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# The influence of wine loss rates on the LCA results for (bottled) wine

## Executive summary

"This study is not intended to be a comparative assertion among closure systems disclosed to the public. It aims at informing the wine industry stakeholders about the importance to consider the different loss and spoilage rate of wine when evaluating the environmental impacts of different closure systems."

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|---|---|
| Title | The influence of wine loss rates on the LCA results for (bottled) wine |
| Study Commissioned by | EAFA European Aluminium Foil Association e.V.<br>Am Bonneshof 5<br>40474 Düsseldorf<br>Germany |
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| About Quantis: | Quantis specializes in Life Cycle Assessment (LCA) and related applications. The company was founded in 2005 and has its global headquarters in Lausanne, Switzerland. Its Swiss office is based in Lausanne and Quantis has additional offices in Paris, France, Montreal, Canada and Boston, Massachusetts, USA. The company provides the highest level of expertise in delivering state-of-the-art analysis and solutions for leading companies, governments and non-profit clients. |

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Wine is a typical drink in Europe, which comes in a variety of formats. Annually about 140 mio hectolitre wine are consumed in the EU. If bottled, different closures are used as natural cork stoppers, synthetic stoppers or screw caps. Several life cycle analyses have been performed focussing on the life cycle of a bottle of wine. Main emphasis was given to the wine production itself and little attention has been paid to the influence of the performance of the chosen stopper on the full life cycle. The goal of this study is to estimate the life cycle environmental profile of a typical bottle of wine based on different existing published references and to determine loss rates of bottled wine in view of different closure systems.

As a first step, ten scientific publications presenting life cycle assessments of wine production are studied in order to determine the average impact of a typical bottle of wine. The following environmental impact categories and interventions are distinguished: climate change, non-renewable primary energy use, water consumption, atmospheric acidification, formation of photochemical oxidants, eutrophication and generation of solid waste. The steps covered comprise wine production from vineyard to consumption, including for example the winery processes and transportation. Omitted stages are documented. A parallel research based on about thirty sources including scientific publications and interviews with wine specialists serves to identify how loss rates of wine are influenced by different types of stoppers and to quantify this influence. Finally, the results of these two work streams are merged to determine the global environmental impact of wine considering the stopper choice and its corresponding loss rate.

In order to determine the average impact of a bottle of wine in a harmonized way among the different studies selected, the results have been recalculated and normalized to a 750 ml bottle of wine, which is a typical reference for the European market.

Table 1 reveals the average results out of the different literature studies as well as the figures, which have been established for the stopper system in particular. The latter have been published by the cork producer Corticeira Amorim in 2008. Large discrepancies occur which relate to the different system boundaries that have been used for the different studies involved. It is important noting that not all categories of impacts are covered in all studies.

Table 1: Potential environmental impacts associated with a bottle of wine on the European market and for the stopper system.

| | Range for cork soppers, synthetic stoppers and screw caps (published from Corticeira Amorim) | Literature review average results and range of results for a typical bottle of wine | |
|---|---|---|---|
| Climate change [kg$CO_2$eq] | 0.002 – 0.037 | 3.3 | 1.0 – 4.0 |
| Non-renewable energy use [MJ] | 0.1 – 0.55 | 47 | 16 – 58 |
| Water use [$m^3$] | 0.013 – 0.042 | 1.5* | 1.2 – 1.8 |
| Atmospheric acidification [g $H^+$eq] | 1.3E-03 – 8.2E-03 | 7.8E-01 | 2.7E-01 – 1.3E+00 |
| Photo oxidants formation [kg ethylene eq ($C_2H_4$)] | 3E-06 – 1.4E-05 | 1.9E-03 | 1.1E-03 – 2.3E-03 |
| Eutrophication [kg $PO_4^{3-}$ eq] | 6E-07 – 9E-07 | 4.5E-03 | 1.4E-03 – 7.8E-03 |
| Solid waste generation [kg] | 0.004 – 0.007 | 0.7* | 0.7 – 0.7 |
| *) figures without use phase considerations | | | |

The environmental profile generated by the literature review shows that the closures as calculated from Corticeira Amorim contribute between 0.001% to 3% to the total score for a bottle of wine depending on the indicator and the type of stopper (cork stoppers, synthetic stoppers and screw caps). The contribution of stoppers to the considered impact categories is neither relevant nor significant when compared to the characteristic values, which have been determined for the life cycle of a bottle of wine.

Wine losses occur over the whole life cycle during filling, storage, transportation and at the consumer. In addition, wine losses occur if the fragile taste is disturbed i.e. by a failure of the stopper involved. Corked taste is a well known failure, which occurs indeed only for bottles which are closed by cork stoppers. Corked taste has different origins, which may relate to the activities of fungi (Armarilla Mellea) or other micro-organisms. As corked taste is detected at the consumer level, subjective judgements introduce considerable uncertainties in the estimation of a typical loss rate.

The literature review and the interviews with specialists on loss rates have shown that the specific relationship between the quality of a bottle of wine and the closure is difficult to determine. It can depend on the type of wine, the duration of conservation, the way bottles are stored, and many other parameters. The results of the review, however, show that the average loss rates of a bottle of wine are different depending on the stoppers. The results are summarised in table 2.

Table 2: Estimated (based on interviews) overall wine loss rates comprising losses and spoilage due to failures in the closure system and the related market share

| | Cork stoppers | Screw caps |
|---|---|---|
| Estimated loss rate | 2 – 5% | 0.2 – 0.5% |
| Market share[1] | 60% | 10% |

The estimated loss rates and spoilage rates increase the amount of wine needed to fulfil the functional unit. This additional amount adds also to the LCA profile and increases the potential environmental impacts. For cork based stoppers this increase is considerable. Figure 1 reveals as illustration the global warming potential of the calculated Corticeira figures for the closures together with the approximated value for the loss and spoilage rates that can be allocated to the different closures.

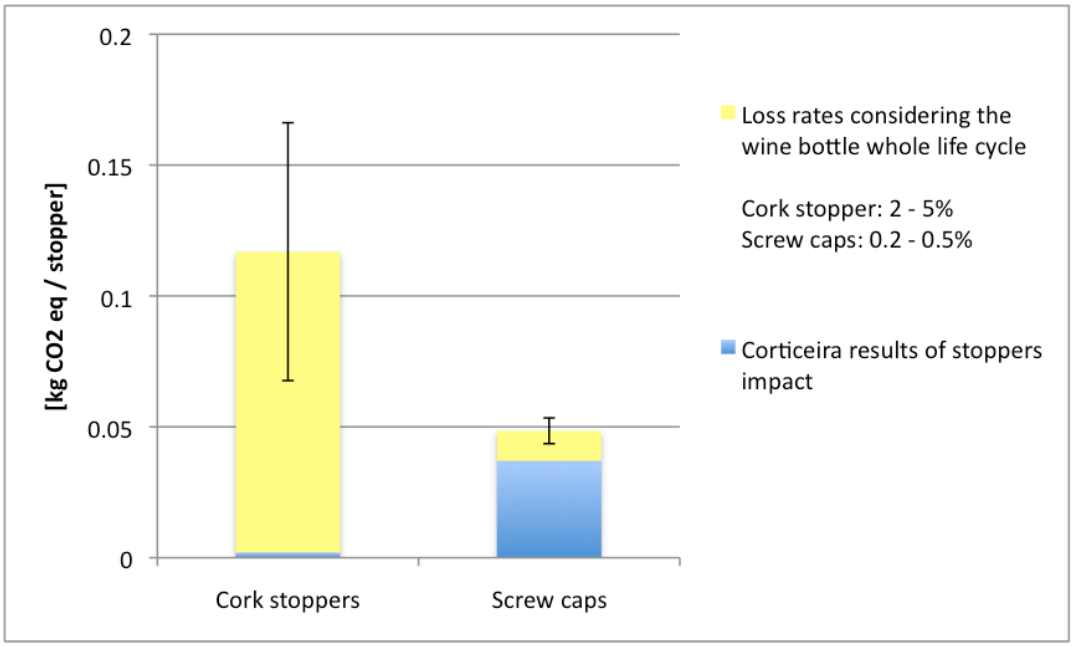


Figure 1: Greenhouse gases emissions associated with cork stoppers including a likely spoilage of 3.5% and screw caps with a potential spoilage rate of 0.35% for a single bottle of wine. The stopper data has been taken from the publication of Coriceira, the wine data result from the literature review.

The differences in other categories are equally influenced by the introduction of a spoilage rate. It appears that the wine loss rate due to the different types of closure is a more important parameter than the stopper material itself. The cork stopper presents a higher impact score when the loss rate is considered; much more bottles are lost (2% – 5%) and overcompensate for the lower specific cork score. It also becomes obvious that loss and spoilage rates need to be considered in order to come to meaningful conclusions with regards to sustainable production and consumption of wine.

[1] References: personal communication with Henri-Laurent Arnaud, editor of “La revue des oenologues”.

The LCA results presented are limited to the goal (objectives) and scope defined. Available primary data and the combination with generic data from preliminary literature studies and existing commercial databases or best estimates introduce uncertainties. In addition not all elements influencing the quality of a bottle of wine have been studied. Other parameters influencing wine loss rates over the whole life cycle of bottled wine except the taste degradation depending on the selected closure type have not been investigated.

With this background it can be concluded that

1. the contribution of the closure itself, whatever the type, to the global impact score for a typical bottle of wine is not significant and is therefore not a key parameter;
2. the wine loss rate induced by the type of closure is a more important parameter than the closure material to determine the environmental footprint of a bottle of wine;

These conclusions indicate that the effort to improve the environmental performance of bottled wine should be engaged on other elements than the stopper material itself. The analysis of the different references available has shown that the key contributors are the glass bottle, the car trip of the consumer to purchase the wine, the grapes cultivation and the winery processes. The related loss rates are therefore key parameters, at the different stages of the wine production.

There are clear and important limitations in studying the closure of wine bottles only. This is due to the fact that different closures have different conservation properties, which are significant for the environmental impact associated with a bottle of wine.