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A life cycle assessment of processed meat products supplied to Barrow Island: A Western Australian case study

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ABSTRACT

This research aims to assess the emissions of greenhouse gases (GHGs) as well as the embodied energy associated with two value added processed meat products supplied to an offshore mining site at Barrow Island, Western Australia. A beef product (Canon Foods Swedish Meatballs) and a chicken product (Canon Foods Crunchy Garlic Chicken Breast) are produced at the Canon Foods facility in Cannington, Western Australia and transported to the final location of Barrow Island by way of their gateway port at Dampier, Western Australia. Using streamlined life cycle assessment (SLCA) methodology, it was estimated that the environmental impact of 1 kJ equivalent amount of Canon's Swedish Meatballs is 1.09 g CO_2-e of GHG emissions and 4.15 kJ of embodied energy, while the impact of Canon's Crunchy Garlic Chicken Breast is 0.38 g CO_2-e of GHG emissions and 5.08 kJ of embodied energy. The life cycle assessment demonstrates that the main cause of the GHG emissions and the high final embodied energy of the product can be linked primarily to the pre-farm inputs of the meat products and not the value adding process itself. The bulk of the GHG emissions of the final value added product can be attributed to the livestock ingredients, particularly beef based products, while the high embodied energy can be attributed to the amount of processing that inputs underwent prior to the Canon value adding process.

1. Introduction

The food processing sector is expected to expand further in order to keep pace with international demand (Jonas and Julia, 2013), and is responsible for around 20% of global greenhouse emissions (EurActive, 2009; Hertwich and Peters, 2009). Also food is one of the three main priorities along with housing and transport, which are responsible for 70% of the environmental impacts in most categories (Tukker and Jansen, 2006). In the case of Australia, the food and beverage sector accounts for a large portion (23.5%) of the total Australian manufacturing sector (Australian Department of Industry, (2014)), and it is therefore essential to keep this sector both financially viable and environmentally sustainable in order to compete in the international market. About 21% of the food manufacturing sector is the meat and meat product manufacturing sub-sector (Australian Department of Industry, (2014)). The main challenges for the Australian meat and meat product manufacturing industry today are not only to produce enough to be commercially viable, but also to expand in order to meet rising global demand and to develop in a way that is environmentally sustainable and does not put a disproportionate strain on the environment.

According to Troy and Kerry (2010), meat production and meat consumption have an environmental impact and are linked to climate change. A holistic method is required to measure the industry's impact on the environment that sustains it. One of the most effective methods is the application of a life cycle assessment (LCA) (Curran, 2012), which is widely valued as a means of evaluating environmental impact during the life cycle of products. This would provide valuable insight into Australia's rapidly changing meat and meat product manufacturing industry (Jonas and Julia, 2013).

Over the past 10 years there has been a sharp increase in the popularity of life cycle assessments (LCAs) in Australia, with around 75 published LCA studies and 63 undergoing a structured review to identify the coverage and comprehensiveness (system boundaries, impact categories) of past assessments (Renouf and Fujita-Dimas, 2013). Most of these LCA studies (70%) were conducted on the agri-food sector and involved the assessment of primary production or primary processing, with only 30% of studies taking the

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'cradle to factory gate' approach of considering the full supply chain (Renouf and Fujita-Dimas, 2013). This unfortunately leaves the Australian LCA community at a crossroads where the environmental impact of the primary product of the nation is quite comprehensively known but the impact of final products largely remains a mystery.

Part of the aforementioned comprehensive Australian coverage of primary produce is related to the processed meat industry, including extensive assessments of beef, chicken, pork and lamb (Bengtsson and Seddon, 2013; Biswas, 2015; Biswas et al., 2010; Peters et al., 2010; Wiedemann et al., 2015, 2012). These studies have provided a unique insight into the challenges that need to be considered in the Australian agri-food industry.

Eady et al. (2010) went into further detail by assessing the carbon footprint of a basket of primary and downstream products from the Australian context, such as bread, tinned lentils, fresh beef, pork and chicken, and two types of pet food. However, this study was limited to generic estimations of very basic downstream foods with very few inputs and did not cover complex, value added processed and packaged foods or the assessment of the goods with regard to embodied energy.

There have been preliminary LCA assessments of some basic downstream products, such as bread and milk, by Eady et al. (2010), and some primary work by Beer et al. (2005) on the production of corn chips from Australian maize. There has even been research nationally into commercially available restaurant served roast chicken (Jonas and Julia, 2013). Although the topics of both meat production and basic downstream product production have been covered to some extent locally, the combined topic of value added, composite processed meat product has not yet been assessed. To date, there is no published Australian study that has focused on the LCA of processed meat products. Therefore, this paper fills the gap in the Australian body of knowledge by providing an LCA analysis of the Australian processed food industry. This research provides a comprehensive analysis of one composite chicken and one composite beef value added product delivered to one of Western Australia's most remote islands builds upon the extensive Australian research into meat and is aided by the previously laid groundwork on basic downstream products that make up a large portion of these value added goods.

This research will assess the environmental impact of the processed meat industry using the local processed meat product manufacturer Canon Foods as a case study. Firstly, the study investigates the Australian processed meat product manufacturing industry using Canon Foods as a case study, in order to create a full process flow for the current methods of manufacture for two of their most commercially successful products. Secondly, it presents an life cycle inventory (LCI) consisting of all inputs and outputs in order to determine the carbon footprint and embodied energy consumption using SimaPro software based on one package of a popular processed beef product and one package of a popular chicken product shipped to Barrow Island in Western Australia. Finally, this paper provides the industry with an overview of the typical parts of the process that are likely to increase environmental impact, in order to select strategies to mitigate this impact.

Carbon footprint and embodied energy consumption impact categories were selected because they are considered to be key environmental impacts of food production (Mattsson, 1999; Swedish Institute of Food and Biotechnology, (2009)). Embodied energy has been defined as: 'the energy required to provide a product (both directly and indirectly) through all upstream processes (i.e. traceable backwards from the finished product to consideration of raw materials)' (Langston and Langston, 2008). This embodied energy consumption or cumulative energy demand (CED) can also be used as a screening indicator for environmental performance instead of performing a full LCA, for instance, in the absence of sufficient data (Huijbregts et al., 2006). Since the very first LCA studies, the cumulative energy demand CED has been one of the key indicators being addressed (Frischknecht et al., 2015). For carbon footprint, it is one of the most important indicator for Australia as the Prime Minister has reaffirmed "the country would "meet and beat" its 2020 emissions reduction goal - a reduction of 5 per cent compared with 2000 levels" (Tom Arup, 2015) during the Paris conference in December 2015.

The use of these two impact categories is deemed sufficient to accomplish these aims, similar to LCAs that have used these categories to great effect in both Western Australian and Australian cases (Biswas, 2015; Gunady et al., 2012; Wiedemann et al., 2012).

Canon Foods produces a 'Swedish Meatball' and 'Crunchy Garlic Chicken Breast', which are a beef and chicken product respectively, and similar to what WA workers in remote areas consume on a daily basis (Raj Gopal, R. pers comm., Canon Foods, Canning Vale, Perth, Australia). Canon Foods is a Western Australian business that sources its ingredients as much as possible from local Australian sources. This implies that their products are relatively low 'food mile' products and present a real case for sustainable food production in the Western Australian industry. Taking a representative case study for the production of food using local ingredients and then transporting it to one of the most difficult to access locations provides indicative data regarding the impact on Western Australian value added meat production. This can be applied to any location in Western Australia without the fear of impact values being underestimated, which might occur if this research had adopted a traditional 'cradle to remote island' approach to LCA analysis.

This streamlined LCA has been applied mainly to assess the environmental implications of the operations and production of an existing facility, Canon Foods, and their 'industrially common' process, with the aim of providing information for decision-makers and researchers primarily concerned with the 'production phase' of processed meat product production (Andersson, 2000).

2. Methodology

The LCA in this study follows the ISO 14040:2006 guideline (International Organization for Standardization, 2006), which consists of the following four steps: i) goal and scope definition, ii) inventory analysis, iii) impact assessment and iv) interpretation (which takes place in the Results and Discussions section).

2.1. Goals and scope

The goal of this life cycle assessment is to evaluate the environmental impact of the production of two processed meat products in Western Australia, one chicken-based and one beef-based, and to identify the environmental improvement opportunity.

Specific objectives pertaining to the overall goals are:

- To assess the environmental impact of Canon Foods' 'Crunchy Garlic Chicken Breasts' based upon the carbon footprint and embodied energy consumption.
- To assess the environmental impact of Canon Foods' 'Swedish Meatballs' based upon the carbon footprint and embodied energy consumption.

The processed chicken meat product selected for assessment was Canon Foods' 'Crunchy Garlic Chicken Breasts'. This product consists of chicken meat, breadcrumbs, soy protein, onion, garlic, vegetable oil and spices, and is produced in Canning Vale, Western Australia, from ingredients sourced both locally in Western