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LIFE CYCLE ASSESSMENT OF THREE TYPES OF PRIMARY DRUG PACKAGING

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ABSTRACT

In this project, a comparative Life Cycle Inventory (LCI) of most common primary containers (sachet, blister pack and pot) for several drugs has been carried out. In addition, different stages in the Life Cycle Assessment (LCA) during the packaging process of drugs have been studied.

The results have provided the identification of the impacts associated to the life cycle of the studied packaging drugs, as well as providing a comparative study between different types of primary packaging material. The data obtained from the assessment of the impacts associated with the primary packaging material throughout its life cycle have provided useful information to establish new preventive strategies within the sector.

INTRODUCTION

All the pharmaceutical industry is a strategic sector for any advanced economy. It has experienced a period of unprecedented prosperity in the last half of the 20th century, resulting on an increased capacity to innovate. This has produced a great proliferation of new drugs that need to be protected, identified and dosed so that they can get in perfect conditions to users and this requires the use of a wide variety of containers. The containers are associated with an environmental impact throughout its life cycle (from obtaining of the raw materials to their treatment and disposal as waste) that has not been analyzed and evaluated in so much detail as it has been the drug itself. Accordingly, important developments such as the elimination of superfluous packaging, the weight reduction of the materials used or changes in the composition of the container have been achieved. However, these actions have not been studied from a life cycle perspective in its entirety and very few studies can be found about LCA of drugs packaging (Belboom, Renzoni, Verjans, Leonard & Germain, 2011). Therefore the likely consequences or transfers of impacts from some life cycle stages to others have not been evaluated yet.

The main goal of this study is the initial analysis of the environmental impacts of common types of primary packaging of several drugs for which the life cycle takes place in Aragón (Spain).

MATERIALS AND METHODS

The study has been carried out following the ISO14040 Life Cycle Assessment (LCA) methodology (International Standardization Organization, 2006).

The study was conducted following the life cycle for six drugs widely used in Aragon for which the life cycle takes place almost on its entirety within this territory. To do this, we first identify agents involved as well as the primary packaging materials of these selected drugs. We developed a complete inventory of life cycle of these drugs packaging and subsequently we modeled these processes. Finally, we evaluated the environmental impact of some stages of the total life cycle.

The system boundaries of the LCI is “from cradle to grave” and data have comprised three manufacturers of packaging, a laboratory that performs the packaging of drugs, a depot, three pharmacies and a company of packaging waste management as well as all associated transport that is specified below. The system boundaries of the LCA addressed in this study are “gate to grave” (Figure 1).

The functional unit (UF) specific to the system under study is one container offered for sale.

The LCA software tool GaBi 4.0 has been used for LCA modeling. The environmental impacts have been estimated according to CML 2001 method (Guinee, 2001).

RESULTS

The criteria for the selection of the containers for the study took into account that they were drugs widely distributioned in Aragón, traceable (the life cycle took mostly place within this territory) and with representative primary packages. The selected drugs were: Ibuprofen 600 mg (blister pack), Omeprazole 20 mg (blister pack), Ibuprofen 600 mg arginine (sachet), Paracetamol 1g (sachet), Acetylcysteine 600 mg (sachet) and Omeprazole 20 mg (pot).

Once the drugs under study were selected, the LCI was started considering all stakeholders involved: three manufacturers of packaging; a laboratory, depot supplying to pharmacies, three pharmacies and the company responsible for the management of packaging waste. The different steps involves in the life cycle for the drugs containers considered can be seen in Figure 1.

After these drugs LCI data were available (subject confidentiality) we decided to tackle the LCA of two of these drugs of very similar functions but packed one in sachet and the other in blister pack. The selected drugs were: Ibuprofen 600 mg arginine in sachet and Ibuprofen 600 mg in blister pack.

We focused on the LCA of these two packaging drugs in the next processes (discontinuous red line in the Figure 1): transportation from laboratory to the depot (190 Km/UF); storage, distribution and product preparation within the depot; transportation from the depot to the pharmacies, average of the total of annual kilometers all 650 pharmacies that serve the haulier (0,026 Km/UF sachet and 0,009 Km/UF blister pack); transportation of returned waste packaging of drugs collected from pharmacies to the depot (0,026 Km/UF sachet and 0,009 Km/UF blister pack); transportation of expired drugs packaging returned from pharmacies to the depot (0,026 Km/UF sachet and 0,009 Km/UF blister pack); transportation of the

packaging waste from the depot to waste management company (460 Km/UF); transportation of expired drugs returned from the depot to original laboratory (190 Km/UF); transportation of hazardous wastes (generated in the process) from the depot to hazardous waste management company (24 Km/UF); transportation of non-hazardous wastes (generated in the process) from the depot to non-hazardous waste management plant company (62 Km/UF).

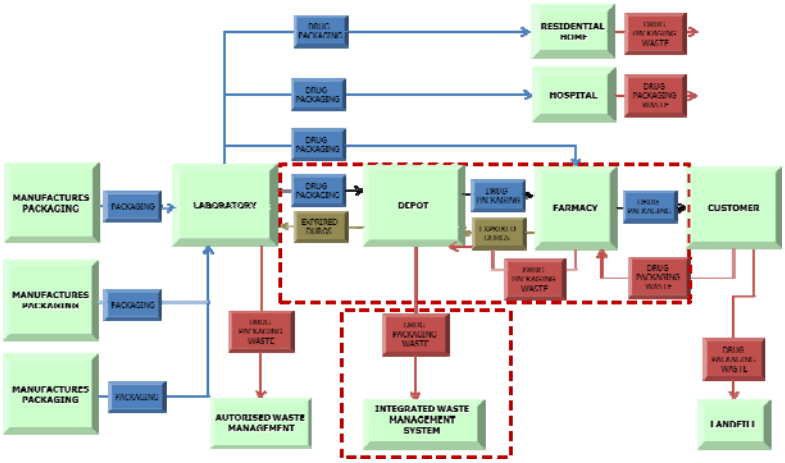

Figure 1. System boundaries of the LCI study. Discontinuous red line shows system boundaries of the LCA.

Impact assessment indicators used for this study are detailed below:

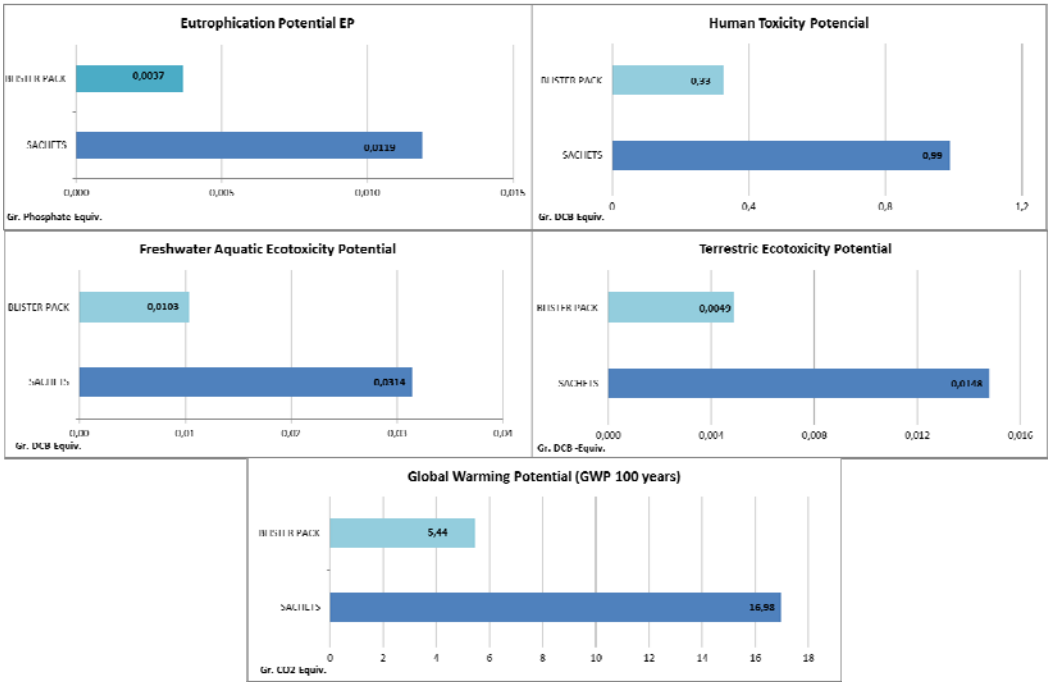

Figure 2. Comparison of five selected environmental impacts of distribution and transport of one container offered for sale (functional unit) of the same drug (Ibuprofen 600 mg) in sachet or in blister pack.

DISCUSSION

This study dealt with a LCI of several drugs with three different packaging types: sachet, blister pack and pot. It has also started the analysis of LCA focusing on two packaging of one same drug and their transportation and distribution processes. The results show that sachet packaging transport has greater environmental impact than blister pack transport per functional unit (one container offered for sale), for all the studied impacts. The magnitude of the increase is on the order of double and even triple in the case of global warming.

These results can be explained because the unit of sale of ibuprofen 600 mg in sachets is much heavier than the case of ibuprofen in blister pack, on the order of three times more. Although both presentations have the same amount of drug (20 one-dose dispenser each of them), one container offered for sale of Ibuprofen in sachet weighs 191 gr and in blister pack only 58,165 gr. Furthermore it should be noted that the volume of unit of sale in sachets is bigger than the blister pack (three times higher).

CONCLUSIONS

The greatest environmental impact generated by the transport and distribution of a same drug (Ibuprofen 600 mg) packaged in sachet against which produces packaging in blister pack, is explained due to a heavier weight of the Ibuprofen in sachet four times higher than the Ibuprofen in blister pack. Although this study shows information about the environmental impacts associated with the transportation of different types of packaging of drugs, to carry out a full study of the complete impact of these two types of containers, it is necessary to expand the system boundaries of the LCA, including laboratory and especially to manufacturing companies as well as to the company responsible for the management of packaging waste. Likewise, addressing a representative study, LCA of other common types of primary containers such as the pot should be also analyzed.

In this study, drug packagings were investigated only from the environmental point of view. It should be supported with other decision-making tools taking into consideration the economic and social effects of packages.

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