FRENCH ENVIRONMENTAL LABELING OF SUNFLOWER AND RAPESEED OILS USING LIFE CYCLE ASSESSMENT

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Abstract

A French national experimentation of environmental labeling on mass market products, including alimentary products, has been introduced by “Grenelle” laws. The data required for this labeling are provided by carrying out life cycle assessment.

The aim of this study is to provide all necessary information to fit the national experimentation for two standard oils: sunflower oil and rapeseed oil. The complete oil life cycle has been studied from the seeds production to the end of life of the packaging. A focus has been made on the impacts of crushing and refining. The data for seed transformation have been collected from different industrial sites that illustrate the diversity of all the French crushing, refining and packaging sites.

The inventory data allows the calculation of the indicators identified for environmental labeling: emissions of greenhouse gases (GHG) and water consumption. The production of 100 g of unpackaged sunflower and rapeseed refined oils leads respectively to the emission of 89 and 127 g CO₂ eq and consumes 1.7 and 0.8 liters of water. Most impacts on the studied indicators are due to the agricultural step. Energy and water consumptions during crushing and refining weigh also in impacts on the studied indicators.

The results of this study are a relevant overview of all sunflower and rapeseed oils produced in France, and are usable as standard values for both producers and users of vegetable oil. Industrials of oil sector use these values to compare to their own process values and to evaluate the improvement due to their ecodesign strategy. For example, the use of a biomass boiler, the reduction of packaging, different choices for the suppliers of the seeds lead to a lower LCA score.

Keywords: rapeseed oil, sunflower oil, vegetable oil, life cycle assessment, greenhouse gases, water

1. INTRODUCTION

A French national experimentation of environmental labeling on mass market products, including alimentary products, has been introduced by “Grenelle” laws. The implementation of this labeling is expected to inform consumers and other stakeholders about various environmental characteristics of market products and to support continuous improvement of products in associated environmental performance. A general standard and a specific standard for food products set the principles of this environmental labeling [1, 2].

The French vegetable oil sector takes part into this experimentation to provide environmental database for oil producers and users (food and no-food industries). The aim of the study is to collect and study all necessary information to fit this experimentation for two standard oils: sunflower oil and rapeseed oil. The results of this study are expected to be a relevant overview of all sunflower and rapeseed oils produced in France.

2. METHODOLOGICAL FRAMEWORK

2.1 Functional unit
The functional unit chosen for oils sector is 100 g of packaged oils. This unit is in line with the food products standard [2].

2.2 System boundaries
All relevant life cycle steps need to be considered in the system boundary (i.e. from cradle-to-grave approach). The complete life cycle of rapeseed and sunflower oils has been studied from the seeds production to the end of life of the packaging (figure 1). Storage and selling phases have been excluded from the study because of a lack of data. Sunflower oil and rapeseed oil can be used for salad dressings, to cook in fat or for deep fat fry. One major problem is to choose the impact allocation between products (Do impacts of the deep fat fryer have to be allocated to potatoes or to oil?). The use phase and the end of life of oil have been excluded from the study for this reason.

2.3 Allocation
An energetic allocation has been done between vegetable oils and by-products (meal and refining by-products with a grey frame in the figure 1). This allocation is in line with the allocation used for French first generation of biofuels [3]. Note that first generation of biofuels can be produced from vegetable oil. Oil production for both biofuels and edible oils is similar

2.4 Environmental indicators
The indicators considered most relevant for food products are: emissions of greenhouse gases (GHG), water quality grouping indicators related to water consumption, eutrophication and aquatic ecotoxicity and biodiversity [2]. In this study, only indicators with the most reliable calculation methods are calculated: emissions of GHG and water consumption.

![Life Cycle Inventory diagram]

Agricultural step
- Seeds transport

Crushing
- Crushing, extraction, crude oil mixture
- Crude oil transport

Refining
- Refined oil transport

Packaging
- Packaging
- Packaging production
- Packaging transport
- Direct use by industry for food or non-food application
- End of life of oil

Meal
- Meal

Refining by-products
- Meal
- Refining by-products

Storage, selling, use
- Storage, selling, use
- Packaging waste transport
- End of life of packaging

Non-bottled oil transport

Figure 1: Life Cycle Inventory considered for the LCA of rapeseed and sunflower oils
The cells in dotted line are the steps excluded from the study.

3. LIFE CYCLE INVENTORY (LCI)
For the agricultural step, data have been gathered from a 2010 report concerning LCA of first generation of biofuels used in France and has been rounded off by CETIOM expertise. Data for seeds transformation have been gathered from production data of Sofiprotreol group. These data include energy, chemicals and water consumptions. Waste and wastewater treatments are also included. Impacts occurred during the production of industrial machines are excluded from this study. The end of life scenarios of used packaging are evaluated from bibliographical studies [4, 5]. This LCI reflects average French oil industry practices in 2010.
4. RESULTS

Impacts induced by the production of 100 g of sunflower and rapeseed unpackaged or packaged refined oils are shown in Table 1.

Table 1: Results of rapeseed and sunflower oils LCA

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>Unpackaged refined oil</th>
<th>Packaged refined oil</th>
<th>Unpackaged refined oil</th>
<th>Packaged refined oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>GHG emissions</td>
<td>g CO₂ eq</td>
<td>127</td>
<td>154</td>
<td>89</td>
<td>112</td>
</tr>
<tr>
<td>Water consumption</td>
<td>liters</td>
<td>0.7</td>
<td>1.0</td>
<td>1.7</td>
<td>1.9</td>
</tr>
</tbody>
</table>

4.1 Greenhouse gases emissions

The use of nitrogen fertilizer and nitrogen monoxide emissions occurred during agricultural step are responsible of most impacts on GHG emissions (Figure 2). The other steps that contribute the more are the industrial step (crushing and refining), seed and oil transports and the packaging (Figure 2).

Figure 2: GHG emissions for unpackaged and packaged refined oil production (g CO₂ eq.)

The industrial steps, including crushing, refining, packing, waste and wastewater treatments, weigh between 8% and 14% in GHG emissions. Crushing has a bigger impact on GHG emissions than refining. Waste and water treatments represent less than 0.5% of GHG emissions.

The distribution of crushing and refining GHG emissions is the same for both rapeseed oil and sunflower oil. The most relevant GHG emissions occur during natural gas combustion (Figure 3). Electricity consumption weights between 7 and 9% in GHG emissions. Chemicals and bleaching earths used in refining represent 17% of GHG emissions. The chemicals transports have lower impacts on GHG emissions.

Figure 3: GHG emission distribution during crushing and refining of rapeseed (%)
4.2 Water consumption

Agricultural step leads to 47% of water consumption for rapeseed oil and 73% of water consumption for sunflower oil (figure 4). Sunflower oil production consumes more water than rapeseed oil production because of sunflower field irrigation. The industrial steps weigh between 18% and 33% in water consumption respectively for sunflower oil and rapeseed oil. Water used for steam and cleaning during crushing and refining weighs between 7% and 13% respectively for rapeseed oil and sunflower oil. No significant difference in water consumption has been showed between rapeseed oil and sunflower oil during crushing and refining. The chemicals and packaging transport and waste and water treatments represent less than 0.5% of all water consumption.

Figure 4: Water consumption for the production of unpackaged and packaged refined oil (L)

5. CONCLUSIONS AND OUTLOOK

The results of this study are a relevant overview of all sunflower and rapeseed oils produced in France, and are usable as standard values for both producers and users of vegetable oil. Industrials of oil sector use these values to evaluate the improvement due to their ecodesign strategy.

The GHG emissions occur mainly during the agricultural step. A reduction of nitrogen fertilizer can significantly improve the GHG emissions. Another way to improve GHG emissions is to reduce energy consumption and to use other energy supplies (wood, solar, etc.) during crushing and refining. Some French oil producers are attempting the use of biomass boiler for crushing and oil refining.

The water consumption profile is different between sunflower oil and rapeseed oil. The fact is that some sunflower fields are irrigated while rapeseed fields never are. Water consumption of sunflower fields is lower than other crops like maize.

6. ACKNOWLEDGEMENTS

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7. REFERENCES