ETM0004

Carbon Footprint of Organic Black Tea Production from Pu Muen Community Enterprise in Chiang Mai

Nitipat Jommongkol[1*], Phiched Thanin [1], and Lersak Bunthan [1]

[1] Faculty of Engineering, North-Chiang Mai University, Chiang Mai, 50230, Thailand.

[*] Corresponding Author: Aekapoj@gmail.com, 08-8252-7267, fax.05-3819-998

Abstract

The objective of this study was to evaluate the impact of global warming from organic black tea. The Carbon Footprint method used to calculate an organic black tea product of Pu Muen community, Mae Ai District, Chiang Mai Thailand. The Pu Muen's black tea product uses hydro power for all production process. This research applies the Life Cycle Assessment (LCA) and Carbon Footprint Product (CFP) methodology. The system boundary considers from cradle to grave. That was starting from cultivation, transport, usage and disposal. The selected functional unit was one box of organic black tea with a net weight of 30 grams including packaging. The Greenhouse gases emission value was calculated based on the IPCC 2007 methodology which was a separation process in the life cycle. The result showed that the carbon dioxide emission content of organic black tea from all stages was 0.449 $kgCO_2e$ or 449 gCO_2e per one box. The production stage had the highest greenhouse gas emission equaling to 0.328 $kgCO_2e$ due to the used in the production the package consist of paper, foil and carton. These package pieces were produced from the industry that have higher amount of greenhouse gas emissions during the production processes.

Keywords: Carbon Footprint Product, Lift Cycle Assessment, Greenhouse gas, Organic Black Tea.

1. Introduction

The greenhouse gas emissions (Greenhouse Gases: GHGs) from Human activities are due to the use of energy, agricultural development, expansion of the industry, transportation, deforestation and including destruction of natural resources and environment. These are the major cause of global warming. At present, buying product or services having less greenhouse gas emissions is one way to allow consumers to participate in the management of GHGs. The Carbon footprint is defined as the total amount of GHGs emission of directly or indirectly from production processes. The value expresses in equivalent kilograms of carbon dioxide (CO_2). Calculate on of carbon footprint value of a product is important since the results can be trusted especially for the consumer. To purchase a product or service that has less greenhouse gas emissions is a way to enable consumers to participate in the management of greenhouse gas emissions caused by its consumption patterns and methods. The Greenhouse Gas emissions analysis of raw materials, transportation, use and disposal throughout product life cycle. A carbon footprint is to keep consumers informed decision to purchase.

Thailand has an area for approximately 97,000 hectares of tea plantations. Most of them cultivated in Chiang Rai province, approximately 45,600 hectares and 41,200 hectares of Chiang Mai. The production of tea leaves and tea products are 85 percent of the domestic consumption. The remaining 15 percent of export revenues over the country 100 million Baht per year [1]. Pu Muen Community is Lahu hill tribe communities in Thailand. It is a location on Doi Fa Hom Pok, Mae Ai district, Chiang Mai province. Their occupation is cultivation of Assam tea variants. A production volume is 160,000 tons per year of fresh tea leaves representing approximately 40,000 kg of dry tea per year. Currently, Pu Muen Community development and tea production is an organic black tea. The application tools and accessories are available in traditional communities. All process of production uses hydro power. Renewable energy can reduce fossil fuel consumption and natural resources such as oil and timber. The Carbon Footprint makes the community aware of the importance of global warming. That can bring data to inform customers and to bring this information to promote the image of the product.

2. Methodology

This research aims to analyze the environmental impacts that occur over the life cycle production of organic black tea. Analysis of the environmental assessment of Greenhouse Gas (GHG) includes four stages: 1) Goal and scope 2) Inventory Analysis 3) Impact Assessment 4) Interpretation. The research used guideline for product category rules of the organic tea, according to the International Organization for Standardization (ISO), ISO14040 [2].

2.1 Goal and Scope of the Study

The objective of the study is to present a carbon footprint product and to evaluate the greenhouse gas emissions of an organic black tea product. The result will be used for Thailand National Guidance on

Carbon Footprint, Intergovernmental Panel on Climate Change(IPCC)2007methodology[3].
The environmental assessment of GHG in five stages presented in Fig 1.

2.2 Inventory analysis

The carbon footprint of organic black tea was evaluated from data plantation site-visit and questionnaires. The questions were related to fertilizer, fuel, and energy used one year ago. The organic black tea processing has eight stages. Input of process are material and energy. Output of process are waste and impact, processes of organic black tea production which are presented in Fig 2.

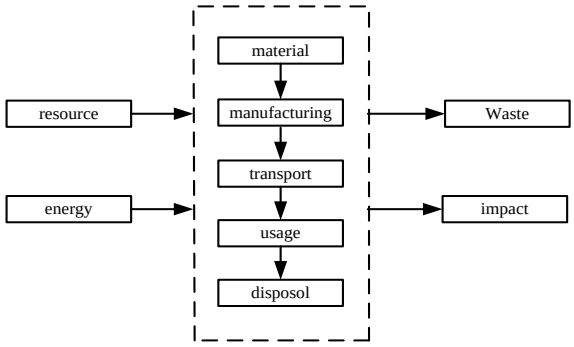

Fig 1. Analysis of the environmental assessment of GHG in five stages.

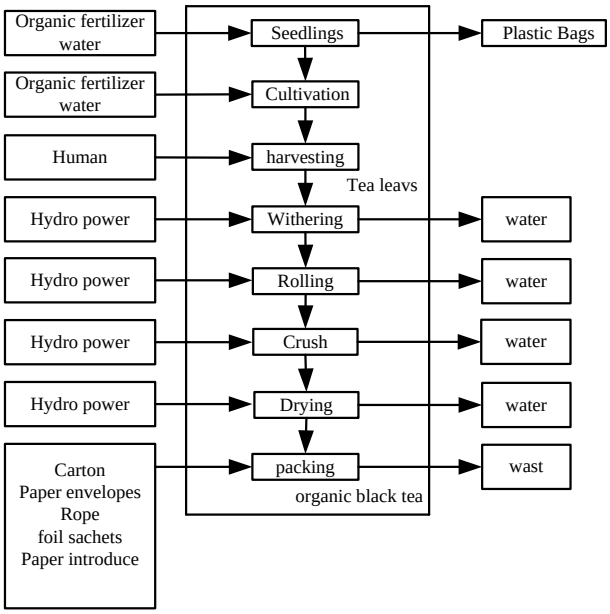

Fig 2. Process of organic black tea production

2.3 System boundary

The system boundary considers from cradle to grave .The functional unit data of this assessment were from the Pu Muen community enterprise. They were separated into five main parts: cultivation, manufacturing, transportation, product usage and disposal.

2.4 Energy Usage

Pu Muen community uses hydro power for electrical generator and mechanical generator. The organic black tea product uses three type of energy resource in all processes. The hydro power energy was used in manufacturing process by withering, rolling, crush, drying and packing. Hydro is renewable energy, which did not have an impact on the emission [4]. In this research the power consumption on manufacturing processes was set to be zero. The diesel fuel was used during the transport stage by four wheel truck and ten wheel truck in disposal process, where the usage process got energy from electricity and water supply. The database emission factor of energy resource show in table 2.

Table 2.Thailand Nation Database Emission Factor [4]

source	unit	$Kgco_2e$/unit
4-wheel truck full load	ton/km	0.0530
4-wheel truck no load	ton/km	0.5863
10-wheel truck full load	ton/km	0.0530
10-wheel truck no load	ton/km	0.5863
electricity	kWh	0.6093
water supply	m^3	0.7043

2.5 Impact Assessment

The Lift cycle inventory (LCI) is classified as global warming impact categories. Greenhouse gas emission is expressed as Global Warming Potential (GWP) per 100 years considering carbondioxide (CO_2), Methane (CH_4), Nitrousoxide (N_2O), Hydrofluorocarbons (HFC_s), Perfluorocarbons (PFC_s), and Sulfur Hexafluoride (SF_6), while the total carbon footprint is expressed equivalent to kilograms of carbon dioxide ($kgCO_2$). The equivalent carbon dioxide is the concentration of carbon dioxide, that would cause the same level of radiative forcing as a given type and concentrate of greenhouse gas. The carbon footprint equivalent is lift cycle inventory value multiply with emission factor of material or energy usage. The equation is hereby presented (1)

$$CF = \sum(\text{Activity data}_i \text{ x } EF_i) \quad (1)$$

CF = carbon footprint equivalent
Activity data $_i$ = Lift cycle inventory value of i
EF_i = emission factor of i ($kgCO_2e$/unit)

Which is the Emission factor used by Thailand National Guidance on carbon footprint Calculation for Product[5]

ETM0004

3. Results

The assessment of greenhouse gas emissions is expressed by the amount carbon dioxide during each life cycle stages as follows. The information in table 3 shows equivalent carbon dioxide per kilogram of the parts in material and manufacturing state. Fresh tea leaves value is combination seeding, cultivation, and harvesting state. The other values are the manufacturing state's value. The usage process has greenhouse gas emissions from water supply manufacturing and electricity boils water for 12 cups of tea. The greenhouse gas emissions of usage process show in table 4. Transport process has greenhouse gas emissions from diesel fuel. The manufacturing process uses four wheel truck transport packaging material from Muang District to Pu Muen Community and transport organic black tea product from Pu Muen Community to Muang District for distribution. Ten wheel truck transport waste from Muang District to Hod District. The disposal process was dumping of waste into the landfill.

Table 3. The amount of Carbon dioxide Production Process

Material	($Kgco_2e$)
Fresh tea leaves	0.081969
Carton	0.177177
Paper envelope	0.006111
Rope	0.005283
Foil sachet	0.029794
Paper introduce	0.027502
Total	0.327836

Table 4. The amount of Carbon Dioxide of Usage Process

Material	($Kgco_2e$)
Water supply	0.012612
Electricity	0.101321
Total	0.113933

Table 5. The amount of Carbon Dioxide Transport Process

process	($Kgco_2e$)
Manufacturing	0.00115
Distribution	0.00393
Disposal	0.00125
Total	0.00633

Table 6. Total greenhouse gas emissions of the entire process.

process	($Kgco_2e$)
Production	0.32783
Usage	0.11393
Transport	0.00633
Disposal	0.00125
Total	0.44580

4. Discussion

The cultivation and harvesting processes of black tea are the same as for green tea and other fermented teas. The packaging increases emission when tea bags are used in the life cycle [8]. The organic black tea is powered by natural water in manufacturing process, thereby making the production process by having no emission. However, there is a higher impact on emission during the production process of packaging box. Carton has the highest carbon content on emissions as in shown in Figure 3. In the usage process, the electrical energy is utilized for boiling water and for production of water supply. The electricity has more carbon dioxide emission than water supply as shown in Figure 4. The transport process analysis is composed of the packaging component transportation, distribution, and waste transportation. The disposal process has more emission because it uses the large trucks and has a longer distance during transportation, as shown in Figure 5. Finally, Figure 6 considers the sum of all stages. The carbon dioxide equivalent to one box of organic black tea has 0.449 $kgCO_2e$. Among all stages, the production stage has the highest greenhouse gas emission.

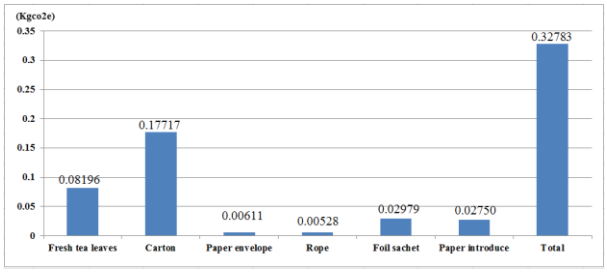

Fig 3. Carbon dioxide content during Production process

ETM0004

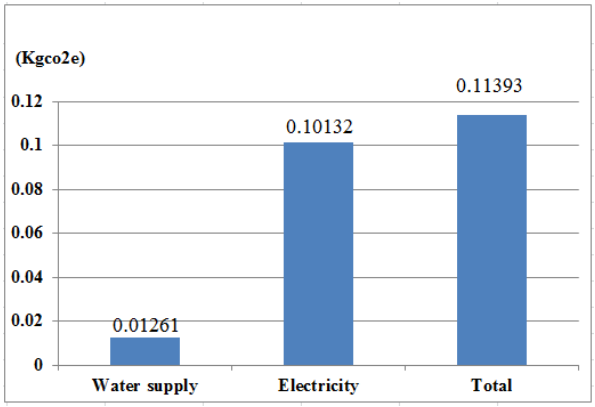

Fig 4. Carbon dioxide content during usage process

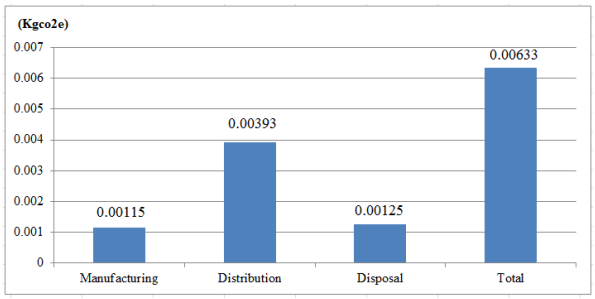

Fig 5. Carbon dioxide content during transport process

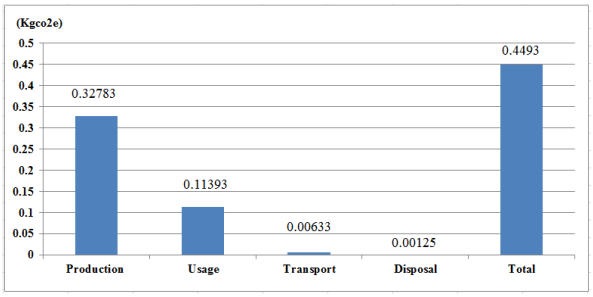

Fig 6. The amount of greenhouse gases on each process

5. Conclusions

Pu Muen's organic black tea uses natural water for the main of energy, which is clean energy that has no environmental emission. The production process has the highest greenhouse gas emissions because of the components for production such as paper envelopes, foil and carton. They are produced in the form of industry. The second highest greenhouse gas emission is the usage process because it uses of electricity and water supply. The result of the research recommends that the community should improve the processes of their production in order to reduce greenhouse gas emissions and to promote the image of the product to be more competitive in the market.

6. Acknowledgement

This research is funded research by North - Chiang Mai University.

7. References

[1] Collection Thailand tea varieties [Internet]. Available from:http://www.nstda.or.th/nstda-r-and-d/10960-collection-Thailand-varieties-tea
[2] International Standards Organization, 2006. Environmental management Life Cycle Assessment Printciple and Framework ISO 14040.
[3] Intergovernmental Panel on Climate Change (IPCC),2006 Guideline for National Greenhouse Gas Inventories. Intergovernmental Panel on Climate Change.
[4] Technical Committee on the Carbon Footprint of Products ,National Metal and Materials Technology Center. Guidelines for assessment carbon footprint product;(2554).
[5] Phairat Usubharatana, Harnpol Phung rassami. Carbon Footprint of Cassava Starch Production in North-Eastern Thailand. ScienceDirect Procedia CIRP29 (2015) 462-467
[6] Emission factor in Thailand [Internet] Available from: http.// thaicarbonlabel.tgo.or.th
[7] Guidelines for assessment carbon footprint of products. Technical Committee on the carbon footprint of products.
[8] Geneviève Doublet and Niels Jungbluth. 2010. Life cycle assessment of drinking Darjeeling tea, ESU-services Ltd, fair consulting in sustainability.