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LCA-based comparison of the climate footprint of beer vs. wine & spirits

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Preface

During the spring of 2010, the author of this report communicated select Life Cycle Assessment (LCA) results for the climate impact of beer versus wine and liquor to the Nederlandse Brouwers. The communicated results originated from the IMV report (Saxe et al., 2006), that were based on LCA data from 2.-0 LCA-Consultants.

Nederlandse Brouwers became interested in the subject and decided to investigate the subject of the climate footprint of beer, wine and spirits further, and asked the Institute of Food and Resource Economics for scientific collaboration in reviewing the current literature on the subject.

This report is a review of the current literature on the climate footprint of the complete life cycle of beer, wine and spirits.

We thank Professor Arne Astrup (Department of Human Nutrition, Copenhagen University) for establishing the connection to the Nederlandse Brouwers, and director Jack Verhoek and the Nederlandse Brouwers for supporting this work. We would also like to thank Mikkel Thrane (Danisco), Bo Weidema (2.-0 LCA Consultants), Anders Kissmeyer (Nørrebro Bryghus), and Paola Masotti (University of Trento, Italy) who contributed with data and advice.

The report has been written by associate professor, dr.agro. Henrik Saxe.

Director Henrik Zobbe
Institute of Food and Resource Economics
University of Copenhagen, October 2010

Summary

This report supports the data previously given to the Nederlandse Brouwers, I.e. based on weight or volume, beer has a far smaller impact on climate change than wine and spirits. The report contributes with more detailed analyses, to give more complex answers.

The reviewed literature demonstrates the relevance of different production phases and the applied delimitation of the analyses for beer, wine and spirits. Both producers and consumers can affect the environmental sustainability of drinking either beer or wine.

This report shows that by choosing beer above wine the consumer typically improves his climate performance of drinking by 400 % when comparing drinks by weight or volume, but only by 25 % when comparing by alcohol content.

The reason that beer has a smaller climate footprint than wine is mainly that wine is on average transported longer distances than beer from producer to consumer. Furthermore, recycling of beer bottles and cans, and the use of light weight plastic bottles is more common in beer than in wine. Cardboard containers for wine and bulk transport of wine combined with local bottling, however, are becoming more common.

Beer, wine and spirits producers alike are becoming more and more aware of their responsibility for the environment and climate change. And users are also responding to the challenges.

If drinking is a question of obtaining alcohol, spirits are the most climate friendly vehicle – 2.5 times better than beer. But drinking whisky is not really a substitute for beer or wine for most people on most occasions. They are supplementary.

There are differences in delimitation, methods of analyses and actual production steps for each study and type of drink – beer, wine or spirits. The numbers in this report must therefore be compared keeping this in mind.

1. Introduction

According to a report from the Institute of Environmental Assessment (Saxe et al. 2006) the climate impact of 1 kg of wine and liquor average **4,55 kg CO_2e**, while that of 1 kg of beer is only **0,92 kg CO_2e** (calculated from its Table 13 and Table 18). In other words the impact of wine and liquor on climate change was found to be nearly 5 higher than beer. Note, that the comparison was based on 1 kg of either type of drink.

This report reviews current literature on the subject to investigate if the above numbers are substantiated by current literature.

It is essential to compare the different types of drinks on a common basis, the so called **functional unit**. In this report we chose **1 liter** of beer, wine or spirits as the functional unit, and we made an effort to include all steps in the production, use and waste phases of each product, i.e. studies of the complete life cycles.

In the discussion chapter we analyze what the use of an alternative functional unit (content of 100 % alcohol) would affect the conclusions.

1.1. Beer and wine as commodities

Beer of barley and wine are major global commodities. According to FAO the global production in 2009 of beer of barley was 168,151,500 tons, and that of wine 27,106,670 tons (FAOSTAT 2010). The European production of beer of barley was 54,398,046 tons, and that of wine 17,712,349.

By weight the global production of beer is 6 times that of wine, while the European production of beer is more than 3 times that of wine.

If we assume that average beer contains 4 % alcohol and the average wine contains 12 % alcohol, then European beer and wine contribute approximately the same to alcohol consumption from these two drinks. On a worldwide scale wine contributes twice the alcohol of beer.

In Denmark the consumption of alcohol from wine has been larger than that from beer since 2007. In 2009 43.3 % of consumed alcohol came from wine, 39.8 % from beer, and 16.9 % from other beverages.

While a large fraction of the consumed beer is often consumed locally, the wine we consume is often imported. This means that wine typically travels longer distances from producer to consumer.

1.2. Life Cycle Assessment

Life Cycle Assessment (LCA) is the accounting of materials and energy flows during each stage of a product's or an action's life and the assessment of associated environmental impacts from cradle to grave.

A typical LCA includes four phases. Phase 1 includes definition of goal, purpose, the functional unit and system delimitations. The functional unit used in this report is primarily 1 liter of wine, beer or liquor in a bottle/can/keg. Phase 2 includes the life cycle inventory, i.e. mapping of all stages involved in the life cycle and associated process data. Here we also find the system expansion or allocation between main and side products. Phase 3 includes evaluation of environmental effects, classification and characterization. In phase 4 the results are interpreted and significant processes – hot spots – are identified (Wenzel et al. 1997, Wenzel and Hauschild 1998).

One of the important environmental aspects is climatic change. The driver of this change is anthropogenic emissions of greenhouse gases (GHG): Carbon dioxide (CO_2), methane (NH_4), nitrous oxide (N_2O) and others. Methane and nitrous oxide have a 23 times respectively 310 times larger impact on climate change per molecule than carbon dioxide seen over 100 years. The effect of all greenhouse gases is expressed in terms of CO_2 equivalents (CO_2e) or Global Warming Potential (GWP).

This report reviews the current scientific literature on the climate effect – climate footprint – of beer and wine. There is little information on the climate footprint of other alcoholic drinks, both the strong ones (spirits) such as e.g. whisky, vodka, gin, liqueurs, and brandy, and the weaker ones such as e.g. apple and pear cider.

2. Beer

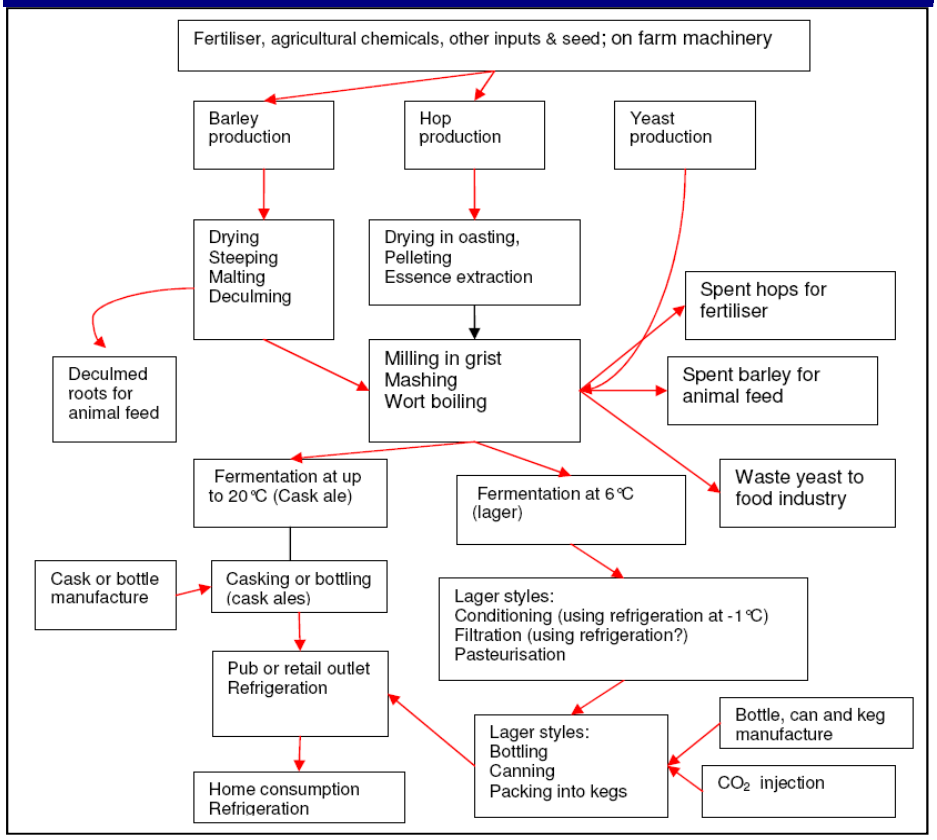
2.1. Setting the scene

In Denmark, where there are many breweries, the CO_2e emission from breweries make up 0.36 % of the national CO_2e-emission (66.6 Mt CO_2e) – 0.19 % (127 Kt) from brewing beer, the rest from soft drinks and bottled water (Bryggeriforeningen 2009a). Emissions caused by production activities at the breweries themselves are 0.04 %; the rest is caused by activities associated with agricultural production (malt barley and hop) and with packaging and transport. Similar numbers were found for the UK (Garnett 2007).

2.2. The climate footprint of beer

The main processes involved in beer and lager production is shown in Figure 2.1.

Figure 2.1. Main processes involved in beer and lager production



Source: Garnett (2007)

It is seen from the review in table 1 that the CO_2e emissions from the agricultural phase of the beer LCAs are relatively low, and do not dominate overall life cycle emissions (Garnett, 2007). This is also true for wine and spirits. Neither is the production phase of beer always the most important step in the life cycle of beer consumption (e.g. Hospido et al. 2005).

Often, the most important phase is often the use phase. That is how the beer is kept chilled, how it is served, how the drinker gets to the beer and how they get home (Cordella et al. 2008). But the choice of container (glass, keg, or can) is also of impor-

tance. Bottled beer turned out to cause less GHG emissions than beer in kegs, mainly due to higher energy consumptions and thus higher GHG emissions associated with glass bottles (Cordella et al. 2008, Nørrebro Bryghus 2009). Beer in plastics can be better than both beer in bottles and cans (Plastech 2008).

The weight of the container, the distance it is transported, and the time it is kept cool before consumption are all deciding factors for the final climate footprint. There is therefore great effort to make bottles lighter and make more use of recycling (Glass Packaging Institute, 2010). Similarly, it is important how far raw materials are transported and how the agricultural products (malt barley and hops) are produced.

Majcher (2009) calculated the total emission of CO_2 from beer produced by organic versus conventional farming. The conclusion was that the organic beer had a 12 % higher impact on the environment with regard to emission of the greenhouse gas. The main reason is a lower yield from organic barley and hops, which requires a larger acreage to grow the raw materials needed for production of the same amount of beer. This effect is enforced by the fact that the organic hops have a weaker taste so more raw material is needed. On top of this, organic hops for e.g. Danish beer was grown in Tasmania and had to be transported over a long distance. Further, more intensive harrowing and other field work is required for organic farming the total use of fossil fuels exceeded that of conventionally farmed hops and barley.

The Danish consultancy firm COWI (2009) has developed a tool for Danish breweries to assist them in calculating the climate impact of their production. It comes with software, manual and a fact sheet. It is not freely accessible. It is rumored to be a relatively crude tool, but it should be able to hot-spot the parts of the beer life cycle that are most important for the individual breweries.

Worldwide brewing companies are turning their attention to the hot spots in the beer life cycle and improve the climate footprint of their brands (Molson Coors, 2010). There have been many strategies to construct GHG reporting, and the Beverage Industry Environmental Roundtable (BIER) recently announced guidance to the beverage industry sector for greenhouse gas emissions reporting (BIER, 2010).

It has become popular to produce CO_2-neutral beer. That is a beer where the producer has focused on the whole lifecycle of beer production, calculated its climate footprint, and bought CO_2-quota elsewhere to offset the remaining emission of CO_2e. Examples

include Fat Tire Amber Ale (Climate CO2nservancy, 2008), Globe Ale (Nørrebro Bryghus, 2009) and Cascade Green (Cascade brewery, 2010).

The distribution of sources of CO_2e emissions is reflected in the literature reviewed in Table 2.1.

Table 2.1. The total climate impact of beer production per liter and of different production steps according to 11 studies

	Literature reference number (as given above)														
Production steps	*1a*	*1b*	*2*	*3a*	*3b*	*4*	*5*	*6*	*7*	*8*	*9*	*10a*	*10b*	*10c*	*11*
	CO_2e emission (g) per liter beer and container														
Glass bottles	462	-	323	103	-	70	-	-	-	121[h]	220	85[p]	218[p]	444[p]	-
Barrels	-	24	-	-	89	-	-	-	-	-	-	-	-	-	-
Cans	-	-	-	-	-	44	-	333	-	-	-	-	-	-	-
Transport to brewery	18	-	-	-	-	-	-	-	-	18[i]	80[m]	-	-	-	-
Labels	35	40	-	-	-	-	-	-	-	-	-	-	-	-	-
Cardboard/plastic	36	>0.5	34	-	-	-	-	-	-	59[j]	-	-	-	-	-
Bottle tops	<0,5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pallets	RC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barley	-	-	189	-	-	102	-	-	-	277[k]	-	106	106	108	-
Malt production	79	79	90	249[a]	249[a]	32	-	-	-	-	100	21	21	22	-
Malt transport	32	32	-	277[a]	277[a]	-	-	-	-	-	-	-	-	-	-
Hop	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Water	8	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbon dioxide	34	34	34	-	-	-	-	-	-	-	-	-	-	-	-
Beer+barrel transport	-	148	-	-	-	-	-	-	-	-	-	-	-	-	-
Process energy	692	692	58	35	34	100	405[c]	-	-	310[l]	240	100[o]	95	92	-
Process waste	2	0	-	-	-	-	-	-	-	-	-	-	-	-	-
Sewage treatment	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-
Distribution	-	-	126	-	-	-	10[d]	-	-	-	-	48	27	126	-
Retail	-	-	421	-	-	-	-	-	-	-	-	-	-	-	-
User phase	-	-	123	-	-	-	80[e]	-	-	-	-	-	-	-	-
All other sources	-	-	100	361	360	-	-	-	-	-	-	48	60	50	-
Total CO_2e	**1401**	**1059**	**1498**	**1024**	**1010**	**1500[b]**	**495[f]**	**1040[g]**	**1100**	**785**	**640[n]**	**408[n,q]**	**527[n,q]**	**842[n,q]**	**920**

Source: 1a and 1b: Bottled beer and draft beer, Nørrebro Bryghus (2009); 2: Climate CO2nservancy (2008); 3a and 3b: bottled beer and draft beer, Cordella et al. (2008) – GHG derived from energy use; 4: Garnett T (2007), Thrane and Nielsen (2009), and EEA 2009; 5: Hanssen et al. (2007); 6. Klimaguiden (2010); 7. Madsen and Lund (2007); 8. Koroneos et al. (2005); 9. Talve (2001); 10: Bryggeriforeningen (2009b).

Not all studies specify or include all production steps. '-': not specified or included in the LCA, or included in another step than this; RC: Re-cycled. a: in recycled bottle, b: in cans, c: in disposable bottle; 11: Saxe et al. (2006). a including process energy; b including the use step; c Production of raw materials and beverage products; d packaging and distribution; e user phase; f some phases are missing; g calculated from energy use in all production phases, even though these were not specified. h glass bottle production; I transportation/storage/distribution; j packaging; k Raw material acquisition; l beer production; m all transport; n excluding the use phase; o including waste.; p including waste/recycling; q 20 % uncertainty.

The total CO_2e emission associated with the climate footprint of beer depends on how much of the life cycle is included. The value for the total life cycle varies from **0.8 – 1.5 kg CO_2e per liter beer**, and excluding the user phase, as low as **0.4 kg CO_2e per liter beer** (Danish breweries average; Bryggeriforeningen 2009b). The latter Danish study demonstrates that the container in which the beer is sold is very important. Eg. 1 liter beer in recycled bottles 0.4 kg CO_2e per liter beer vs. 1 liter beer in disposable bottles: 0.8 kg CO_2e per liter beer. 1 liter beer in cans emits the intermediate 0.5 kg CO_2e per liter beer.

Another hotspot for saving CO_2e emission in the complete beer LCA include new technology, such as using an enzymatic technique rather than conventional malting in beer production. On a world wide scale this could save up to 3 million tons CO_2e (Kløverpris et al. 2009), or 18 g CO_2e per liter barley beer, or about 10 % of the climate footprint of the brewing process.

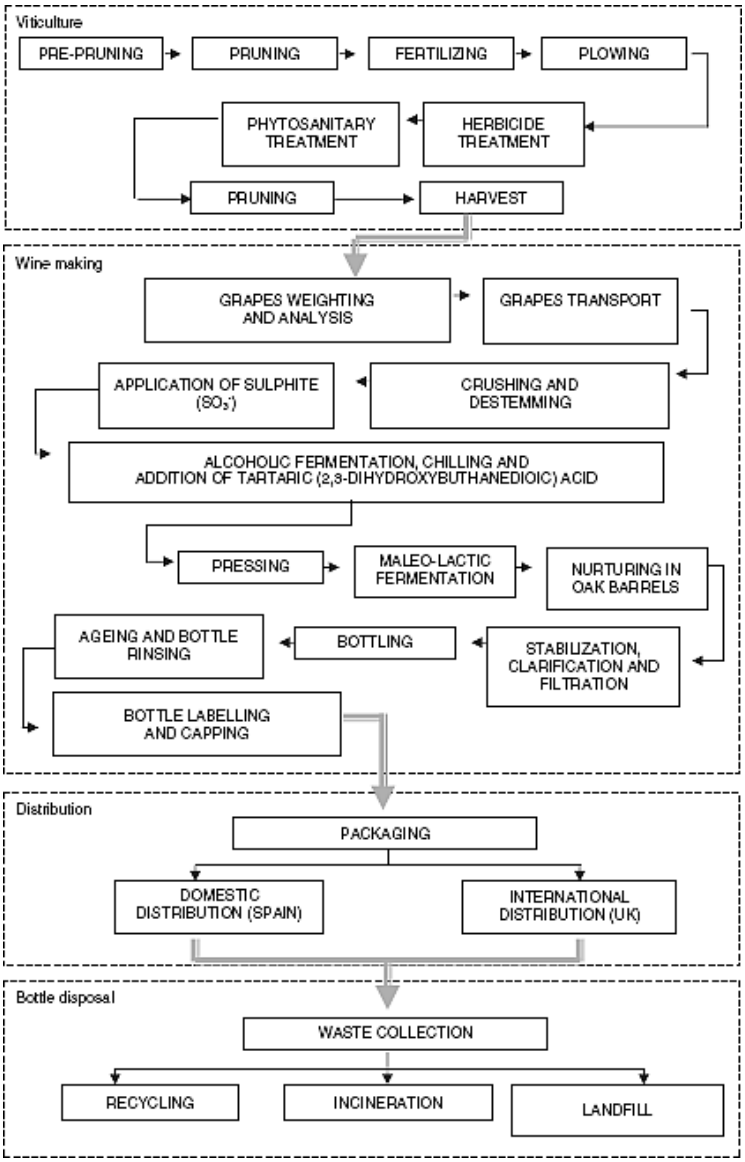
3. Wine

3.1. The main processes involved in wine production

The main steps in a wine LCA is shown in Figure 3.1 below. There are four major steps in wine production: Viticulture, Wine making, distribution and bottle disposal.

The main steps in a complete beer LCA is shown in Figure 3.1.

Figure 3.1. Main processes involved in wine production



Source: (Gazulla et al. 2010)

According to Gonzalez et al. (2006) the relative impact of the first three stages is 27 % (viticulture), 32 % (bottles), 41 % (transport). According to Gazulla et al. (2010) the relative impact of the four stages are 46 % (viticulture), 4 % (wine making), 36 % (bottles and barrels), and 14 % (transport from Spain to UK). These two references demonstrate the large variability in results there is to be found between different studies. Transportation is the joker.

3.2. Transportation is the hotspot in wine LCA

As beer, wine is produced all over the world (OIV, 2009), but as mentioned in the introduction, wine is on average transported over greater distances than beer before it is consumed, and long-distance transport means GHG emissions (Colman and Päster, 2007). The greatest climate impact from the wine life cycle often comes from transportation. Transportation involves distance, means of travel, and hours of cooling. Train and truck transport induce respectively four and five times more GHG emissions than container ship, while airplane cause 10 times more GHG emissions (Colman and Päster, 2007; Cholette and Venkat, 2009).

According to Colman and Päster (2007), the transport of bottled wine cause from 1.8 – 4.0 kg CO_2e. Interpreting results from different countries is not straight forward because the distance from e.g. Argentina to Copenhagen is not the same as from Argentina to San Francisco. The same bottle of wine consumed in Copenhagen may thus cause far more (or far less if originating in Europe) CO_2e emission than when consumed in San Francisco. When reading Table 2 it must be understood that the data is always seen from a given city and country, which would not have the same values in another city and country. However, we have decided not to make an effort to calibrate all data for a single city and country, but simply present data as they are.

The containers of wine are typically glass or beverage cartons. The overall climate footprint of wine also depends on the weight of the chosen container. A recent analysis gives a good overview (Bio Intelligence Service S.A.S., 2010). Heavier bottles cost significantly more to transport than beverage cartons per liter contained wine. A recent study reviews LCA studies of beverage cartons (Falkenstein et al. 2010).

3.3. The climate footprint of wine

The overall result for climate impact of wine is concluded to range from **1.9 – 5.3 kg CO_2e per liter**, where transport is the deciding factor (Table 3.1). As wine is typical-

ly transported over long distances we put more weight on the high end of this range. This even more so because the retail and user phases are not included wine LCAs (Table 3.1.) as they were in some beer LCAs (Table 2.1.).

Table 3.1. The total climate impact of wine production per liter, and of different production steps according to 12 studies

Production steps	*Literature reference number (as given above)*													
	1a	1b	1c	2	3	4	5	6	7	8	9	10	11	12
	CO_2e emission (g) per liter wine													
Vineyard / viticulture	-	-	-	957	671	273	656	160	-	-	-	942	388	-
Winery / wine making	1920[a]	-	-	483	53	252	28	-	-	-	-	-	-	-
Barrels, bottles	-	-	-	1933	521	485	431	940	-	-	-	1246	-	-
'juice containers'	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transport/distribution	2667	-	-	1828	214[c]	892	[d]	260	-	-	-	-	-	-
Storage	-	-	-	4	-	-	-	-	-	-	-	-	-	-
Disposal/recycling	-	-	-	55[b]	-	-	9	-	-	-	-	-	-	-
Retail & user phases[e]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total CO_2e	**4587**	**2827**	**5333**	**5260**	**1459**	**1902**	**1124[d]**	**1360**	**2133[d]**	**992[d]**	**5089**	**2187[d]**	**-**	**4550[e]**

Source: 1:Colman and Päster (2007), all three wines were consumed in Chicago, the three wines being a. Yellow Tail originating from NSW/Australia, b. Coulée de Serrant originating from Loire/France, and c. Napa wine air lifted from Napa/California ; 2: Point (2008), Nova Scotian wine consumed in Nova Scotia; 3: Gazulla et al. (2010), Spanish wine, transport to UK; 4: Aranda et al. (2005), Spanish wine; 5: Fullana et al. (2005), Spanish wine; 6: Cichelli et al. (2010), local Italian wine; 7: Ardente et al. (2006), Italian wine, at gate; 8: Pizzigallo et al. (2008), Italian wine, at gate; 9: Panela et al. (2009), Spanish wine, corporate carbon footprint; 10: Benedetto (2010), Sardinian wine, at gate; 11:; 12: Saxe et al. (2006).

Not all studies specify or include all production steps. '-': Not specified or included in the LCA, or included in another step than this. [a] Including viticulture and containers; [b] recycling; [c] including disposal; [d] long-distance transport not included; e the retail and user phases never seem to be included in wine LCAs; [e] average of wine and spirits.

Just as for beer (section 3.3), carbon neutral wine is available; one is from Grove Mill in New Zealand. The winery has worked to reduce their carbon footprint and offset the remaining emissions through a certification program (treehugger, 2006). Another is Wolf Blass green label packaged in lightweight recyclable PET bottles, which reduce the complete LCA GHG emissions by 29 % (Wolf Blass, 2009).

4. Spirits (liquor)

We only know of a few good references for the climate footprint of spirits (liquor). The climate footprint of spirits varies slightly according to the type of spirits – whiskey, gin, vodka, brandy, etc., but also according to individual studies.

4.1. Whisky

The initial steps in making whisky are essentially identical to those for beer, whether it is malt whisky or grain whisky (Garnett, 2007). Distilling residues are converted into animal feeds. The spirits produced in the UK are matured in oak casks in Scotland for a minimum period of 8 years or more.

4.2. Gin

Gin is normally based on barley or maize or molasses and is a neutral spirit alcohol with no flavor at all (Garnett, 2007). Cheaper gins can be made by adding essential oils to diluted neutral spirit alcohol, but cannot be called 'distilled' or 'London' gin.

4.3. Vodka

As for gin, vodka is initially a neutral spirit, which in the EU is usually produced from grain (wheat, barley, maize, rye) or molasses. In Eastern Europe it may also be based on potatoes or rice (Garnett, 2007).

Table 4.1. The total climate impact of spirit production per liter, and of different production steps according to 3 studies

Production steps	*Literature reference number (as given above)*				
	1a	*1b*	*1c*	*2*	*3*
	CO_2e emission (g) per liter spirits				
Agriculture	417	341	341	-	620
Distilling	179	408	408	400	913
bottles	232	232	232	782	474
Cardboard	-	-	-	164	-
Transport/distribution/storage	-	-	-	-	248
Disposal/recycling	-	-	-	-	-
Retail and user phases	-	-	-	-	-
Total CO_2e	828[a]	981[a]	981[a]	1346[a]	2255

Source: 1: Garnett (2007), a. whisky; b. gin and vodka 2: Pernod Ricard (2009); 3: Scotch Whisky Org. (2006).

Not all studies specify or include all production steps. '-': Not specified or included in the LCA, or included in another step than this. [a] Note that these sums are excluding important life cycle phases.

The Garnett (2007) numbers are estimated from UK production volume, the share of UK GHG emissions from various production stages, and UK production volume. The numbers are thus rough estimates only.

The overall result for climate impact of wine is concluded to range from **0.8 – 2.3 kg CO_2e per liter**, where the high end of the range is the most realistic, since disposal, retail and user phases were never included (Table 4.1)

5. Comparison of climate footprints

For comparison, the functional unit was always 1 liter beer, wine or spirits (Table 2.1, Table 3.1, and Table 4.1). Based on the above results, the production and use of 1 liter beer caused climate foot prints ranging from **1.0-1.5 kg CO_2e per liter beer**. If we include the retail and use phases, we estimate the average and most representative emission caused by the full life cycle of **1 liter beer** to be **1.5 kg CO_2e.**

Wine ranged from **1.9-5.3 kg CO_2e per liter wine**. If we include hypothetical retail and user phases, we estimate the average and most representative emission caused by the full life cycle of **1 liter wine** to be **6 kg CO_2e.**

Spirits ranged from **0.8 – 2.3 kg CO_2e per liter spirits.** Since spirits often travel as long distances as wine (Scotch Whisky is sold all over the World), we estimate that the average and most representative emissions caused by the full life cycle of **1 liter spirits** to be **6 kg CO_2e**, i.e. as high as wine. The bottles are typically heavier for spirits than for wine (Garnett, 2007).

These results in comparing beer and wine and spirits climate footprint reasonably supports the information the author of this report initially offered to the Nederlandse Brouwers. Wine and spirits have 4 times the climate footprint of beer. We originally estimated 5 times larger footprints for wine and spirits than for beer.

6. Discussion

6.1. The choice of functional unit

Even though 1 kg or 1 liter are the most commonly used functional units when it involves food and beverages, it is important to ask the question: Does the functional unit reflect (the motive for) the use of the product? Choosing 1 liter as the functional unit implies that 1 liter of beer can be substituted by 1 liter or wine or spirits. At least for spirits, that is certainly not the case.

The question is: 'why do we drink?' If the beverage was water, the answer would be to quench our thirst. If the beverage was anything else the answer depends on the drink. If it is carbonated water the answer could also be 'to quench our thirst'. But it could also be 'to enjoy a sugar- and/or caffeine-high' (a personal satisfaction) or 'to be seen drinking a coke' (a social satisfaction). If it is a smoothie or pure juice it could be 'to enjoy the good taste and obtain vitamins'. If it is beer, wine or alcohol, the answer is mostly 'to enjoy ourselves', 'to socialize', 'to calm ourselves' or even 'to forget ourselves'. In that case 1 liter – a measure of volume, and the commonly use functional unit for what we drink is not a realistic choice of functional unit. A functional unit based on the content of 100 % ethanol could be a better basis for comparison of alcoholic drinks.

6.2. Ethanol as functional unit

In the UK, units of alcohol are used as a guideline for consumption of alcoholic beverages. A unit of alcohol is defined as 10 ml of pure alcohol (ethanol). It is not the same thing as a standard drink. The size of standard drinks varies significantly from country to country.

If we assume the average alcohol content of beer to be 4 %, the average alcohol content of wine to be 12 %, and the average content of spirits to be 40 %, then the climate foot prints of beer, wine and spirits would no longer be **1:4:4** (based on weight), but **1:1.3:0.4** (based on alcohol content).

Using alcohol content as the functional unit thus makes wine nearly as climate friendly as beer (only 30 % worse), and spirits 2.5 times better than beer.

6.3. Other environmental indicators

Cordella et al. (2008) found that inorganic emissions, land use and fossil fuel consumption were the most critical environmental issues of beer LCA. In this report we focused exclusively on GHGs and the climate footprint resulting from the use of materials and energy.

To make a true comparison of the three types of drink – beer, wine and spirits – in terms of their overall environmental footprint, more than just the climate footprint would have to be included.

7. Conclusions

Through a review of current literature, this report substantiates that based on weight or volume beer is substantially more harmful to potential climate change than wine or spirits – when measured by the complete lifecycle from agriculture to the use phase and including waste and recycling of containers.

However, for three reasons this information must be used with care by brewers who consider using this information to promote the sales of beer:

1. Beer and wine – and spirits in particular – are not commensurable products. They are not necessarily used to fill the same need of the users.

2. Measured by alcohol content instead of by weight or volume, wine is nearly as climate-friendly as beer, and spirits leaves the smallest climate footprint of the three.

3. Effects on climate change may not be the most important environmental aspect of making and choosing to drink beer, wine or spirits. Conclusions based on an overemphasis on the Global Warming Potential, and being blind to other consequences to the environment, and to health and socioeconomic effects could backfire.

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