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The true cost of Wine from a biorefinery perspective

The prices of food and beverages displayed on supermarket shelves seldom reflect the true costs and benefits associated with their production and consumption. These true costs are partly hidden costs — resulting from the environmental, social, and human health impacts of agricultural commodity-related activities (what is called sometimes negative externalities) — and are either disregarded or seen as necessary trade-offs, ultimately being externalized to society (1). Recently, the FAO issued a call to action urging governments to invest in research, data collection and capacity building to "use real cost accounting to systematically take into account hidden costs and benefits in order to guide structural changes towards agri-food systems that provide affordable, healthy and sustainable diets". Important to have in mind that no standardized True Cost Accounting (TCA) methodology exists, and that product-based studies remain limited.

A research gap so far is the overlook of the externalities linked to non-food by-products* along the value chain, despite their potential as significant biomass sources across various applications. Incorporating these by-products into TCA aims to provide a more holistic view of the system, promoting a multi-stakeholder biorefinery approach that optimizes biomass conversion into products for different markets (food, materials, energy).

Our objective is to highlight the potential of exploring this under studied aspect, and the potential of enhancing circularity, to strengthen the resilience, social value, and economic competitiveness of the sector (2).

As first step, this contribution addresses this gap by integrating by-product valorization into the true cost framework, using the Swiss PDO wine industry — a major economic driver rooted in Swiss traditions — as a case study. It also seeks to compare by-product recovery scenarios to evaluate their impact on the true cost and recommend potential strategies for implementing a biorefinery approach.

The scope of the studied system includes viticulture, the winemaking process, and distribution, while excluding health impacts at the consumption level. The downstream non-food value chain is considered at the manufacturing stage, particularly regarding the recovery of grape marc — the residue left after pressing grapes for wine. This includes the transportation of the by-product to the recovery facility, its treatment, and the subsequent use of the valorised products and second generation by-products within the Swiss wine industry. The integrated production system, which is prevalent in about 85% of the vineyard area (3), is modelled on cooperative wineries with a circular economy perspective and focuses on white wine production, reflecting Switzerland's particularly high local consumption. The list, weight, and origin of ingredients are defined using representative PDO wines as a point of reference.

To evaluate the benefits of transitioning to a biorefinery approach, the study explores three primary recovery routes for winery by-products: agronomic, energy, industrial. It highlights two key valorization methods —methanization and distillation— and expands the scope to include fossil-based and conventional systems that are replaced.

* *By-product* refers to 'a substance resulting from a production process which is not the final product intended by that process, but which is certain to have a subsequent and direct use. The recovery is partial, specific or local. Where it exists, the economic added value remains low, subject to economic uncertainties.' (4)

The evaluation of the hidden costs and benefits related to the wine value chain is conducted based on the methodology proposed by Crosnier et al. (5) and complemented with newly developed methods.

Overall, the hidden costs associated with wine production are estimated at 7.63 CHF per litre. Most of these costs are due to biodiversity (79%) and environmental externalities (9%), primarily linked to grape production rather than winemaking, followed by socio-economic externalities. Including the recovery of grape marc presents a promising opportunity to reduce environmental hidden costs. Main findings are the following:

- Methanization offers environmental benefits across all impact areas — resource depletion, climate change, and ecosystem damage — providing an estimated annual savings of around CHF 1'022'970 for the Swiss white wine sector, five times greater than those of the distillation approach.
- Agronomic recovery via digestate from the methanization of grape marc provides a 93% higher net benefit compared to grape pulp from distillation.
- Energy recovery through biogas from methanized grape marc reduces environmental costs by 34% more compared to ethanol produced through the distillery process.
- Using recycled fertilizers yields an annual financial saving of approximately CHF 4,780 for cooperative winegrowers.

These initial findings should be put into perspective, considering the high dependence on the type and quantity of by-products considered, as well as the current lack of reliable data which hinders a comprehensive assessment of the distillation pathway. This pathway could still offer potential economic benefits, such as direct or indirect revenue from the sale of grape marc and other distillation products and by-products. Further research is needed to explore additional valorization pathways and integrate them, to better reflect the system's diversity.

References

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Keywords

Please choose the main keywords of your contribution (with an X, unlimited number)

- Agriculture
- Biodiversity
- Diversification
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