for the food ingredients issued from apple pomace fermentation is currently too poor.

The extraction of **bioactive compounds** is also an additional method of valorisation. Indeed, apple and apple pomace are rich in polyphenol and phenolic acid, which are used in nutraceuticals, cosmetics, or pharmaceuticals. However, several problems also limit this way of valorisation. First, the extraction costs are high and require investments that the French and Belgian manufacturers interviewed do not seem to be ready to make. In addition, the prices of non-upcycled molecules are lower than the ones extracted from apples. Finally, yields need to be improved to allow enterprises to be competitive.

The last way of valorisation identified, currently emerging and niche, is **packaging**. Apples are a source of fibres, which can be an interesting substitute for petrochemical products. However, the markets for this valuation are limited. Legislation, particularly in France, imposes strict rules regarding pesticide residues. In addition, the process requires specific investments, which few plastics manufacturers seem ready to make.

In conclusion, although there are several opportunities for valorisation, many limitations still exist in each sector and none make it possible to valorise a significant quantity of apple pomace.



Would you like to receive more information about apple by-products recovery in the regions targeted by the B-Resilient partners?

Please do not hesitate to contact with your local partner!



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