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OWC 2020 - Supply & Value Chain Forum

Topic 1 - Experiences and innovations for a continuous improvement in reducing the environmental impacts of the production processes

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ENVIRONMENTAL IMPACT ASSESSMENT OF ORGANIC CARROT PRODUCTION AND SUPPLY IN SWEDEN

Techane Bosona[*1], Girma Gebresenbet[1] and SusOrganic project

[1]Energy and technology, Swedish university of agricultural sciences, Uppsala, Sweden

Targeted audience: Farmers, Advisors, extension services (including transition support), Food (non food) processors, Trade (incl. retailers) / fair trade, Consumers (and citizens), Students, Researchers

Are you able to make an oral presentation in English?: Yes

Prefered language for oral presentation: English

Summary: This paper presents the results of life cycle analysis (LCA) of fresh and dried organic carrot produced and supplied in Sweden. Cumulative energy demand (CED) and climate change impact have been investigated using cradle-to-consumer gate approach. The functional unit (FU) was 1 ton of fresh product at farm. The major life cycle stages were agricultural production, post-harvest process, and transport. The total CED values were 2.64 GJ and 6.67 GJ per FU for fresh and dried carrot respectively. Regarding climate change impact, the values were 121 kg CO_2 eq and 111 kg CO_2 eq per FU for fresh and dried carrot respectively. The drying process increased CED but reduced the climate change impact. In addition to reducing climate change impact, the drying process increases shelf life and selling price.

Background: 1. Background

Promoting sustainable food production like organic agriculture system is important to reduce the environmental impact of agriculture sector which is the contributor of most of environmental impacts. About 40% of global land area is covered by agriculture; 70% of global water withdrawal is for agriculture; and 30% of greenhouse gas emissions come from agricultural activities (Jonathan Foley, 2010).

Assessing environmental impact of agriculture is complex (Tamburini et al., 2015). On the other hand the need for knowledge on environmental impact of agricultural products is increasing. Quantifying environmental impacts supports information-based decision making in food production and supply chain management (Stoessel et al., 2012). In Sweden, the consumption of carrot is increasing. Therefore, investigating the environmental impact of organic carrot production and supply enables to generate valuable information and to have increased understanding on environmental impact.

Core messages and conclusions:

2. LCA Methodology

This study applied LCA framework as standardized with ISO 14040 (LCA handbook, 2004). The goal of the study was to assess the environmental burdens of organic carrot production, processing (drying) and distributing in Sweden. A cradle-to-retailer gate LCA was conducted. A functional unit (FU) of 1 ton fresh carrot at farm gate was used in both fresh and dried carrot cases. Main life cycle stages include agricultural production, post-harvest, and transport stages. Average yield of organic carrot is about 58t/ha. Low-density polyethylene (PELD) has been considered for packaging. At transport stage, 80 km for collection of products from farm to processing facility (or wholesaler depots), 50km from the processing facility to retailers, and 5km from retailer to consumer home have been used. Per FU, about 0.57 t fresh carrot and 0.11 t dried carrot was estimated to be delivered to retail.

Life cycle inventory is the most effort-consuming step in the LCA studies (Tamburini et al 2015). In this study, both primary and literature based data sources as well as ecoinvent database have been used. Two impact categories, the cumulative energy demand (CED) and global warming potential (GWP_{100}), have been investigated using a LCA software SimaPro (version 8.2).

3. Results and discussion

From LCA results, total CED values were found to be 2.64 GJ and 6.67 GJ per FU for fresh and dried carrot respectively (see Figure 1). The energy consumption at post-harvest stage is high for both fresh and dried organic products. In case of fresh carrot value chain, about 83% of energy consumption at post-harvest stage is due to packaging activities followed by storage and cooling energy consumption. In case of dried carrot, electricity used for drying contributed about 88% of CED value at post-harvest stage followed by packaging stage (12%).

Figure 2 illustrates that the GWP values from fresh and dried carrot supply chains were 121 kg CO2 eq and 111 kg CO2 eq per FU respectively. For fresh carrot, transport stage was environmentally hot spot (60%) followed by farm stage (29%). In dried carrot case, the contribution of transport stage to total emission is reduced (due to reduced volume and tonnage of dried carrot) to 39% while that of post-harvest stage increased to 30%. In addition to reducing GWP, drying process increases the shelf life of carrot and its selling price increasing sustainable organic food supply.

4. Conclusion

A cradle-to-consumer gate LCA study was conducted comparing dried organic carrot value chain with fresh organic carrot value chain, for organic carrot value chain CED increased from 2.6 GJ to 6.7 GJ while GWP was reduced from 121 kg CO_2 eq to 111 kg CO_2 eq per FU. The study enabled to understand the influence of the carrot drying process on energy consumption and environmental impacts of organic carrot value chains. This study also contributed to the LCA data base on organic food products.

Suggested readings and/or references to your work:

1. Foley J. (2010). The other inconvenient truth. TED Talks, filmed October 2010. http://www.ted.com/talks/jonathan_foley_the_other_inconvenient_truth#t-540163 Accessed on October 26, 2015.
2. Karlsson H. (2011). Seasonal vegetables: An environmental assessment of seasonal food. Master thesis; Norwegian university of life sciences.
3. LCA handbook (2004). Handbook on Life Cycle Assessment Operational Guide to the ISO Standards. Kluwer Academic Publishers; eBook ISBN: 0-306-48055-7; New York.
4. Röös E. and Karlsson H. (2013). Effect of eating seasonal on the carbon footprint of Swedish vegetable consumption. Journal of Cleaner Production, 59 (2013): 63-72.
5. Tamburini E., Pedrini P., Marchetti M.G., Fano E.A., Castaldelli G.(2015). Life Cycle Based Evaluation of Environmental and Economic Impacts of Agricultural Productions in the Mediterranean Area. Sustainability 2015, 7, 2915-2935; doi:10.3390/su7032915 sustainability ISSN 2071-1050.

Image 1:

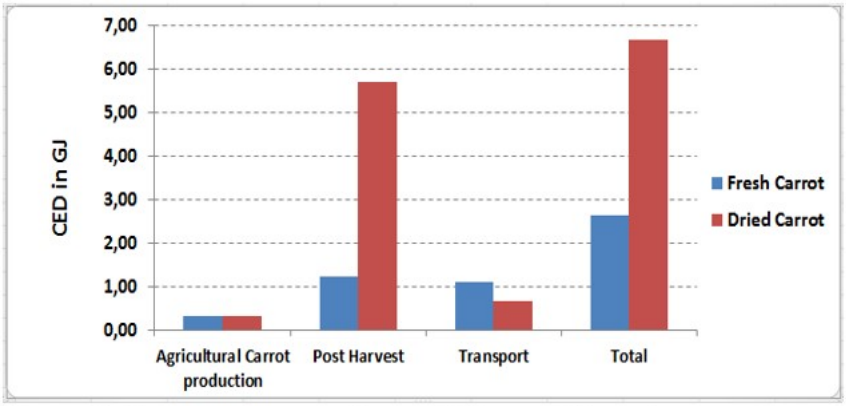

Figure 1: Energy consumption at different life cycle stages. The values are in mega joule (MJ) per functional unit.

Image 2:

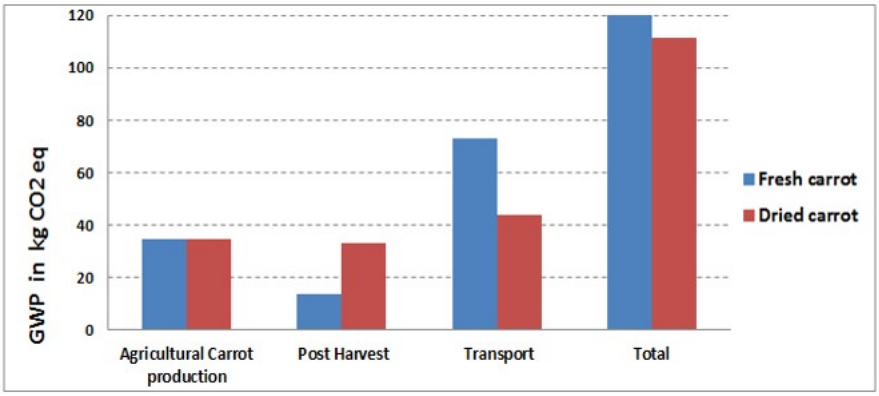

Figure 2: Climate change impact per FU at different life cycle stages.

Disclosure of Interest: None Declared

Keywords: Cumulative Energy Demand; Organic carrot; Carrot drying; Life cycle analysis