



Implementing by-product management into the Life Cycle Assessment of the mussel sector

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ARTICLE INFO

Article history:

Received 6 May 2009

Received in revised form 29 March 2010

Accepted 30 March 2010

Keywords:

Calcium carbonate
Life Cycle Assessment
Mussel
Pâté
Shell
Valorization

ABSTRACT

In Galicia (NW Spain), the mussel sector is an economic and social cornerstone, with great relevance at both regional and international scales. The environmental impact of this sector has been recently discussed from a Life Cycle Assessment (LCA) perspective. In previous studies, it was concluded that the management of mussel shells and mussel organic by-products needed to be implemented into future life cycle assessments. In this article, LCA methodology was used in order to assess the environmental performance of two valorization alternatives for mussel by-products: mussel shell valorization to produce calcium carbonate, and mussel organic remains valorization to produce pâté.

From the environmental characterization for mussel shell valorization, propane and electricity production, sludge and ash management, haulage and atmospheric releases were identified as the hot-spots on which improvement potentials should be focused. Furthermore, the environmental profile for mussel shell valorization was compared to those for incineration and landfilling as alternative management options.

The environmental characterization of pâté production from mussel organic by-product led to the recommendation of acting on the formulation of mussel pâté, the thermal energy demand and the product transport. Additionally, this valorization alternative was compared to another common scenario which considered the use of mussel organic by-product to manufacture fish meal.

Finally, the valorization of mussel shells and organic by-products was implemented into the assessment of the Galician mussel sector. Thus, mussel by-product management was found to contribute to the potential environmental impacts to a lesser extent than mussel culture, purification and canning transformation.

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1. Introduction

The food production system is a great consumer of both energy and natural resources. This together with current consumption patterns has resulted in an increased interest regarding the environmental performance of food products. It is generally accepted that a significant environmental burden of any country will arise from its food production, processing, transport and consumption rates (Edwards-Jones et al., 2008; Foster et al., 2006; Garnett, 2008).

In Galicia (NW Spain), the food industry occupies an outstanding position in the manufacturing framework of the region. It accounts for an employment share of above 17% and a net product sales share greater than 19% (Sainz et al., 2007). This fact is closely linked to the fish processing sub-sector. The latter is embedded

within the Galician fishing sector, which shows an annual turnover above 1000 million Euros and a regional GDP share over 10%. Specifically, Galicia occupies leadership positions in aquaculture. In fact, 80% of the Spanish aquaculture production concerns Galician aquaculture (Xunta de Galicia, 2007), with a total production above 300,000 tonnes. Mussel culture (*Mytilus Galloprovincialis*) comprises 96% of this value, providing more than 60% of the economic turnover of the regional aquaculture sector (Xunta de Galicia, 2007). Furthermore, mussels from Galician rafts account for 98% of the total produced in Spain (MAPA, 2007), with 43% at European level and 11% at world scale (FAO, 2007). Nevertheless, the Galician mussel sector does not focus only on cultivation. It also comprises other activities such as those performed by dispatch centres, mussel cooking plants and canning factories (Franco, 2006). All these activities generate several waste materials that have to be managed. In the Galician mussel sector, the management of two specific waste materials should be highlighted: shell and mussel organic remains. These waste streams are usually named as mussel by-products since the term ‘mussel waste’ is generally used to classify the emissions of dissolved nutrients and organic particulate

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material from the mussel culture. With regard to mussel by-product management two main systems stand out:

- Management of mussel shells and other mussel debris. These mainly come from canning factories and, to a lesser extent, from mussel cooking plants and dispatch centres. The most popular management option for these waste materials is their valorization to obtain calcium carbonate (Barros et al., 2009a).
- Management of mussel organic remains. This by-product from canning factories, cooking plants and dispatch centres can be sent to factories that produce fish meal. However, the production of mussel pâté from mussel organic waste is currently a valorization alternative gaining increasing popularity. Mussel organic by-product refers to small mussel meat remains which are discarded in the course of mussel processing.

Life Cycle Assessment (LCA) is a useful methodology when evaluating the environmental performance of a product or process through the use of a comprehensive approach that considers the complete product life cycle (Baumann and Tillman, 2004). This tool has already been used for seafood (Pelletier et al., 2007). Specifically, Iribarren et al. (in press, submitted for publication) studied mussel cultivation and processing in Galicia under an LCA perspective. The present paper aims to implement the management of mussel by-products from processing factories into the target life cycle, an area that has been highlighted with need for further research (Iribarren et al., submitted for publication).

The rationale behind the use of LCA for this case study lies in its life-cycle perspective and the wide range of potential uses. Thus, the LCA for the mussel sector provides production chain transparency and accountability for this specific seafood industry (Iles, 2007). Furthermore, results may support decision making tasks for companies and policy makers. For example, future regional policies involving the environmental performance of mussel products could be correctly oriented, and operational performances within this sector could be benchmarked on the basis of eco-efficiency criteria (Lozano et al., 2009). Moreover, mussel companies are expected to use the LCA results to support their marketing strategies. Beyond

the regional relevance of advancing towards a complete LCA for the mussel sector in Galicia, the usefulness of this study also reaches countries with an emerging market for mussels, such as China or Chile. This article should be understood as a new step to promote sustainability in seafood production and consumption (Ayer et al., 2009).

2. LCA framework

2.1. Objectives and introduction to the case study

According to the conventional Spanish market share of mussels (MAPA, 2001; Tirado and Macias, 2006; Xunta de Galicia, 2006, 2007), most of the cultured mussels (75%) are sent to dispatch centres and canning factories to produce fresh and canned mussels. The rest is processed in cooking plants where frozen mussels (80% of the input to the cooking plant) and boiled mussels for partial canning factories (20% of the input) are produced.

A dispatch centre is any on-shore or off-shore establishment for the reception, conditioning, washing, cleaning, grading, wrapping and packaging of fresh molluscs for human consumption. The purification process consists of the maintenance of the molluscs for a certain period of time in water that is free of pathogens, so that the molluscs filter the water and get depurated (Amengual, 1989). Therefore, mussel dispatch centres are responsible for the provision of fresh mussels.

Canning factories produce canned mussels from cultured mussels. Note that these factories receive mussels from the cultivation sites and not from dispatch centres. This is because the thermal treatment in canning factories avoids the mussel purification step within dispatch centres (Xunta de Galicia, 2005).

Regarding mussel by-products, canning factories are the main source of shells and mussel debris, and also give rise to mussel organic remains. Moreover, dispatch centres constitute a relevant source of mussel organic by-product. Fig. 1 presents the systems which are taken into account for the implementation of by-product management into the LCA of the Galician mussel sector. As observed, it was assumed that mussel shells and debris only come from canning factories, while mussel organic remains (i.e.,

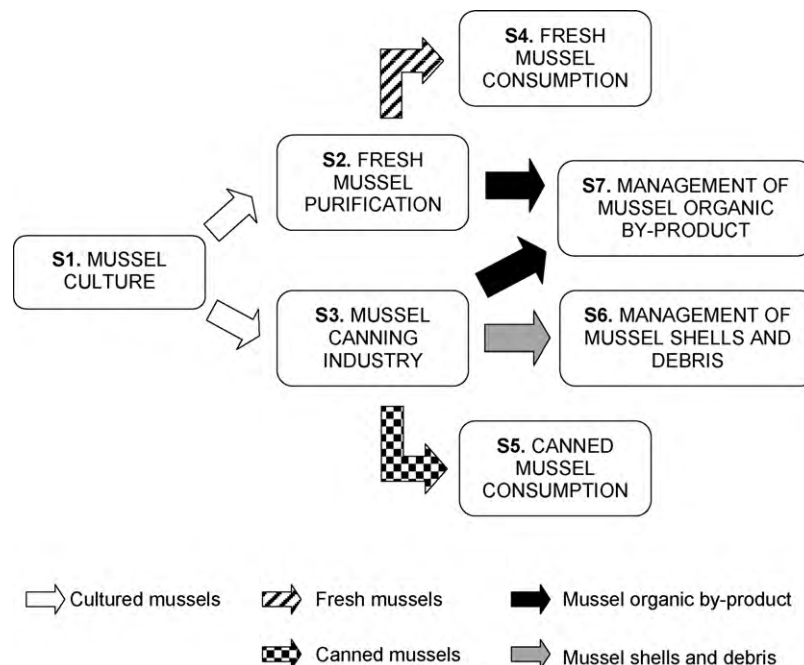


Fig. 1. Systems for the implementation of by-product management into the LCA of the Galician mussel sector.

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