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Tapping carbon footprint variations in the European wine sector

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ABSTRACT

A number of studies have highlighted the usefulness of carbon footprint (CF) to report environmental results in the wine sector, due to its common use by stakeholders and its favourable acceptance by the general public. The main aim of this study was to calculate the CF of 9 different types of wine in three different European nations (Italy, Luxembourg and Spain) under the same life-cycle methodological assumptions, to determine the main reasons for varying CF results. Moreover, the consequences that these discrepancies can cause in CF reporting were explored. Results demonstrated relevant differences in CF values depending on the appellation and on the type of wine. These were linked to a variety of factors, such as wine ageing, optimization of inputs, harvest yields, data quality or agricultural practices (i.e. organic vs. conventional). In fact, these differences, linked to the differing niche markets of the wines assessed, indicate the difficulty in standardizing specific mechanisms for GHG emissions communication in the wine sector.

1. Introduction

The use of Life Cycle Assessment (LCA) has become a common mechanism to evaluate and report the environmental performance of services and products, due to its holistic approach, assuring the comprehensiveness of the environmental assessment, and for its standardized method, guaranteeing reproducibility (ISO, 2006a, 2006b). Its use in the wine sector was late to develop when compared to other industrial processes of agricultural origin. However, in the past decade numerous publications have used LCA to analyse the environmental impacts linked to viticulture (see e.g. Vázquez-Rowe et al., 2012a; Bosco et al., 2011; Petti et al., 2010), vinification (Point et al., 2012) and associated processes (Ruggieri et al., 2009). Furthermore, a number of studies have highlighted the usefulness of carbon footprint (CF) as an appealing and popular pathway to report environmental results in this particular sector (Pattara et al., 2012; see also Weidema et al., 2008).

The main objective of this study was to calculate the CF of a set of 9 different types of wine belonging to 7 different appellations in three different European countries (Italy, Luxembourg and Spain) under the same assumptions in terms of life cycle methodological issues (functional unit, allocation, inventory data, etc.) in order to determine the main causes for differing CF values between wine types and appellations.

CF is a worldwide standardized indicator to estimate the emissions of greenhouse gases (GHGs) throughout the life-cycle phases of a given product, service or activity according to the Kyoto Protocol and Life Cycle Thinking principles (BSI, 2011). While CF is a single issue indicator that focuses on the carbon balance assessment of a product life cycle, LCA methodology includes a broader spectrum of indicators with multiple goals. The advantages of CF when compared to LCA in terms of communication to stakeholders and public opinion are, among others, the reduced complexity when interpreting the results and the pertinence of global warming which is universally acknowledged as an important environmental concern (Pattara et al., 2012; Weidema et al., 2008). Hence, CF has become a commonly used indicator for eco-labelling of food products, especially in some European nations, such as the United Kingdom or France (Alves and Edwards, 2008; Gadema and Oglethorpe, 2011). This has led to a rapid development of what could be named a *race to report* the GHG emissions of products by stakeholders in order to gain competitiveness and market visibility.

Numerous CF publications and *carbon calculators* have been developed specifically for the wine sector (Bosco et al., 2011; Carballo-Penela et al., 2009; Gazulla et al., 2010; Pattara et al., 2012; WFA, 2011). Moreover, Vázquez-Rowe et al. (2012b) suggested the creation of an *environmental vintage* which would complement the quality standards provided by the vintage based on a GHG emissions grading system for a particular wine.

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The assimilation of using CF as a reporting mechanism in the wine sector can be identified as a phenomenon that has been reproduced based on environmental dissemination patterns in other food and beverage sectors, but current available literature fails to provide a solid basis for the selection of this indicator for wine, as well as the advantages and limitations of using this indicator. The present paper, which is well framed in the current literature of wine-LCA case studies (e.g. Bosco et al., 2011; Notarnicola et al., 2003; Pattara et al., 2012; Petti et al., 2010; Pizzigallo et al., 2008; Point et al., 2012; Vázquez-Rowe et al., 2012b), investigates these potentials by providing new issues of interpretation of CF results and reporting when comparing several wine production life-cycles in Europe.

2. Materials and methods

2.1. Goal and scope

CF constitutes the estimation of the carbon dioxide equivalent (CO_2 eq) emissions linked to a particular product or service from a life cycle perspective (BSI, 2011). The current study assesses the CF of 9 different wine production systems in 3 different European nations (Table 1). The chosen methodological framework to compute CF was the ISO standards for LCA (ISO, 2006a, 2006b). However, it is expected that by April 2014 the new ISO 14067 should be available for specific computation of CF studies. The IPCC 2007 assessment method was selected to compute the GHG emissions (Frischknecht et al., 2007), using the 100 year frame, while Simapro v7.3 was the software chosen to carry out the CF calculations (Goedkoop et al., 2010). The functional unit (FU) for this study was a 750 mL bottle of wine, which is the most common reference unit used in the wine-LCA literature (Petti et al., 2010).

Despite the fact that some of the wineries included had already been used for prior LCA studies (Benedetto, 2010; Carta, 2009; Rugani et al., 2009; Vázquez-Rowe et al., 2012a, 2012b), in the current assessment all wine farms were harmonized in terms of inventory data and methodological assumptions in order to allow direct comparability. More specifically, the harmonization consisted of providing data completeness for the different wine farms during the production phase, interpreting the main constraints concerning the lack of data availability and applying the same assumptions regarding methodological issues in CF, such as FU, default Life Cycle Inventory (LCI) database, assessment method or system boundaries. Additionally, results for the different wineries were not available for the same year of assessment. In fact, a recent study published by Vázquez-Rowe et al. (2012b) demonstrated the important interannual variations that can be found within the same appellation regarding GHG emissions in the viticulture stage, due to changes in yield and in fertilization and use of vine protection agents. However, the fact that each of the farms examined in the different appellations is not subject to the same climatic and soil conditions within each season, as well as the impossibility of conducting an interannual assessment for the wine farms evaluated, makes this issue unquantifiable and, therefore, irrelevant in terms of comparability of trends between the different wines in the present study. Nevertheless, it should be noted that interannual variations may imply a considerable source of uncertainty in the individual CF of each appellation (Garnett, 2007). Finally, it is important to note that providing representative values for each of the analysed appellations, based on the inventory data collected for each wine farm, is not an objective of the current study. However, we do expect that the inventory data and the CF results can be used as reference for these appellations in future studies, as long as a series of limitations (e.g. agricultural practices) are considered.

2.2. Description of the case studies and system boundaries

As shown in Table 2, the inventory data collected for the Galician and Italian wineries included the agricultural activities of vine planting and viticulture. All the inventories, except *Rías Baixas*, referred to one single viticulture estate, whereas the data retrieved for the mentioned appellation were based on the reports of 40 different winegrowers (Vázquez-Rowe et al., 2012a). Furthermore, no data were available for the vinification and bottling stage of *Rías Baixas* wine, therefore limiting the assessment to the agricultural phase exclusively. Finally, the three production systems considered for *Moselle Luxembourgeoise* wine in Luxembourg only took into consideration the vinification and bottling stages of the wine production system. Nevertheless, it is important to note that, as in the case of the *Rías Baixas* appellation, the production of grapes is highly fragmented in smallholdings (Les Domaines de Vinsmoselle, 2012).

The vine nursery stage, which encompasses the production of rootstocks and buds for the early development of the vine plant, was excluded from the system boundaries due to lack of data

Table 1
Main characteristics of the wine farms assessed.

Appellation	Region	Type	Data source	Vineyard area (ha)	Grapes collected (t)	Year of assessment	Ageing time (months)	Average price (€/bottle)
Cannonau di Sardegna	Sardinia (Italy)	Red (organic)	Carta (2009)	20	172.8	2008	4	12
Chianti Colli Senesi	Tuscany (Italy)	Red (organic)	Rugani et al. (2009)	10	70.5	2007	12	14
Mixed[a]	Marche (Italy)	Red/White	Carta (2009)	1700	22,100	2008	6	11
Rías Baixas	Galicia (Spain)	White	Vázquez-Rowe et al. (2012b)	55.55	593.64	2010	–	–
Ribeiro	Galicia (Spain)	White	Vázquez-Rowe et al. (2012a)	14	120	2010[b]	8	14
Vermentino di Sardegna	Sardinia (Italy)	White	Benedetto (2010)	550	6000	2009	4	6
Moselle Luxembourgeoise	Luxembourg	White	*Unpublished*	230	3859	2008	0	7
Moselle Luxembourgeoise	Luxembourg	Red/Sparkling	*Unpublished*	57	140	2007/2008[c]	6/15	14/24

[a] The assessed winery includes the production of *Verdicchio*, *Montepulciano*, *Sangiovese*, *Passerina*, *Pecorino* and *Cabernet Sauvignon* wine varieties. Most of the wine produced in this winery is commercialized as belonging to the Verdicchio dei Castelli di Jesi appellation.
[b] Vázquez-Rowe et al. (2012a) included the assessment of the winery from 2007 to 2010.
[c] Average activities of the two years of assessment were reported.