CONCEPT OF LIFE CYCLE ASSESMENT AND BEER INDUSTRY

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ABSTRACT: The overall context of the research project reported here has been to inform government policy development to reduce the environmental impacts of drink consumed, within the context of the industry sustainability strategy. The specific objectives have been to determine what evidence is available relating to the environmental impact that occurs in the life cycle of drinks. We analyze in detail the evidence available for environmental impacts that arise from the life cycles of these commonly consumed drink products.

KEYWORDS: malt, brewery grain, brewhouse operation, emission factors.

1. INTRODUCTION

There is general agreement that the production, processing, transport and consumption of drinks accounts for a significant portion of the environmental burden imposed by any European country. The UE Environmental Impact of Products study identified the products and services based on both private and public expenditure and volume consumed. The environmental impacts of twelve areas of consumption (one of which incorporates drink) were assessed under a range of themes used in Life Cycle Assessment (resource depletion, ozone layer depletion, human toxicity, ecotoxicity, photochemical oxidation, acidification and eutrophication).

Life Cycle Assessment (LCA) studies the environmental impact arising from the production, use and disposal of products. LCA provides a mechanism for investigating and evaluating such impacts all the way from the extraction of basic materials from nature, through material and component production, assembly, distribution, product use and end-of-life management (which may be disposal, reuse, recycling or recovery). LCA considers impacts on all environmental media-air, water and land. This holistic system wide, view is one of the principal benefits of LCA. The results of LCA studies are used to inform environmental purchasing decisions, product design, process selection and policy making.

LCA studies the environmental aspects and potential impacts throughout a product's life from raw material acquisition through production, use and disposal. The general categories of environmental impacts needing consideration include resource use, human health and ecological consequences.

The product system is the chain of activities linking raw material extraction and/or production with processing, use and disposal. LCA considers the environmental impact of such systems in terms of the environmental consequences of flows between such systems and the environment.

2. MATERIALS AND METHODS

The ISO 14040 definition also describes three of the four main elements of an LCA study, which are: goal definition and scoping, life cycle inventory development (compiling the inventory of relevant inputs and outputs), life cycle impact assessment (evaluating the potential impacts associated with the inputs and outputs identified in the life cycle inventory), improvement analysis (interpreting the results in relation to the objectives).

Beer is one of the better-studied products: however different studies reach different conclusions due to different assumptions and boundary choices. Packaging can be highly significant as a source of environment impacts if glass bottles are used, whilst beer production appears to be at least as significant as barley-growing and hop-growing in terms of global potential.

Water use is clearly a significant (if essential) aspect of the production cycle of many drinks. Brewing uses 4 liters of water per liter beer.

3. RESULTS AND DISCUSSIONS

The basic ingredients of beer are malted barley (approximately 95.5% solid ingredients w/w), hops (approximately 95.5% w/w), yeast and water. Other ingredients can include maize, sugar and other additives.

In a lifecycle analysis of beer production and transport of raw materials used in beer production was found to contribute over one third of the total global environmental impact of the beer production lifecycle, shown in figure 1.

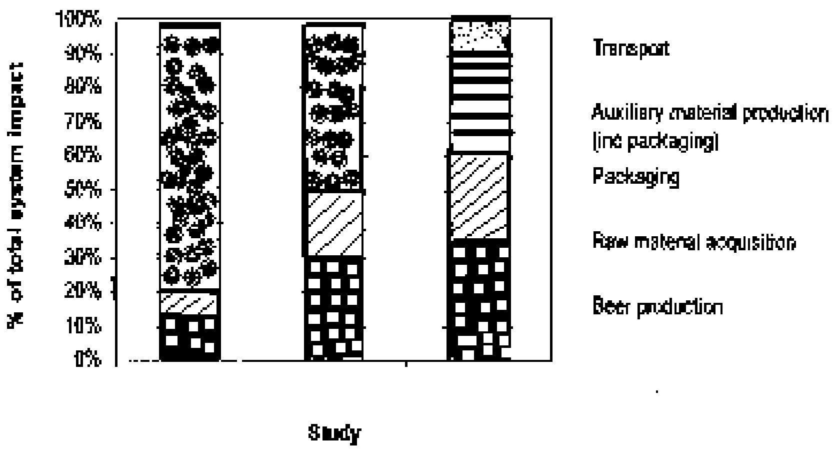

Fig.1. Contribution of beer production subsystems to climate change potential

The most significant environmental impact of the agricultural subsystem is eutrophication. This is linked to releases of nitrogen and to a lesser extent phosphoruous, from production and use of fertilisers. Was found that raw material production and transport account 53% reported to the eutrophication potential of the entire beer life cycle.

In this analysis the malting of barley was included in the category of raw material production. The magnitude of the global environmental impact of the raw material subsystem was matched only by the subsystem accounting for production and transport of packaging materials.

Data covering the environmental impacts of growing both spring barley and winter barley has been compiled; this indicated that these impacts are in fact very similar to those arising from the cultivation of bread wheat, in table 1.

A view of the environmental effects acknowledges the high environmental impact of hop growing but suggested that these are mitigated to some extent by the small area involved and the landscape impact of the traditional crop.

Energy consumption during primary processing is identified as the most important environmental impact of operations within the brewery, contributing 30% of the global warming potential of the lifecycle.

Environmental burdens for production of selected grain crops - Table 1

Environmental theme & units	Winter barley	Spring barley
Energy used, MJ	2.4	2.4
Global warming, g 100 year CO_2	726	710
Eutrophication, g PO_4^{3-}	2.5	2.3
Acidification, g SO_2	2.9	2.3
Pesticides used, dose ha	0.002	0.001
Abiotic depletion, g Antimony	1.4	1.5
Land use assuming mean of Grade 3a, ha	0.00016	0.00018

The beer production process accounts for 50% more energy use than product distribution, double that of raw material acquisition and three times as much as packaging. It was calculated that 23% of global warming potential of the lifecycle was produced during primary processing of beer, cooling contributing double that of any other operation.

Impacts of wastewater from brewing are most significant with respect to eutrophication potential. The wastewater treatment plant contributes over 30%of the lifecycle eutrophication potential. Reports of COD production in brewing itself accounts for less than 25% COD emission in the beer lifecycle, with the greatest contribution to COD emissions made by the production of packaging board and paper.

Regarding the packaging it was concluded that production and transportation of packaging materials contributed one third of the total global environmental impact of the beer lifecycle. The life cycleanalysis examined production of 0.33L disposable glass bottles of beer formed from 60% topaz glass and 40% recycled glass.

The production of glass bottles is the most environmentally significant operation in this subsystem. 85% of the impact of bottle production easy in global warming potential, resulting from the high energy requirements of glass manufacture. Bottle production was also found to have a significant impact in the beer lifecycle on climate change potential, for which it contributes 78% of the impact of the life cycle, ozone depletion (91%), eutrophication potential (52%), acidification (90%), human toxicity (91%) and earth toxicity (94%).

The main environmental impacts of packaging were global warming potential and acidification potential. Production and transportation of packaging materials accounted for 44% of the global warming potential of the entire beer production life cycle and 52% of the acidification potential.

4. CONCLUSIONS

The process of beer production (brewing) has been found to account for only a small proportion of the environmental impact of the life cycle of beer.
The environmental report, the largest brewery, identifies the main environmental issues associated with the brewing process as CO_2 release from energy consumption, water consumption and effluent discharge.

The main points emerging from the evidence about beer is presented in table 2.

Beer main points emerging with environmental impacts - Table 2

LCA studies	Water and eutrophication impacts	Energy use impacts (global warming potential and acidification (GWP))	Refrigeration and packaging impacts
Few LCA studies, with conflicting results	Water use an important impact	Production phase of beer has GWP equal to that of barley and hop growing, bottled water associated with higher GWP than tap water.	Energy used in refrigeration, for drinks storage, may be an important impact

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