

Evaluation of the environmental impact of portion bag for food packaging: a case study of Thailand

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Abstract. This study applied life cycle assessment methodology in evaluating environmental impact of portion bag. The objective of this study was to identify the hotspot of environmental impact through life cycle of portion bag. The options were proposed for improving environmental performance of the product. The system boundary was defined as cradle-to-grave which included the ethylene production, LDPE and LLDPE resins production, portion bag production, disposal, and transportation. All materials and emissions were calculated based on 1 piece of portion bag which weighed 2.49 g. IMPACT 2002+ was used for assessing environmental impact on SimaPro V8.2 software. The result found that the most of environmental impact was generated from LDPE and LLDPE resins which was used as raw material for producing portion bag. After normalization, non-renewable energy showed the highest potential to concern. This impact related directly to the natural gas drilling, ethane production, ethylene production, resin productions, and energy in all process. In conclusion, it should be suggested that the selection of bio-material for producing portion bag can play an important role to reduce the environmental impact. The research demonstrates the possible way and benefits in improving cleaner raw material and suitable way of product's end-of-life for producing green portion bag in the future.

1. Introduction

Our world has faced many environmental problems since the start of Industrial Revolution in 1975. Many innovations have been created to facilitate the daily life of human, and one of them is plastic. With a wide range of properties, plastics were used in many applications such as packaging, container, film, textile, bag, etc. This is the one reason that the consumption rate of plastic increases every year as well as plastic wastes generation. In Thailand, packaging plastic is an important section in plastic industry. It was produced for supporting other industries, for example, food, chemical, and automotive industries. With the short life cycle of application, however, the volume of packaging plastic waste was increased in each year. Most of the plastic packaging is composite packaging which is difficult to recycle.



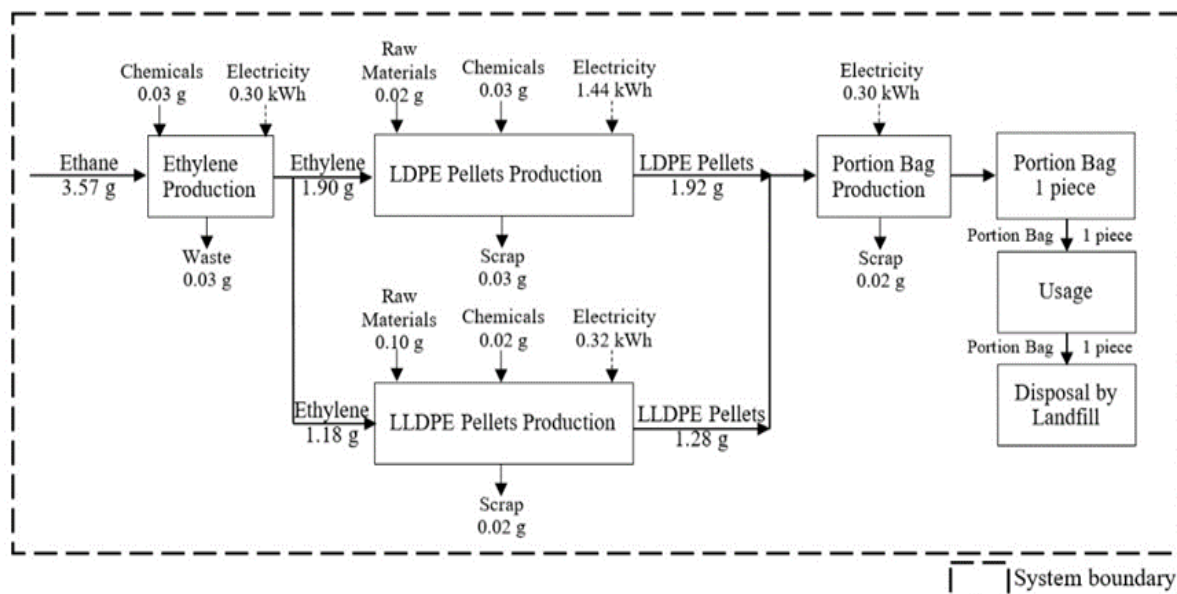


Figure 1. System boundaries of this study.

Although there are some methodologies for recycling packaging plastic, it still has high cost of operation and low cost for resale [1].

Life cycle assessment (LCA) is the methodology for identifying environmental impact associated from cradle-to-grave [2]. The LCA is a technique to evaluate the environmental impacts of product, which included raw material extraction, production, usage, and disposal [3]. Recently, some studies have evaluated the environmental impact of a multilayer polymer bag (made of low density polyethylene (LDPE) and polyamide (PA) for food packaging with LCA methodology [4]. However, the case study of LCA assessment of portion bag product is very rare. Therefore, the objective of this study is to assess the environmental impact of low density polyethylene (LDPE) and linear low density polyethylene (LLDPE) by using LCA methodology. The boundary system of this study was cradle-to-the grave. The end of life options for portion bag were proposed and comparison. All environmental impacts were calculated by using SimaPro V8.2 software with background data contained in Ecoinvent V.3 database. Furthermore, feasible measures will be proposed of options for reducing environmental impacts.

2. Materials and methods

This study was investigated the environmental impact of portion bag by using LCA method. The LCA technique used in this study was based on ISO 14040 framework and ISO 14044 guidelines, which consisted of four steps such as goal and scope definition, inventory analysis, impact assessment, and interpretation. The detail in each step can be described as follows:

2.1 Goal and scope

The goal of this study was to assess the environmental impact of the portion bag with zip lock as a case study. The portion bag was made from LDPE and LLDPE resin. The hotspot of environmental impact was identified. The options were proposed for improving environmental performance of the product.

2.2 Functional unit and system boundary

As shown in Figure 1, all environmental impact was calculated based on 1 piece of portion bag which weighs 2.49 g per piece. The scope of determination was started from raw material acquisition (cradle) to the end of life (the grave).

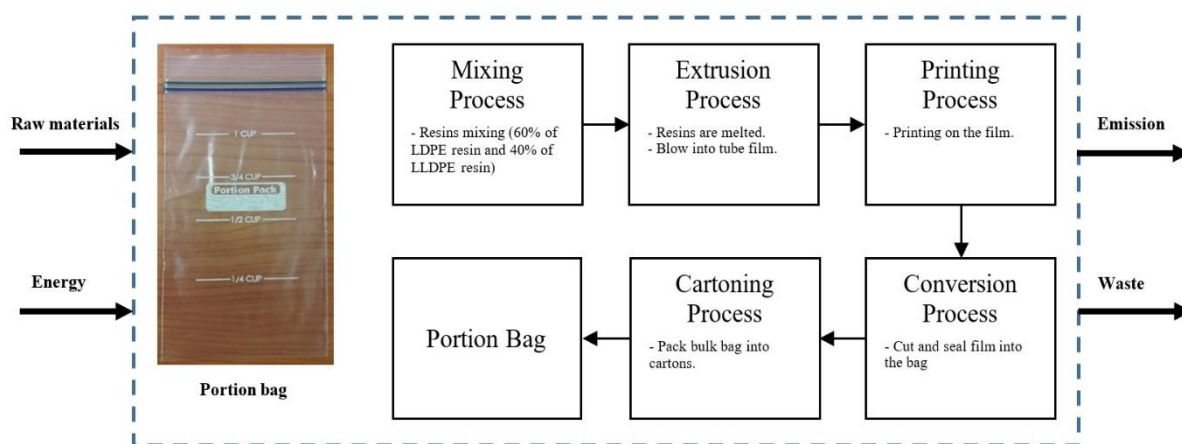


Figure 2. Portion bag production process.

2.3 Data collection and Inventory analysis

Portion bags were produced by blending 60% of LDPE resin and 40% of LLDPE resin. All material inputs and emissions from petrochemical processes (e.g. the ethylene production, LDPE and LLDPE productions) and plastic converter factories (e.g. portion bag production) were collected from the factories in Thailand, as shown in Figure 2. The portion bag production processes can be divided into 6 steps which are, mixing, extrusion, printing, conversion, cartoning and deliver to the customers. All input and output materials from “Portion bag production” were collected in each processes.

2.4 Life cycle impact assessment

All the input and output were allocated to base on 1 piece of portion bag (2.49 g) before assessed the environmental impact with SimaPro software. The processes were extrapolated from Impact 2002+ V.2.12 method and Ecoinvent V.3 database within the SimaPro software in the 8.2 version for identifying all processes and materials [5].

2.5 Interpretation

The results of the impact assessment through life-cycle of portion bag were interpreted to propose the option for improving environmental.

3. Results and discussion

3.1 Midpoint characterization result

In every impact except terrestrial ecotoxicity and aquatic eutrophication, the highest of environmental impact was generated from raw material acquisition (LDPE and LLDPE resins), as shown in Figure 3. Terrestrial ecotoxicity was mainly generated from lorry, while aquatic eutrophication was come from cargo ship. Long distance to transport product from Thailand to United States was the largest portion of aquatic eutrophication in this study (66.13%). Meanwhile, the disposal of portion bag by landfill was highlighted for land occupation.

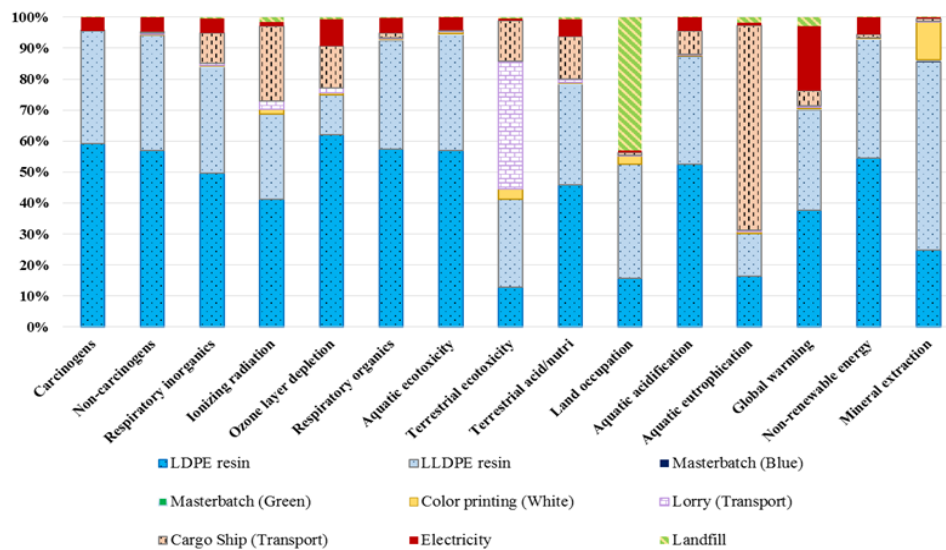


Figure 3. Environment impacts of portion bag.

3.2 Normalization

The result of normalization impact category was shown Figure 4. It can be indicated that there are five most environmental impact categories such as non-renewable energy, carcinogens, respiratory inorganics, global warming, and non-carcinogens, respectively. Environmental impact of raw material (LDPE and LLDPE resins) is highest in every impact like midpoint result. Therefore, the hotspot of environmental impact of portion bag life cycle was LDPE and LLDPE resins.

3.3 Options for reducing environmental impacts

From this study result, the hotspot of environmental impact was LDPE and LLDPE resins. Meanwhile, non-renewable energy impact category is highest value after normalization. Therefore, the goal of proposed option is to decrease the environmental impact of raw material. Options for reducing environmental impacts of life cycle portion bag was shown in Figure 5.

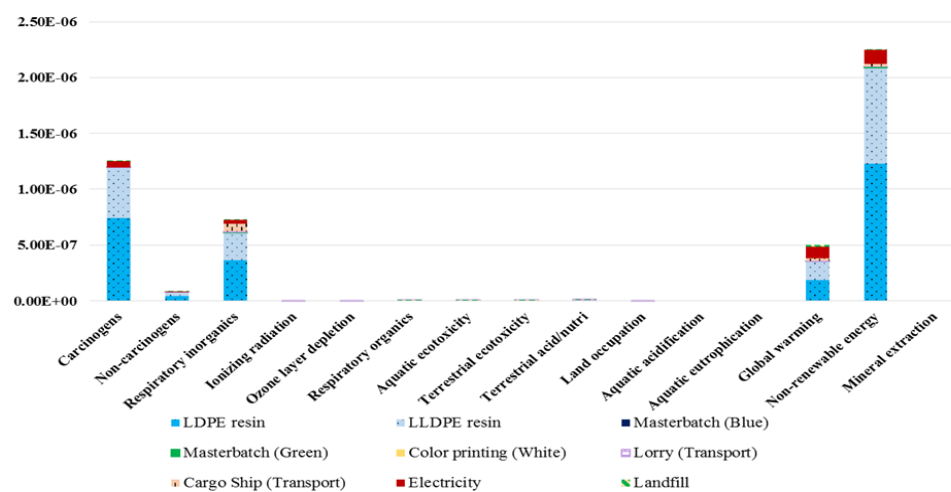


Figure 4. Normalization result of environmental impact from portion bag life cycle.

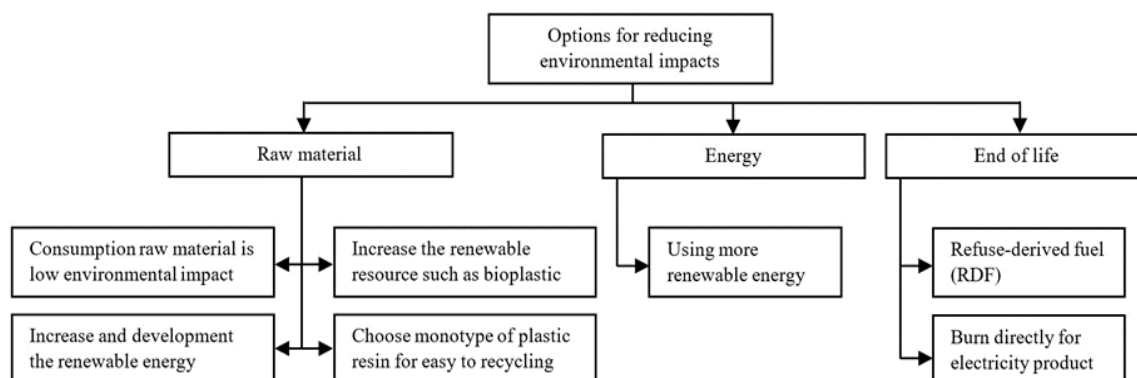


Figure 5. Proposed options for reducing environmental impacts of portion bag.

4. Conclusion

The environmental impact of life cycle portion bag was investigated in this study. The hotspot of environmental impact was LLDPE and LDPE resins. The proposed options are developed based on the result of LCA to minimize the environmental impact through life cycle of portion bag. Therefore, the possible measures to reduce environmental impact are focused on raw material extraction, energy consumption, selection to end-of-life, and replacing conventional raw material by bioplastics or biodegradable plastics. It can be concluded that using cleaner raw material and selecting suitable way of product's end-of-life can lead to produce green portion bag in the future.

5. References

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