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An Industrial Ecology approach to solve wine surpluses problem: the case study of an Italian winery

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ABSTRACT

The wine industry worldwide is undergoing a chronic surplus of production, estimated at more than 30 millions of hectoliters. This extra waste (unsold wines) have to be handled in order to not aggravate the wine environmental impacts. With the aim to reduce this surplus, the present research evaluates new grape uses: by blending them with other fruits in the formulation of a "100% fruit juice". The idea is to move from a linear model, in which grapes are grown only for wine production, to a complex one, in which grapes are grown for other uses too, in order to obtain a better use of raw materials, as opposed to waste production. This research apply a particular form of Industrial Ecology, integrating raw materials among farms. In order to evaluate the idea, a life cycle assessment was carried out, to make a comparison of two scenarios (the linear and the complex). Results show reduced emissions of greenhouse gases and a reduced amount of unsold wine to be treated. The wider market scenario provides healthy products to consumers: fruit juices. Regarding this last point, it should be emphasized that this fruit juice concept is already on the market since two years. This approach to wine surplus has demonstrated that transferring part of the must to the fruit juice production lightens the environmental load of a company (increased sustainability), lightens the unsold wine problem (increased efficiency in the resources use), and expands market opportunity by providing healthy products to consumers (increased competitiveness).

1. Introduction

The wine industry worldwide is undergoing a chronic surplus production, estimated by the *Organisation International de la Vigne et du Vin* (OIV) at more than 30 millions of hectoliters (OIV, 2014a), which depreciates prices (Ramos et al., 2012) and this situation occurred for several years (Aylward, 2012). Even if this problem is closely related to the vintage conditions, from a European point of view the wine sector is going also through deep changes. The appearance on the global market, since the late 1980s, of new wine producing countries (South Africa, New Zealand, Australia, Chile, the US, etc.) (Morrison and Rabellotti, 2014), and, in spite of the chronic surplus of production, the continued decrease of European vineyards (OIV, 2014a) contribute to a dynamic situation. Worldwide, the OIV observes a gap between production and consumption of wine with a tendency to generate surpluses. Since the 1970s, the EU addressed this waste by giving economic incentives, as a market intervention (Meloni and Swinnen, 2012), to wine producers for its distillation (*crisis distillation*): a tool intended to be used only to tackle conjunctural surpluses. Later the problem has become structural rather than due to a moment of emergency and the *crisis distillation* has also started to cover 'quality wines' (Commission of the European Communities, 2006). The European Regulation (EC) n.479/2008 on the common organisation of the wine market has sanctioned the end for these incentives with effect from August 2012. In 2006, among others reforms, the EU Commission proposed the "green harvesting" a program aimed at eliminate surpluses through ex-ante measures rather than ex-post measures (incentives for distillation) (Meloni and Swinnen, 2012). As Belisario-Sánchez et al. (2012) highlighted, the simple use of wine to produce

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bioethanol is not economically and energy efficient, and causes a significant environmental impact, if there is no proper treatment of wastewater. Therefore, when a surplus occurs, it is important to manage it with a "low environmental impacts" strategy. The importance of lowering the environmental impacts during the production phases is also stated by the European Commission: '*products of the future shall use less resources, have lower impacts and risks to the environment and prevent waste generation already at the conception stage*' (European Commission, 2001). Appropriate waste management is recognized as an essential prerequisite for sustainable development and, as the scale of the negative environmental, social and economic impacts of food waste are becoming more apparent and global food security is becoming more pressing, food waste is increasingly recognized as being central to a more sustainable solution of the global waste challenge. Therefore a growing number of national and regional policies identify food waste as a priority waste stream (Papargyropoulou et al., 2014). In this paper, with the aim of reduce the wine surplus, an innovative idea for grape-based product has been evaluated. The strategy is to adopt the model in which energy and matter flow in natural ecosystems by adapting it to the human production processes. This may provide more efficiency and better environmental performance: this approach is what in literature is called Industrial Ecology. As Frosch and Gallopoulos (1989) stated, the traditional model of industrial activity, in which individual manufacturing processes take raw materials and generate products (to be sold) and waste (to be disposed of), should be transformed into a more integrated model: an industrial ecosystem. In such a system, the consumption of energy and materials is optimized, waste generation is minimized and the effluents of one process serve as the raw material for another process. More in specific, the approach proposed here is defined as "*Industrial Symbiosis*", the part of Industrial Ecology that engages traditionally separate entities in an integrated new production system to competitive advantage involving physical exchange/integration of materials, energy, water and/or by-products (Chertow, 2000). This research has combined some rural products, belonging to the same geographic area (southern part of Piedmont, Italy), for blend them into an innovative fruit juice made primarily with grapes. The idea is to move from a linear model, in which grapes are grown only for wine production (Scenario A), to a more complex one (Scenario B), in which grapes are grown for other uses too, in order to obtain a better use of raw materials, as opposed to waste production. The ingredients used were must (Barbera cv.), apple (Golden Delicious cv.), peach (Redhaven cv.) and pear (Williams cv.). According to the OIV (2014b), grape must is a liquid product obtained from fresh grapes, whether spontaneously or by physical processes (crushing, removing stems from grape berries or crushed grapes, draining, pressing). In order to verify if the proposed idea attain a more efficient use of grape and if the risk of unsold wine can be reduced, an analysis of the two production scenarios was carried using a Life Cycle Assessment (LCA) method. This choice was also made because, as Ardente et al. (2006) highlighted, when developing effective environmental policies in the improvement of products and services, the first step is the definition of their ecoprofiles. The analysis was carried out on the basis of the International Standards ISO 14040 series.

1.1. Wine and sustainability

The wine sector can be considered more environmental friendly than many others (Gabzdylova et al., 2009; Barber et al., 2009) but it requires, obviously, resources, such as water, energy, agrochemicals, wine additives and it produces large amounts of wastewater and organic waste (Arcese et al., 2012). This industry is currently engaged in developing green policies through the adoption of more sustainable production schemes (Villanueva-Rey et al., 2014) and this topic is seen as very important. This shift provides new opportunities to increase sales, especially in a context which is largely influenced by the global economic crisis (Villanueva-Rey et al., 2014). The interest in sustainability is also confirmed by a growing body of academic literature even if, especially in wine, being 'sustainable' is often misunderstood with being organic or biodynamic (Santini et al., 2013). With a worldwide overview, this author notes different sustainability levels in each wine country: some of them are 'greener' and, for example, California has an old tradition in this topic. The "Lodi Winegrape Commission", launched in 1992, focused on integrated pest management, is considered to be the foundation of sustainable winegrowing programs. Since then, the so-called 'emerging countries' — in particular, South Africa, Australia and New Zealand — have followed the same path, with policies that have sustainability as a central asset. In Europe there is a growing interest in this topic and in Italy, in particular, sustainability is focused primarily on environmental indicators, GHG and LCA analysis. Sustainability in wine sector involves two main aspects:

- Vineyard: soil management, water use, conservation/promotion of biodiversity, reductions of agrochemical use (Corbo et al., 2014);
- Winery: wastewater treatment, GHG reduction, the reduction or substitution of wine additives with more eco-friendly and natural substances (e.g. biopolymers), packaging (e.g. lighter bottles, recycled paper, etc.).

2. Material and methods

Wine production is a complex process that starts with the vineyard management (from planting) and ends, following the cellar operations, sales and distribution, with the end of life (disposal or recycling of packaging). As Pattara et al. (2012) noted, in the agro-food industry, various methods have been used to quantify and analyse the environmental impacts throughout the product life cycle. The first tool applied was LCA, defined in ISO standards 14040 and 14044, as an internationally recognized environmental accounting apparatus, which offers a standardized framework for quantifying the environmental impacts of a product or a production system throughout its life cycle (Bosco et al., 2011). The "life cycle thinking (LCT)" concept, from which LCA derives, avoids the so-called 'shifting of environmental burdens' from one part of the life cycle to another (Arcese et al., 2012), and the LCA method consists of a holistic accounting of the energy and mass that are exchanged from the biosphere to the technosphere (input/output accounting). In the last few years, a growing number of studies have been carried out internationally on LCA in the wine sector (Pattara et al., 2012): Villanueva-Rey et al. (2014) reported on 'Old World' wines in Spain, Italy, France and Portugal, while Herath et al. (2013) looked at 'New World' wines in Canada, Australia, Chile, California and New Zealand. Confirming the importance of this topic, even the EU has founded a project (ECO-Prowine) which involves 105 pilot wineries in Italy, Spain, Portugal, Bulgaria, Greece and Austria, to promote sustainability in the wine sector by using LCA method with the aim to reach a label for sustainable European viticulture (Corbo et al., 2014). In comparison with other industrial processes, however, the LCA applied on food products has more difficulties: the agricultural phase cannot be easily standardized and the variability of natural processes (Bosco et al., 2011), related to vintage's climate conditions, influences the analysis (Ardente et al., 2006).