# Innovative biorefinery development for valorisation of raisin finishing side-streams: Dry wine making process

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Raisins are dried grapes produced by sun, shade, or mechanical drying. In Greece, the famous variety Corinthian currants (black raisins), is an old, historic product that played an important role in the development of the Greek State, as an important exporting product. They are still exported in many countries in large quantities; however their production cost is high because they are cultivated in non-irrigated, sloppy mountainous areas (300-1200 m altitude) of the North and West Peloponnese, and in two Ionian Islands. There are three main subvarieties of the product, the *Gulf*, produced in the Corinth area, the *Provincial*, produced elsewhere in W. Peloponnese, and the *Vostizza*, which is the top quality, produced in the area of Aeghion and is a Product of Designated Origin (PDO). In recent years companies working with this product have made a lot of progress and innovation, including engagement in intense research activities to determine the nutritional value of the product. The published research shows that the currants are an excellent source of antioxidant polyphenols, and retain their antioxidant activity during processing (Chiou *et al* 2014). They are also rich in fibre with potential prebiotic properties, present high bioavailability of micronutrients (Kanellos *et al* 2013a), have anticancer properties (Kountouri *et al* 2013), and a moderate Glycaemic Index (Kanellos *et al* 2013b), albeit their sweetness, therefore they can be consumed by diabetics. A currant possessing company produces a large amount of a lower quality side-stream per day with ~70% invert sugar content. In Greece, this side-stream is mainly used for vinegar production and to a lesser extent for raisin syrup production. To exploit this highly nutritional side-stream, the contained sugar can be converted to a variety added-value products such as syrups (brown, white, liquid or solid), wines, distillates, single cell protein (SCP; e.g. baker's yeast) and other valuable biotechnological products (bacterial cellulose, nanoporous cellulosic materials, etc.). The solid residues can also be valorised, in a biorefinery manner, through the production of antioxidant-rich preparations, prebiotics, and porous cellulosic materials for various novel applications (Fig. 1), such as wine, vinegar, and balsamic vinegar production with innovative processes based on immobilised cells technologies and selected microorganisms.

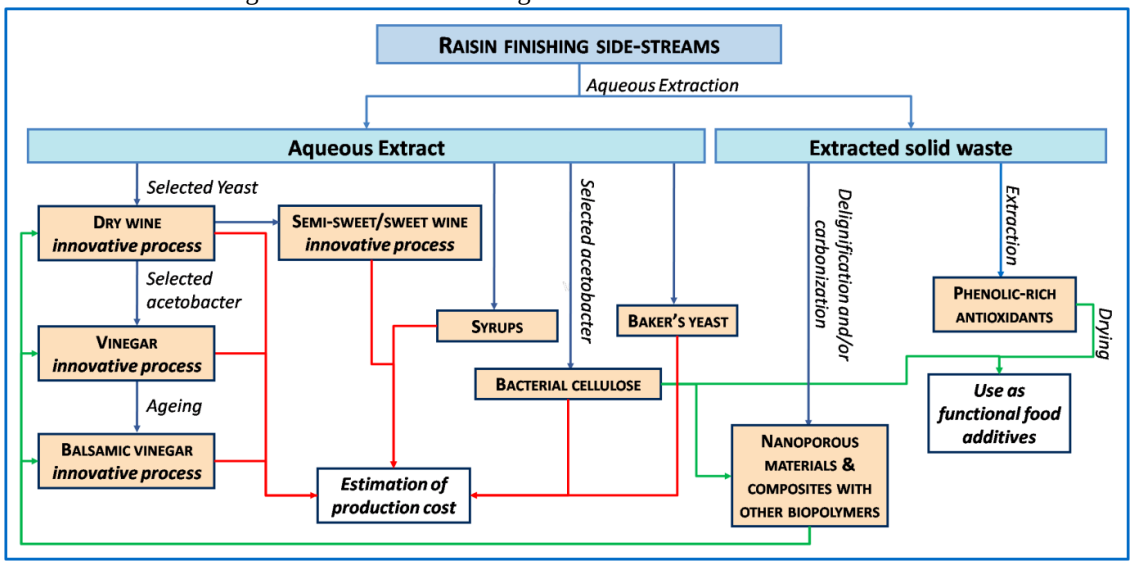


Fig. 1. Proposed biorefinery for valorisation of Corinthian currant processing side-streams.

In the frame of this biorefinery concept, the production of dry wine using must extracted from the *Vostizza* currants side-stream, at ambient and extremely low temperatures using immobilized yeast, is described. Warm extraction (70ºC) of the currants was applied to obtain a ~11.3ºBe density extract with no addition of $SO_2$. The

extract was fermented by the cryotolerant and alcohol resistant yeast strain *Saccharomyces cerevisiae* AXAZ-1, immobilized on delignified wood cellulose (DC), at 22, 15, 10 & 4ºC. Ethanol and wine productivities were high, indicating suitability of the biocatalyst for low temperature wine making. The operational stability of the biocatalyst was good, which was active even at 4ºC (fermentation time 3-4 weeks). The residual sugar was low in all cases (0.017±0.02 g/L). The titratable acidity was 3.61±0.23 g/L (expressed as tartaric acid). The volatile acidity was low (0.60±0.11 g/L expressed as acetic acid). Furthermore, the flavour and clarity of all wines produced at low temperatures (below 10ºC), especially those produced by immobilized cells, were better at the end of fermentation, compared to wines produced at higher temperatures, as also indicated by the Solid-Phase Microextraction (SPME) GC/MS analysis of aroma volatiles (Table 1). However, the phenolic content of the wines was lower at lower fermentation temperatures and when immobilised cells were used.

Table 1. SPME GC/MS analysis of the aroma of wines produced by immobilized cells on DC at 22, 10 and 4ºC.

| Group of compounds | Concentration(μg/L) | | |
|---|---|---|---|
| | 4ºC | 10ºC | 22ºC |
| Alcohols | 6,35 | 7,67 | 11,32 |
| Esters | 27,38 | 21,06 | 21,35 |
| Organic acids | 1,76 | 1,40 | 0,93 |
| Carbonyls | 0,16 | 0,15 | 0,05 |
| Terpenoids | 0,16 | 0,62 | 0,17 |
| Other | 0,86 | 0,55 | 0,36 |

Based on these findings, an industrial process for dry wine making in the frame of the above biorefinery, is proposed, in which the produced wine can also be used as raw material for the production of other products of good quality and added-value, such as distillates (raisin brandy) or semi-sweet/sweet wines (Fig. 2). For these products, the wine making process must be in conjunction with the syrups/extracts, yeast, vinegar, and distillates production units.

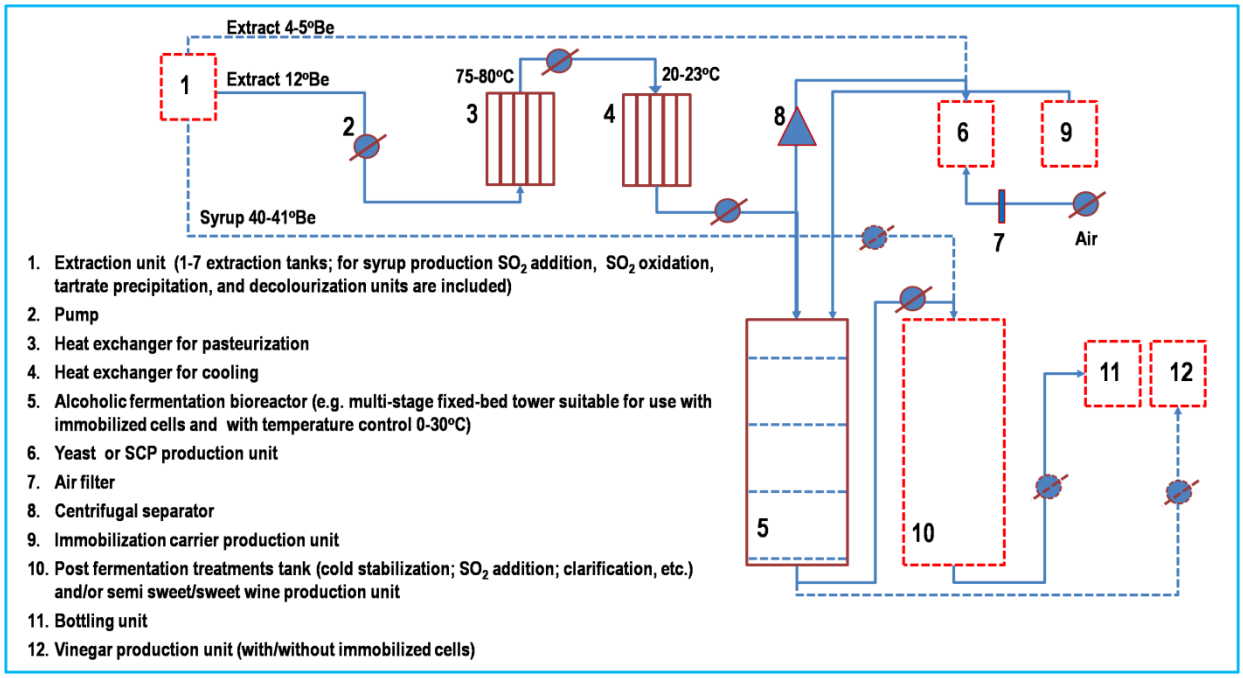


Fig. 2. Flow diagram of dry wine production and other products from raisin finishing side-streams.

Acknowledgements

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References

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