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The utility of Life Cycle Assessment in the ready meal food industry

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ABSTRACT

Lifestyle and consumer habits increasingly demand ready meals with high quality standards. A ready meal is a packaged food product already prepared for eating with minimum handling. Generally, ready meals only require heating or hydration, and can even consist of a complete prepared dish including all the ingredients, such as a stew. The ready meals industry uses raw materials with high environmental loads, needs energy and water and generates solid and liquid waste that must be properly managed. The environmental performance of the food industry is an issue of great importance for consumers, companies and administrative authorities responsible for environmental policies. This work demonstrates the utility of using the Life Cycle Assessment (LCA) approach to identify more sustainable options in the ready meals food sector.

The complete production process for a canned ready meal, a stew product based on cooked pulses and pork meat cuts (sausages and ham), has been analyzed in a real factory using an LCA approach through its entire life cycle, with a cradle to grave perspective. Two different methodologies were applied for the impact assessment step in LCA: a problem-oriented method (midpoints) and a damage-oriented method (endpoints). The subsystems showing the highest environmental loads turned out to be food ingredients and solid waste management. The impact categories most affected by the production cycle of the ready meal were land use, fossil fuel consumption and water ecotoxicity. An impact analysis of different packaging systems for the specific product, applicable to packaging selection, was performed, considering five alternative scenarios to tinplate cans. The selection of biopolymer packaging systems as an alternative end-of-life scenario could help to reduce the environmental impacts of the ready meal product under study.

1. Introduction

During recent decades consumers, companies and authorities responsible for the development of improved sustainability have all become more interested in the environmental performance of food products (Consoli, 1993). The food and food processing industry contribute to the European Union in terms of production 536,151 million euros (almost 15% of the total industrial production) (EUROSTAT Panorama of European Business, 2000). An ecological analysis should be one of the bases of future food production systems and food consumption. Minimal environmental impact and efficient utilization of natural resources must be important criteria in the development of food products as well as in the selection of food systems (Mattsson and Sonesson, 2003).

The demand for ready meals is now increasing (Hospido et al., 2006). Lifestyle and consumer habits increasingly demand ready meals with high quality standards and minimum handling. An industrial cooked dish is one of the food products with the most complex agri-food chains due to the fact that it includes a variety of raw materials of different international origins and many life cycle stages (Zufia and Arana, 2008). In relation to meal preparation it has been reported that the largest impact occurs in the production of the raw materials used (Sonesson and Davis, 2005). In previous cases where LCA was applied to food production, agriculture was found to be the main hotspot for almost all the environmental questions studied, from the origin of the inputs to the agricultural step, to the consumer phase, and to the waste management of the packaging (Eide, 2002). The need for sustainable agriculture has become a universal demand. Practices such as growing a variety of crops, crop rotation or soil protection, better irrigation systems and ploughing techniques are advisable. In the ready meals food industry it is also important to consider the higher environmental costs of meat production compared to vegetable production.

Frequently, in the food industry sector raw materials come from distant countries with low production costs. Transportation of raw materials to the factory as well as that of manufactured products to the market is another significant contributor to environmental impact. The benefits of food sold locally, from a transportation

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energy perspective, are still debated. It has been reported that actions to reduce the farm and food mile externalities, and to shift consumer decisions on specific shopping preferences and transport choices would have a substantial impact on environmental outcomes (Roy et al., 2009).

Another important aspect that should be taken into account in order to improve sustainability in the ready meals food sector is prevention of food losses (Tempelman et al., 2004). Packaging is important in order to reduce food losses in the retailer and consumer steps (Erlöv et al., 2000; Büsser et al., 2008; Williams et al., 2008). While food losses at industrial level can be estimated more precisely, the amount of uneaten, wasted or partly used food at the household level is difficult to determine. At the household level different kinds of food waste are produced, such as preparation discards, plate waste, spoiled food and products with expired shelf dates. On this level, food products are frequently discarded, only partly consumed or even unopened. Alternative options for food waste management have been analyzed using a life cycle approach (Lundie and Peters, 2005). Results showed that, for the impact categories considered, home composting was the best option for food waste management (among others analyzed, such as centralized composting and landfilling food waste with municipal waste as codisposal). Nevertheless if operated without the required controlled aerobic conditions, home composting could greatly increase greenhouse gases emissions as a consequence of anaerobic methanogenesis. The same study also showed that landfilling food waste with municipal food waste was a relatively good option except with respect to climate change and eutrophication potential (Lundie and Peters, 2005).

Ready meal containers have their own environmental loads, since resources have been consumed in their manufacture, such as tinplate for making cans. Additionally, containers become the source of a great part of the solid waste generated in this food sector. Packaging has given rise to environmental concerns over the last few decades (Williams et al., 2008) resulting in strengthening of EU Regulations in order to reduce the amounts of packaging material. Over 67 million tons of packaging waste is generated annually in the EU, comprising about one-third of all municipal solid waste. As shown, in the UK alone, 3.2 million tons of household waste produced annually corresponded to packaging material (Davis and Song, 2006).

Life Cycle Assessment is a technique to assess the environmental aspects and potential impacts associated with a product, process, or service, by compiling an inventory of relevant energy and material inputs and environmental releases during its life cycle. LCA can identify environmental and critical points where the environmental management system should be improved (Curran, 2004) and it is the environmental management tool most frequently used nowadays. LCA has a wide-ranging application in the development of products, of environmental policies and in marketing (Baumann and Tillman, 2004). The applications (among others) that can be highlighted are: decision making, product and process design, research and development, purchasing, information for defining company strategies, identification of areas of improvement, selection of environmental indicators, environmental labeling and ecological product statement. LCA is an ISO standardized method (ISO 14040-14043). The European Union has pointed out that LCA is the best tool to evaluate the potential environmental impact of products in, for example, the "Integrated Product Policy Communication" (COM/2003/302), as well as in the two "Thematic Strategies on the Sustainable Use of Natural Resources" (COM/2005/670). Two types of LCA can be distinguished: attributional and consequential LCA (although sometimes different names are used by different authors). An attributional LCA aims at describing the environmental properties of a life cycle and its subsystems. A consequential LCA aims at describing the effects of changes within the life cycle.

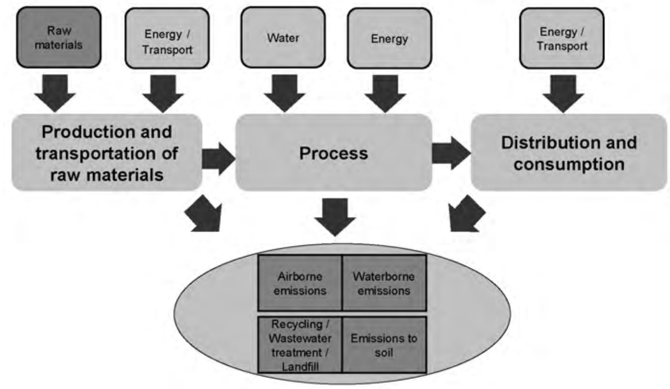

Fig. 1. Outline of the system under study.

In recent years, several LCA studies have focused on food products, such as basic carbohydrate food (bread, potatoes, rice, pasta), fruit and vegetables, dairy products, meat products, fish production and processing (Foster et al., 2006; Roy et al., 2009) as well as canned tuna fish (Hospido et al., 2006). Recently, an LCA case study has been published for an industrial cooked dish with an ecodesign approach (Zufia and Arana, 2008). Nevertheless, to our knowledge, there are very few studies available specially focused on the ready meals sector. In this study, an attributional LCA was first carried out for the identification of the main impacts and the critical items involved in the complete productive process of a ready meal, an industrial stew dish, to allow decision making. Secondly, further analysis of food-packaging systems, applicable to packaging selection was performed.

2. Materials and methodology

2.1. Goal and scope definition

2.1.1. Objectives

The aim of this work is to show the utility and the interest of Life Cycle Assessment (LCA) as a tool for improving environmental management in the ready meals food sector. To serve this purpose, a case study of one product in this sector, a canned stew product based on cooked pulses and pork meat cuts (sausages and ham) produced in a real factory was inventoried and analyzed using the LCA methodology, from a cradle to grave perspective. Moreover, the LCA methodology was applied considering different packaging systems as alternative end-of-life scenarios for the specific product, in order to provide useful information for packaging selection.

2.1.2. Functional unit, system description and boundaries

The functional unit (FU) selected is 1 kg of finished product ready to be consumed.

Fig. 1 shows the outline of the system under study. The system considered includes the whole life cycle with a cradle to grave perspective: production of ingredients and materials, transportation of raw materials to the factory, product processing, product consumption (energy/transport), emissions (to soil, airborne, waterborne and recycling/wastewater treatment/landfill) involved in the production and consumption of the canned dish. An industry located in Spain, which produces around 8000 tons of this product per year, was considered for the inventory data.

The system has been divided into seven subsystems:

(i) *Food ingredients*. The environmental loads assignable to the processes for obtaining raw materials employed as food ingredients (except water), including farming activities and the foodstuff processes. For the production of one functional unit