Revision of European Ecolabel Criteria for Soaps, Shampoos and Hair Conditioners

PRELIMINARY RESULTS FROM THE TECHNICAL ANALYSIS

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Revision of European Ecolabel Criteria for Soaps, Shampoos and Hair Conditioners

PRELIMINARY RESULTS FROM THE TECHNICAL ANALYSIS

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ABREVIATION LIST

CDV – Critical Dilution Volume

C&L – Classification & Labelling

CLP – Regulation on classification, labelling and packaging of substances and mixtures

DALY – Disability-adjusted life year

DID-list – Detergent Ingredient Database

DSD – Dangerous substance directive 67/548/EC

DPD – Dangerous preparation directive 1999/45/EC

ECHA – European Chemicals Agency

EPD – Environmental Product Declaration

ESIS – European chemical substances information system

GHS – Globally Harmonised System

GNPD – Global database of new products

IPCC – Intergovernmental Panel on Climate Change

LCA – Life cycle assessment

PAF – Potentially Affected Fraction of species

PE – Polyethylene

PET – Polyethylene terephthalate

PP – Polypropylene

PVC – Polyvinyl chloride

SDS – Safety data sheet

SETAC – Society of Environmental Toxicology and Chemistry

SVHC – Substances of very high concern

vPvB – Very persistent and very bioaccumulative

1. Introduction

A technical analysis of the environmental performance of shampoos, soaps and hair conditioners along their life cycle has been carried out. This analysis has been done following a Life Cycle Assessment approach. The main objectives of this analysis are:

- To conduct environmental assessment for every stage of soaps, shampoos and hair conditioners product life cycle.
- To identify possible alternatives to hazardous substances and processes with high environmental impact.

These results will aid the revision of the EU Ecolabel criteria for the product category "Soaps, shampoos and hair conditioners", since they allow to indentify the environmental hot spots of studied products and the impact of changes proposed in terms of criteria and restrictions.

2. Methodology and information sources

The technical analysis has been done using a Life Cycle Assessment approach. Different kinds of products included in the Ecolabel product category (soaps, shampoos and hair conditioners) have been studied along their life cycle.

For the environmental assessment, the analysis has been done based on ISO standards EN ISO 14040:2006[1] and EN ISO 14044:2006[2] and the Reference Life Cycle Data System (ILCD) Handbook[3]. The EU Draft document "Product Environmental Footprint. General Guide"[4] has been also taken into account.

The products currently included in the Ecolabel category studied were pre-analysed in order to determine if important differences exist among them, mostly in terms of formulation. As a result, a LCA for each kind of product included in the category has been performed: shampoo, liquid soap, solid soap and hair conditioner.

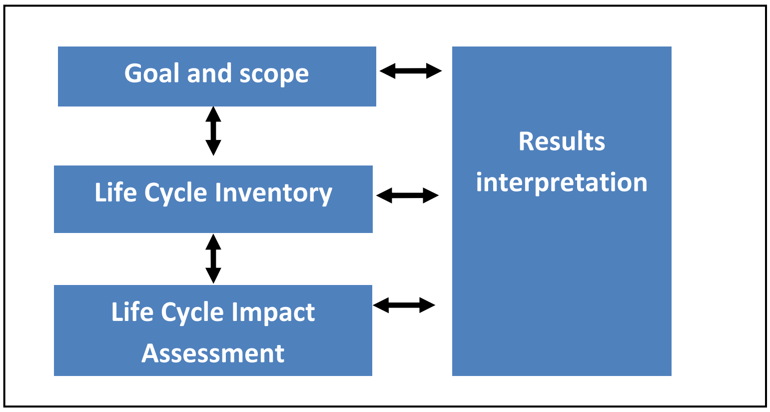
The LCAs allowed assessing the relative environmental load of each life cycle stage in order to have an overall profile of the products' performance. Moreover, several comparative analyses and sensitivity analyses have been performed in terms of ingredients and packaging materials, in order to determine if relevant environmental improvements can be reached by regulating specific parameters through Ecolabel criteria.

2.1. Methodology for LCA study

The steps followed to perform the LCAs are those defined in the standard methodology of ISO UNE-EN ISO 14040:2006 and UNE-EN ISO 14044:2006 (see Figure 1). These four steps have been carried out in an iterative process.

[1] EN-ISO 14040:2006 Environmental management -- Life cycle assessment -- Principles and framework
[2] EN ISO 14044:2006 Environmental management -- Life cycle assessment -- Requirements and guidelines
[3] International Life Cycle Data System Handbook, European Commission, available online at: http://lct.jrc.ec.europa.eu/pdf-directory/ILCD-Handbook-General-guide-for-LCA-DETAIL-online-12March2010.pdf.
[4] "Product Environmental Footprint. General Guide", European Commission, unpublished.

Figure 1: Steps of the Life Cycle Assessment, according to UNE-EN ISO 14040:2006



Goal and scope

Defining the goal and scope is the first stage of the LCA and probably the most important since here the scope and how the results have to be used is defined. Both elements defined determine the working plan of the entire study. The limitations of the system and the establishment of the functional unit, as well as the inputs and outputs considered will allow the assessment and comparison of environmental impacts.

Life Cycle Inventory

The inventory analysis of the LCA comprises the data collection and the calculation procedures to quantify the inputs and outputs (energy, raw materials, air, water, soil, etc.) through the system boundaries. To make the analysis easier, the system is divided in several interconnected subsystems.

Life Cycle Impact Assessment

The impact assessment is the phase in which the set of results from the inventory analysis are processed in terms of potential environmental impacts. It consists of four distinct steps: classification (classification of inventory flows into different impact categories: resource depletion, human health and ecological consequences, etc.), characterisation (transformation of pollutants mass values to environmental impact indicators equivalent values) common numeric values for each impact category), normalisation (extrapolation of the results based on population, geographical area, time dimension) and weighting (transforming the results for several categories into one score). The steps classification and characterisation are obligatory whereas normalization and weighting are optional. Only the integrated weighting of the midpoints to endpoints was performed applying the Impact 2002+ life cycle impact assessment method but this is more a weighting (in mathematical terms) within the LCIA part and is not based on value judgements as the one considered and defined in the ISO 14040 under "weighting section".

Interpretation of LCA results

A critical interpretation of the results will be done in order to verify its reliability. In this step the completeness, sensitivity and consistency of data gathered and results obtained will be done.

The interpretation of the results will help to define the most relevant environmental impacts and the stages where attention has to be paid in order to minimize the impact. These results will be the base for the revision of the Ecolabel criteria.

2.2. Information sources

Inventory data have been obtained mainly from existing studies and reports from the cosmetic data bases as well as from LCA databases (Ecoinvent 2.2). Primary data has been used for formulations, taking as case studies real formulation of each category of products (solid soap, liquid soap, shampoo and hair conditioner). Real formulations have been taken into account and studies carried out by LEITAT. In order to respect confidentiality average formulation has been defined based on these formulations.

The main sources of information for both tasks – the LCA and the hazardous substances identification are:

- Existing studies about similar products

A detailed search of published studies has been performed, in order to analyze and integrate data considered of value for the project. Existing LCA studies have been identified and studied. Moreover, a wide screening of other existing information related to the issue has been done, such as other scientific publications and literature (statistics, Ecolabels, etc.). This information was useful in order to fill the data gaps.

Studies used are referenced in the document as well as in the final section "Bibliography and References".

- Information from products Database

Information of the characteristics of different products existing in the market has been gathered in order to do a preliminary analysis of the most common substances used (both for content and packaging) and the most common formats.

For this qualitative analysis the Database Mintel GNPD (GlobalDatabase of New Products[5]) has been used. Each kind of product, i.e. shampoo, liquid soap, solid soap and hair conditioner, has been analyzed in terms of content and packaging.

Representativeness has been taken into account, so that different kinds of products included in the category has been taken into account: standard products, ecolabeled products, baby products, professional and household products.

Table 1. Number of products analysed from the Mintel GNPD database

Product group	Number of products analysed
Liquid soap	20 362
Solid soap	4 183
Hair conditioner	5 327
Shampoo	13 188

[5] http://www.gnpd.com.

3. Goal definition

Goal definition is the first step of a LCA study, and it defines the general context for the study. In the goal definition, parameters such as the intended application, the reasons for carrying out the study, the target audience, the limitations and assumptions have to be described.

In this case, the goal of this technical analysis is to quantify the potential environmental impacts of products included in the Ecolabel category “soaps, shampoos and hair conditioners” during all their life cycle phases. This analysis is not aimed to do a comparison among different products or brands. The main objective is to analyse the impact of each life stage and its contribution in relation to other stages and the global environmental load of the product. So that, although specific products will be taken as case studies for some stages, the study is aimed to analyse the performance of an average product manufactured in Europe. Consequently, in a first stage a general LCA has been done in order to have the complete environmental profile of each kind of product.

The results of this study will set the basis for discussions and proposals on the revision of Ecolabel criteria. Potential environmental improvements of Ecolabel criteria have been assessed by analysing different scenarios and sensitivity tests, for instance by changing substances compositions in order to see the effect of most hazardous substances substitution. As a result, a comparative analysis of standard products and products with more strict future criteria has been obtained. The goal of this comparison is to quantify the potential improvement of the environmental performance of these products by applying proposed Ecolabel criteria.

The target audience of this form the members of the European Board of EU Ecolabel and also the stakeholders involved in the revision process, including representatives of industry, industrial associations and NGOs.

4. Scope of the study

The scope of the LCA study consists of describing the system to be analysed along with the associated considerations and specifications. In the study proposed, a life cycle assessment from cradle to grave is considered; that means that all stages of products life cycle are taken into account (see Figure 2).

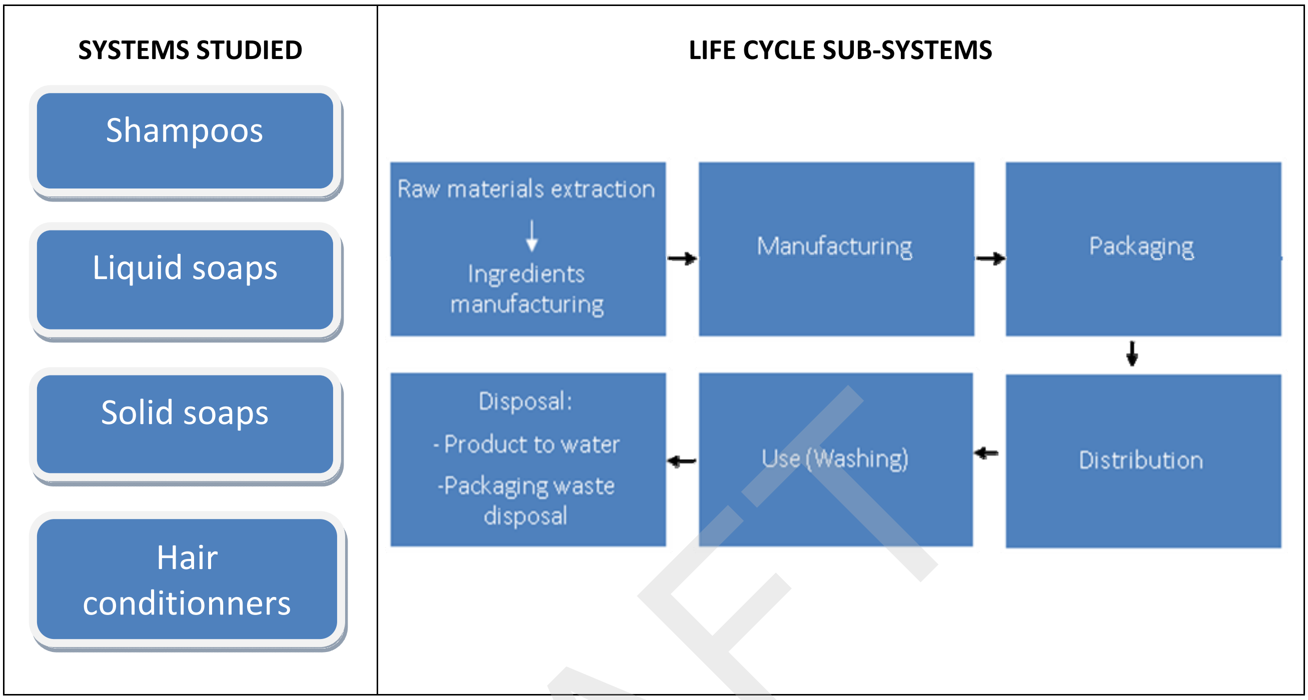
In 2007, when Ecolabel criteria for soaps, shampoos and hair conditioners were defined, it was agreed not to include some aspects in the use phase such as the water consumption and the energy to heat water and that Ecolabel should focus on product characteristics. The reasons were that these processes consume much resource and have a huge impact that will alter the results, and moreover the environmental impacts concerned with associated activities, such as heating water, are difficult to reduce by ecolabelling of soaps and shampoos. Moreover, in general in the Ecolabel scheme it is considered that it is difficult to set requirements on the first life phases: Raw material extraction/refining and manufacture of ingredients. Experience has shown that ecolabelling is most efficient in reducing the environmental impact of soaps and shampoos after use and, to a lower extent, the health effects during use. This is done by regulating the inherent properties of the ingredients of the products and the packaging weight and material[6].

Nevertheless, this analysis will consider relevant inputs needed for the use of the products in order to have a vision of the whole life cycle. Some stages such as the water consumption during use or distribution are not parameters likely to be regulated by Ecolabel, but it is important to consider them in a first stage in order to obtain a global environmental profile of a product, and to see the relative contribution of each stage to the global environmental impact.

[6] Final report. EU Eco-label for shampoo and soaps. Ecolabelling Norway. Eskeland,, M.B, Svanes, E. May 2006.

From the final results, a first classification will be done to propose which aspects are vey relevant and should be included in the Ecolabel criteria.

Figure 2: Scope of the systems studied



5. Functional unit

The functional unit describes qualitatively and quantitatively the function(s) or the service(s) provided by the product analysed. In this case, a common functional unit should be defined for the four kinds of products in order to increase the comparability of results. The main function of the products analyzed is to wash a part of the body and to provide aesthetic improvements.

The Functional unit for soaps, shampoos and hair conditioners:

A washing action of a part of the body with the main objective of provide hygienic results and/or aesthetic improvements

5.1. Reference flow

In order to obtain more comprehensive results from the LCA study, the reference flow for LCA analysis will be based on mass criteria of the whole product, taking as reference the average product unit sold. Being a bottle or package of personal care product that has as the main function washing a part of the body or bringing aesthetic properties to it and that is rinsed-off after application.

So that, each product functional unit will depend on the most usual format and capacity of the product (liquid soap's bottle or bar soap). The reference flow studied will be the amount of product contained in that bottle/package.

According to Mintel Database, the most usual capacity of liquid soaps, shampoo and hair conditioners bottles is 250 ml (43%), so a bottle of 250 ml has been considered as the standard product capacity (see other shares of bottle capacities in Table 2). Considering that these products have an average density of 1018 kg/dm^3, the **reference flow** in this case is 255 g of soap/shampoo/hair conditioner.

Table 2. Shares of weights of liquid soaps, shampoos and hair conditioners sold in Europe in year 2011

Capacity	Percentage of products (liquid soap, shampoos and hair conditioners)
250.00 ml	43%
300.00 ml	18%
200.00 ml	15%
500.00 ml	8%
400.00 ml	8%
Other capacities	8%

Source: GNPD Mintel Database

For solid soaps, the reference flow has been defined as a soap bar. According to Mintel Database, half of the solid soaps have a weight of 100 g, therefore this weight has been considered as the standard format (see other shares of soap bar weights in Table 3). Consequently 100 g of soap has been defined as the reference flow in our study.

Table 3. Shares of weights of bar soaps sold in Europe in year 2011

Bar weight	Percentage
100.00 g	50%
125.00 g	11%
150.00 g	8%
75.00 g	8%
90.00 g	6%
1000.00 g	6%
200.00 g	5%
Other capacities	6%

Source: GNPD Mintel Database

Consumer behaviour aspects

In order to quantify the number of applications (washing actions) for each reference flow it has been taken as a standard dosages defined by COLIPA[7]. In the case of solid soap standard dosage has been taken from a study conducted by a Brazilian company Nature Cosméticos[8], each 100 g of soap lasts on average 25 days (25 showers or washing actions). See dosages considered in Table 4.

[7] Final report. EU Eco-label for shampoo and soaps. Ecolabelling Norway. Eskeland,, M.B, Svanes, E. May 2006.
[8] Ugaya, Cassia M. L. ; Brones, F. ; Corrêa, S.: S-LCA: Preliminary results of Natura's cocoa soap bar. A presentation at the Life Cycle Management Conference LCM 2011 in Berlin.; available online at: http://www.lcm2011.org/papers.html, accessed January 2012.

Table 4. Standard dosages and frequency of use of studied products

Hair conditioner*	Dosage 14 g per washing action
Shampoo*	Dosage 8 g per washing action
Liquid soap (shower)*	Dosage 5 g per washing action
Solid soap**	Dosage 4g per washing action

*Source: Final report. EU Eco-label for shampoo and soaps. Ecolabelling Norway[9];

**Source: -LCA: Preliminary results of Natura's cocoa soap bar.Natura Cosméticos[10]

Considering these parameters (capacity of products and standard dosages), reference flow for each kind of products studied is presented in Table 5 below:

Table 5. Reference flow for the 4 kinds of products studied

Product	**Reference flow**
Liquid soap	A bottle of 250 ml of liquid soap (containing 255 g of product), with the main function of personal washing and personal care for 51 washing actions
Shampoo	A bottle of 250 ml of shampoo (containing 255 g of product), with the main function of personal washing and personal care for 32 washing actions
Hair conditioner	A bottle of 250 ml of hair conditioner (containing 255 g of product), with the main function of personal washing and personal care for 28 washing actions
Solid soap	A solid bar soap of 100 g with the function of washing the body or a part of the body for 25 washing actions

5.2. Unit reference for EU Ecolabel criteria

Independently of functional unit used for the LCA study, the proposal for the reference unit for the Ecolabel revised criteria is to maintain the criteria based on the active content (AC), being the reference unit for criteria: **One gram of organic ingredients.**

According to the background report from the EU Ecolabel criteria development for the product group under study[11] as well as other Ecolabels such as e.g. Nordic Ecolabel for Cosmetic products[12], using the active content as a base for the reference unit is the best unit in order to encourage the use of efficient ingredients and avoid dilution of products.

[9] Final report. EU Eco-label for shampoo and soaps. Ecolabelling Norway. Eskeland,, M.B, Svanes, E., 2006.
[10] Ugaya, Cassia M. L. ; Brones, F. ; Corrêa, S.: S-LCA: Preliminary results of Natura's cocoa soap bar. A presentation at the Life Cycle Management Conference LCM 2011 in Berlin.; available online at: http://www.lcm2011.org/papers.html, accessed January 2012.
[11] Final report. EU Eco-label for shampoo and soaps. Ecolabelling Norway. Eskeland,, M.B, Svanes, E., 2006.
[12] Nordic Ecolabelling of cosmetic products Version 2.1 – Background document.
16 February 2011, available online at: www.nordic-ecolabel.org/.

6. Systems description and boundaries

The system boundary has been defined following general supply-chain logic, including all phases from raw material extraction to the end-of-life treatment of the product, and according to the intended application of the study (See Figure 3).

In this case, the system of each of the four categories of products (shampoo, liquid soap, solid soap and hair conditioner) has been analysed. The system includes the following sub-systems: raw materials (including raw materials extraction and ingredients manufacturing), manufacturing, packaging, distribution, use and final disposal.

The biggest differences among the four systems defined were found in phases such as raw materials and use phase. Nevertheless, for similar phases like distribution or manufacturing, common processes could be considered for all systems.

Raw materials

In this sub-system raw materials and processing of ingredients are included. Composition and formulation of these products have been analyzed in order to gather these data. Some parameters taken into account are: Origin of substances (e.g. vegetal, petroleum), production processes (energy and resources used) of substances and the performance of substances (toxicity properties to assess potential environmental impacts). Transport processes have been not considered due to lack of data.

Formulations have been defined from COLIPA frame formulations[13], where the main functions and substances used for each product are defined. Frame formulations described by COLIPA detail the type of ingredients and their maximum concentration for most cosmetic products on the European market. In order to fix more realistic percentages of each substance used, real formulations have been also considered (due to confidentiality reasons this data was respectively incorporated in an anonymous way). From these two sources average concentration of each ingredient has been estimated.

Manufacturing

Standard processes and technologies to manufacture the studied products have been analyzed. The use of energy and water during manufacturing is reported, together with waste generation, air emissions and water emissions.

Packaging

The primary and secondary packaging have been analyzed. Some relevant aspects are: weight of material, recycled origin of materials, recyclability and use of hazardous substances. A common packaging (a plastic bottle) has been considered for shampoo, liquid soaps and conditioners. Solid soaps have been studied separately.

Transport/Distribution

The average distribution of products in the European market has been analyzed, consisting in the transport from the plant to the final point of sale, including transport among intermediate storages. Storage processes in manufacturing plant and intermediary storage have not been included in the system.

[13] COLIPA GUIDELINES. Cosmetic Frame Formulations. Guidelines realized in collaboration with the European Association of Poison Centres and Clinical Toxicologists (EAPCCT). January 2000.

Use

The use of products is the washing action done by the user. It includes, as input the product dosage and (cold[14]) water necessary to wash the body, hands or hair.

During use it is important to investigate whether a risk that the product may have a negative health impacts exists. The potential for negative health impacts could be reduced by increasing the health requirements on fragrances, preservatives and hazardous compounds[15]. Life cycle assessment results do not reflect these effects in the use phase (either due to generic use of data or because the inputs are "diluted" with the inclusion of all the LCA inputs), so these effects are deeper analysed in the section 9 on analysis of alternative substances.

Disposal

Two kinds of “waste” have been included in the system:

- Disposal of the product into water after use phase. As products studied are rinsed-off, it is considered that the whole product is released to wastewater after washing action. It is considered that wastewater produced is purified in a household sewage plant.
- Disposal of the packaging. A scenario has been defined for each kind of packaging where a part is recycled and the other goes to disposal. Impacts from recycling have been included in a system but balanced with environmental benefits occurring due to avoidance of use of virgin materials (LCA processes pre-defined products life cycles allocation rule). All impacts coming from waste disposal are included in the system.

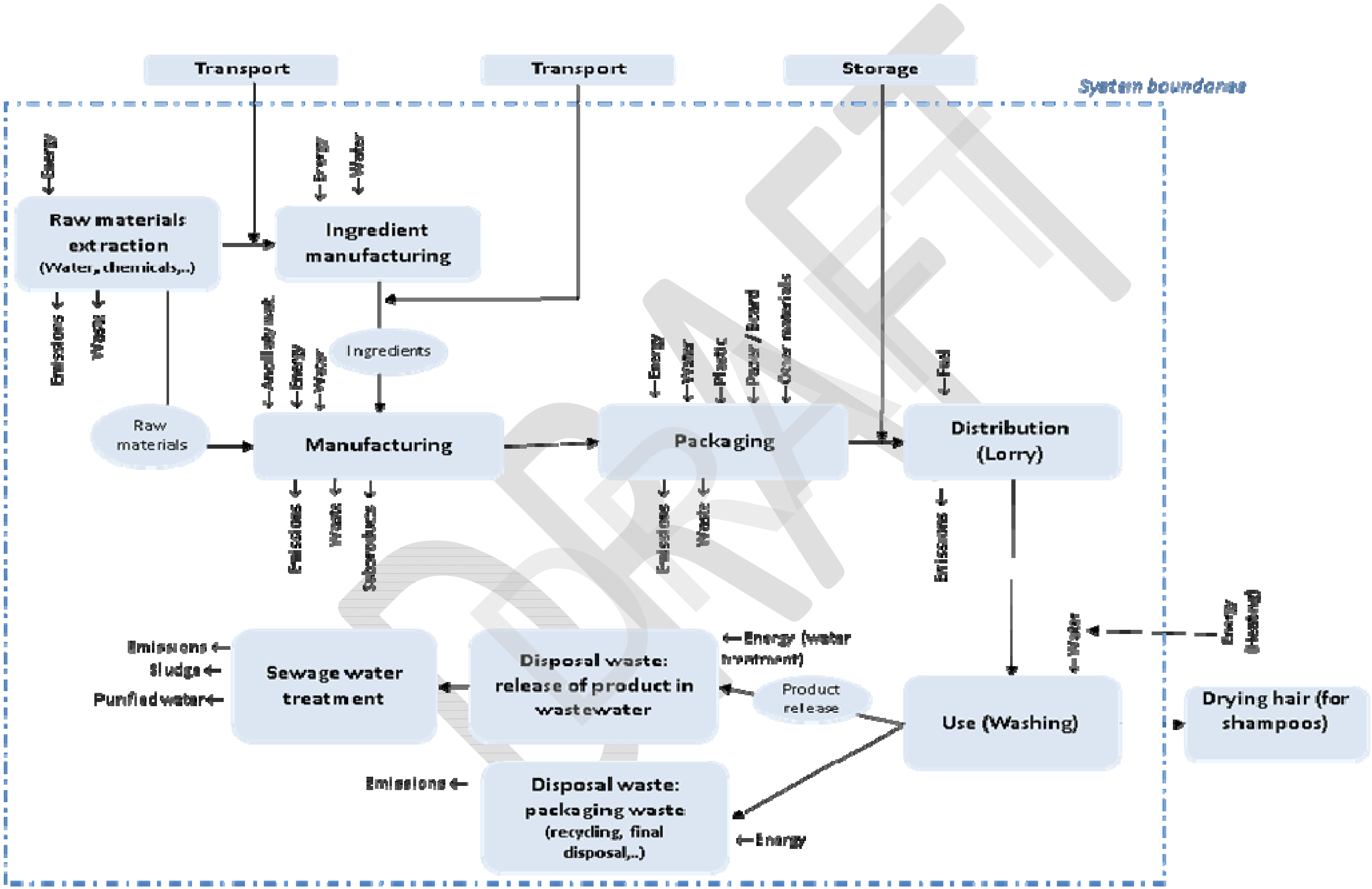
7. Cut-off rules and hypothesis used

As general cut-off rule, chemical substances used as ingredients in products with a percentage of less of 0.01% are not included.

For other materials (packaging), flows with a weight lower than 1% of the total flow may be not included, if it is considered not being relevant in environmental impact terms.

[14] Energy for water heating in not included.
[15] Final report. EU Eco-label for shampoo and soaps. Ecolabelling Norway. Eskeland,, M.B, Svanes, E. May 2006.

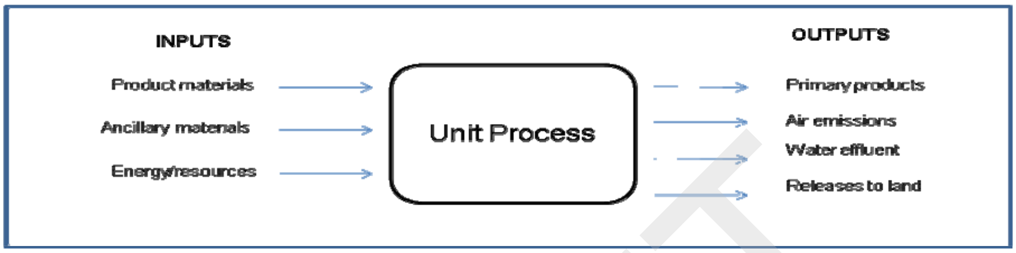
Figure 3. Flowchart of the system for soaps, shampoos and hair conditioners.



8. Life Cycle Inventory (LCI)

Life-cycle inventory (LCI) is a “cradle to grave” accounting of the environmentally significant inputs and outputs of the system. The inventory involves the compilation and quantification of the inputs (materials and resources) and outputs for the product system throughout its life cycle (See Figure 4). The environmental burdens measured in this case study include material input requirements, total energy consumed, air and water emissions released, and total solid wastes associated with the product’s life-cycle. LCI data is normalized with respect to the study’s functional unit.

Figure 4. Inventory inputs and outputs scheme



For each sub-system defined, inputs and outputs of the processes have been gathered and quantified. For the most important stages primary data (information gathered from products) has been used when possible. For secondary data other studies and existing databases (such as Ecoinvent) have been used. For a few stages which are not considered of high relevance, because they do not depend on the product characteristics, such as distribution or use phase, generic data from other studies was also used.

For each sub-system, the information sources are the following:

- Raw materials and ingredients manufacturing: Standard formulations defined by COLIPA[16] have been used, which determine the most commonly used ingredients by function and maximum percentages. In order to fix more realistic percentages of each substance used, few real formulations (to which LEITAT has access confidentially) for each kind of producthave also been used. From these two sources average concentration of each ingredient has been estimated.
- Manufacturing process: In this case, due to the lack of data from manufacturers, the manufacturing process outputs and inputs have been taken from Ecoinvent Database. Nevertheless, the stakeholders are invited to contribute to the improvement of this stage assessment by submitting us with data.
- Packaging: Typologies of packaging and materials used have been defined based on Mintel GNDP Database.
- Distribution: For the distribution phase, secondary and literature data have been used.
- Use: In this stage, the input considered is the water consumed, since it is a necessary resource for the washing action. The amount of water is estimated based on available information from literature.

[16] COLIPA GUIDELINES. Cosmetic Frame Formulations. Gudelines realized in collaboration with the European Association of Poison Centres and Clinical Toxicologists (EAPCCT). January 2000.

- Disposal phase: In this phase, the composition of the wastewater produced is directly related to the ingredients used in the product formulation. Waste packaging treatments are defined according to packaging typologies and European statistic data of waste treatment.

The different kinds of products studied differ mainly in terms of raw materials, so that this stage has been analysed separately for each product. Other life stages have been analysed jointly.

8.1. Raw materials for liquid soaps

Formulation of liquid soap has been defined taken as a basis frame formulations of COLIPA for liquid soaps. COLIPA frame formulations indicate the most common formulation and the maximum amount for each ingredient. In order to adjust quantities to more real formulations, real formulations of two products (one Ecolabelled and other one non-Ecollabelled) have been used. The composition of a base case for a liquid soap is presented in Table 6.

Table 6. Base case formulation of liquid soap

Function	Ingredient	Substance used for LCA analysis	Percentage (%)	Amount (g) in 255 g of product
Water	Water	Water	84.00 %	215.1
Surfactants	Sodium lauryl ether sulfate with 2 mole EO	Sodium sulphate,	6.87 %	17.53
	Disodium Cocoamphodiacetate	Fatty alcohol, from coconut oil	2.55 %	6.503
	Sodium Chloride	Sodium Chloride	0.55 %	1.403
	Cocamidopropyl Betaine	Fatty alcohol, from coconut oil	1.05 %	2.678
	C8-16 fatty alcohol glucoside	Fatty alcohol, petrochemical	1.20 %	3.060
Emollients	Polyol coconut fatty acid ester	Fatty alcohol, from coconut oil	0.50 %	1.275
pH adjustment	Citric acid monohydrated	Polycarboxylates	0.50 %	1.275
Preservatives	Benzyl alcohol	Benzyl alcohol	0.20 %	0.510
	Sodium benzoate	Benzoic-compounds	0.19 %	0.501
	Potassium sorbate	Potassium hydroxide	0.03 %	0.085
Inorganic salt	Sodium Chloride	Sodium Chloride	2.00 %	5.100

Limitations and hypothesis done: Some substances are not available in LCA Databases used, in those cases similar or equivalent substances, which are presented in Table 6 (column Substances used for LCA analysis), have been used.

8.2. Raw materials for solid soaps

A base case of solid soap has been defined considering the COLIPA frame formulations for solid soaps, with some adjustments made with real products formulations. The composition is given in Table 7 below.

Table 7. Base case formulation of bar soap

Function	Ingredient	Substance used for LCA analysis	Percentage (%)	Amount (g) in 100 g of product
Saponified oils (92%)	Tallow	Tallow	92.0%	57
	Coconut oil fatty acids	Coconut oil fatty acids		14
	Stearic acid	Fatty acids, from vegetarian oil		14
Emulsifying / humectant	Glycerine	Glycerine	6.0%	5.52
Perfuming	Perfume	-	1.0%	1.38
Colorant	Colorants	-	0,1%	0.092
Chelating agent	EDTA	EDTA	0,2%	0.184
Bleaching agent	Titanium dioxide	Titanium dioxide	0,1%	0.092
Water	Water	Water	8.0%	8

Limitations and hypothesis done: Some substances are not available in LCA Databases used, in those cases similar or equivalent substances, which are presented in Table 7 (column Substances used for LCA analysis), have been used.

8.3. Raw materials for shampoos

A base case of shampoo has been defined considering the COLIPA frame formulations for shampoos, with some adjustments made with real products formulations. The composition is given in Table 8 below.

Table 8. Base case formulation of shampoo

Function	Ingredient	Substance used for LCA analysis	Percentage (%)	Amount (g) in 255 g of product
Anionic surfactants	Sodium laureth sulfate	Sodium sulphate	7.0 %	17.85
Amphoteric surfactant	Cocoamidopropyl Betaine	Fatty alcohol, from coconut oil	2.5 %	6.375
Non ionic surfactants	Fatty alkanolamides	Fatty acids, from vegetarian oil	0.5 %	1.275
Viscosity controlling agents	Propylene glycol	Propylene glycol	1.5 %	3.825
Preservatives	Sodium benzoate	Benzoic-compounds	0.1 %	0.127
	Benzyl alcohol	Benzyl alcohol	0.1 %	0.127
PH adjustment	Lactic acid	Acetic acid	0.08 %	0.204
Water	Water	Water	11.8 %	225.22

Limitations and hypothesis done: Some substances are not available in LCA Databases used, in those cases similar or equivalent substances, which are presented in Table 8 (column Substances used for LCA analysis), have been used.

8.4. Raw materials for hair conditioners

A base case of hair conditioner has been defined considering the COLIPA frame formulations for hair conditioner, with some adjustments made with real products formulations. The composition is given in Table 9 below.

Table 9. Base case formulation of hair conditioner

Function	Ingredient	Substance used for LCA analysis	Percentage	Amount (g) in 255 g of product
Oils, waxes, silicones	Cetyl stearyl alcohol	Fatty alcohol,	3.3 %	8.42
	2-octyldocecaine	Fatty acids, from vegetarian oil	0.3 %	0.77
	Lanoline	Slack wax	0.3 %	0.77
Proteins	Provit B5	-	0.4 %	1.02
	Nutrilan keratine	-	0.02 %	0.05
Cationic surfactants	Dioactadecyl dimethyl ammonium chloride	Ammonium chloride	1.0 %	2.55
	Cetyl trimethyl ammonium chloride	Ammonium chloride	0.8 %	2.04
Emollient, humectants	Propylene glycol	Propylene glycol	2.0 %	5.10
Viscosity controlling agents	Methyl hydroxypropyl cellulose	Carboxymethyl cellulose	0.6 %	1.53
Polymers, resins	Polyvinyl	Polyvinyl	0.062 %	0.16
Perfume	-	-	0.2 %	0.51
Preservatives	Parabens	Benzoic-compound	0.2 %	0.51
Water	Water	Water	90.82 %	231.59

<u>Limitations and hypothesis done</u>: Similarly like for other products, some substances are not available in LCA Databases used, in those cases similar or equivalent substances, which are presented in Table 9 (column Substances used for LCA analysis), have been used.

8.5. Raw materials considered for worst case scenario

In the worst case formulation, some substances susceptible to be restricted by the new criteria of eco-label and which are currently present in some products under study (liquid soaps, shampoos, hair conditioners) have been included in the formulations in order to assess its effect on the environment (and to compare them with the defined base cases). Worst case scenarios are based on the results of the Identification of hazardous substances (section 9), but the analysis has limited to few substances due to limited availability of data in LCA Databases.

The substances added for liquid soaps, shampoos and hair conditioners are as follows:

- PRESERVATIVES:
  - formaldehyde (present in 0,2% of products)
  - parabens (present in 14,70% of products)
  - triclosan (present in 0,95% of products)

- MASKING AGENT: BHT (present in 3,53% of products)
- CHELATING AGENT: EDTA (present in 0,57% of products)
- SILICONES D4 (octamethylcyclotetrasiloxane)

For solid soaps:

- Emulsifying: Propylene glycol (7 % of products)
- Perfume: Benzyl alcohol (1.7 % of products)

Exact formulation used for comparison between base case formulation and worst scenario are detailed in sections 10.2, 10.3, 10.4 and 10.5.

8.6. Manufacturing

The manufacturing process done in plant for **liquid soaps, shampoos and hair conditioners** consist basically of mixing and pumping the ingredients delivered into mixing vessels. Once the product is fabricated, filling is the final step. A cleaning process is involved after each batch.[17]

Traditional **bar soaps** are made from fats and oils or their fatty acids which are reacted with inorganic water-soluble bases. The main sources of fats are beef and mutton tallow, while palm, coconut and palm kernel oils are the principal oils used in soap-making. Raw materials may be pre-treated to remove impurities and to achieve the colour, odour and performance features desired in the finished bar. The main chemical processes for making soap, are saponification of fats and oils and neutralization of fatty acids, usually done in continuous processes. The next processing step after saponification or neutralization is drying. Vacuum spray drying is used to convert the neat soap into dry soap pellets. The moisture content of the pellets varies depending on the desired properties of the soap bar. In the final processing step, the dry soap pellets pass through a bar soap finishing line. The first unit in the line is a mixer, in which the soap pellets are blended together with fragrances, colourants and all remaining ingredients. The mixture is then homogenized and refined through rolling mills and refining plodders to achieve thorough blending and a uniform texture. Finally, the mixture is continuously extruded from the plodder, cut into bar-size units and stamped into its final shape in a soap press. Some of today's bar soaps are called "combo bars" because they get their cleansing action from a combination of soap and synthetic surfactants. Others soaps, called "syndet bars" have surfactants as the main cleansing ingredients. This kind of soaps has not been taken into account, as they are not very common in the European market.

As for these manufacturing processes data from manufacturers was not available yet; therefore, the soap production process from Ecoinvent database 2.2 has been used for both cases (see Table 10 below). This module contains energy input, production of waste and emissions for the production of solid soap out of fatty acids from palm and coconut oil. Transports and infrastructure have been not included. No water consumption has been included. Data is based on the ECOSOL study of the European surfactant industry.[18]

[17] Henkel ag & co. Kgaa. Case Study of shampoo undertaken within the PCF Pilot Project Germany. November 2008.
[18] ECOSOL study of European Surfactant Industry. Common translation rules used, reported in Chemical report (Althaus et al. 2003).

Table 10. Aggregated inputs and outputs to the environment along the soap manufacturing process

Energy	**Amount (1kg soap)**	**Units**
Electricity	0.0183	kWh
Heat	3.92	MJ
Emissions to air	**Amount (1kg soap)**	**Units**
Particulates, > 10 um	0.000151	kg
NMVOC, non-methane volatile organic compounds, unspecified origin	4.50E-06	kg
Sulfur dioxide	1.11E-05	kg
Carbon monoxide, fossil	3.32E-06	kg
Methane, fossil	0.000178	kg
Mercury	3.30E-07	kg
Chlorine	6011E-08	kg
Carbon dioxide, fossil	3.50E-05	kg
Carbon dioxide, biogenic	0.00635	kg
Emissions to water	**Amount (1kg soap)**	**Units**
Acidity, unspecified	4.19E-06	kg
Solved solids	0.00244	kg
Suspended solids, unspecified	0.00144	kg
BOD5, Biological Oxygen Demand	0.00134	kg
COD, Chemical Oxygen Demand	0.00638	kg
Sulfide	2.70E-06	kg
Chromium, ion	2.01E-07	kg
Iron, ion	0.00061	kg
Nickel, ion	3.53E-08	kg
Mercury	3.82E-08	kg
Lead	1.61E-08	kg
Nitrogen	6.06E-06	kg
Zinc, ion	1.77E-07	kg
Waste generated	**1kg soap**	Units
Disposal, inert waste, 5% water, to inert material landfill/CH U	0.00239	kg

Stakeholders are invited to support the project team with complementary process specific input and output flow data.

8.7. Packaging

Packaging can be defined as the materials used for the containment, protection, handling, delivery, and presentation of goods. Packaging can be divided into three broad categories:

- Primary packaging: is the wrapping or containers handled by the consumer.
- Secondary packaging: is the term used to describe larger cases or boxes that are used to group quantities of primary packaged goods for distribution and for display in shops.

- Transit packaging: refers to the wooden pallets, board and plastic wrapping and containers that are used to collate the groups into larger loads for transport, which facilitates loading and unloading of goods.

In this study, only primary has been included. Secondary packaging has been analysed but it has been not counted due to the low percentage of products having secondary packaging. Transit packaging has been excluded.

In the packaging stage, materials and package manufacturing have been taken into account. It is considered that plastic package manufacturing is made through injection. For different plastic materials, the same process of injection moulding for PVC, PE and PP mouldings have been considered, although there are little differences in the inputs required to produce 1 kg of moulded product of each material, e.g. amount of energy needed.

Liquid soaps, shampoos and hair conditioners

For the packaging a sample of 13 700 products has been analysed in GNPD Mintel Database to determine the most commonly used materials and formats of packaging. The most usual shape of the primary packaging is a bottle (83% of products). The shares of various materials used are presented in Table 11, where it can be seen that PE is the most used material (34.74%), followed by PET (25.38%) and PP (14.67%).

Table 11. Shares of materials used for primary packaging of liquid soaps, shampoos and hair conditioners

Material	Percentage
PE plastic	34.74%
PET plastic	25.38%
PP plastic	14.67%
PVC plastic	1.18%
HDPE plastic	4.04%
Plastic (generic)	17.20%
Others materials	2.79%

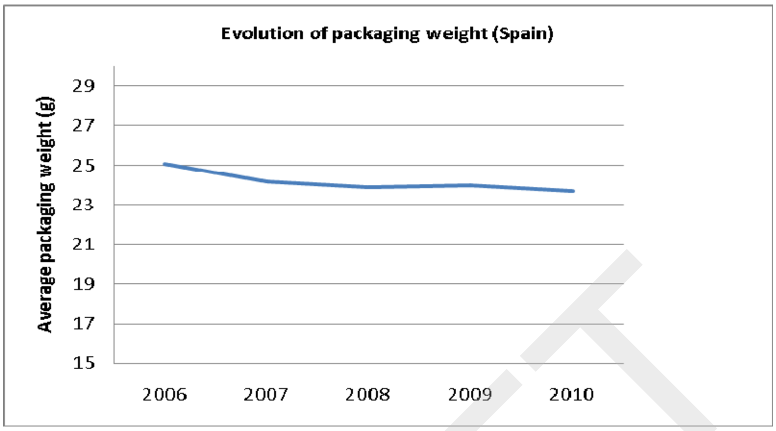
Source: Mintel GNPD Database

For primary packaging of soaps a bottle of 250 ml of PE plastic has been considered. It was chosen to calculate a real product in this case. However, for providing a reference for the environmental performance of an average product a non-realistic scenario could also been drafted based on the shares given in Table 11 (To be considered in a later project stage).

The current limit in Ecolabel criteria regarding packaging weight is 0.3 g of packaging for one gram of product, so that for a 250 ml bottle made of non-recycled plastic and if no return or reusing processes take place the maximum packaging weight according to current EU Ecolabel packaging criteria is 76.5 g (0.3 x 255 g of product). Therefore, the weight for the LCA analyses is determined as 76.5 g.

It is considered that the average weight would be lower, nevertheless current data of average weight of products packaging was not available. In 2006 the average ratio was determines as 0.05 – 0.1 g packaging/g product[19]. According to Ecoembes, weight packaging (metallic and plastic) for all products packaged in Spain decreased 6% from 2006 to 2010 (see Figure 5). Assuming that packaging of soaps, shampoos and hair conditioners at European level also follows this trend, the current average weight of products packaging would be lower than that determined in 2006.

Figure 5. Evolution of average packaging weight in Spain (2006-2010)



Source: Elaboration from Ecoembes data[20]

For packaging manufacturing a process of injection has been considered, where the inputs of energy and waste have been included for the analysis.

Labelling: 28% of packaging bottles analysed have labels, usually auto-adhesive labels made of plastic. 93% of bottles have some kind of printed decoration; 30% of printing method is serigraphy, 26% auto-colour printing and 21% embossing printing.

Only 3% of products are sold with secondary packaging, according to the data available. This package is usually made of cardboard or flexible plastic. For the study it has been excluded, but it should be accounted in weight calculations of Ecolabel criteria.

In Table 12 characteristics considered for liquid products' packaging are presented.

Table 12. Packaging characteristics for liquid products

Packaging (Bottle)	Amount	Observations
Capacity	250 ml	
Weight bottle	76.5 g	
Weigh of product contained	255 g	
Manufacturing process	-	Injection moulding process (Ecoinvent process)
Printing process		Standard Ecoinvent processes

[19] Final report. EU Eco-label for shampoo and soaps. Ecolabelling Norway. Eskeland,, M.B, Svanes, E. May 2006.
[20] www.ecoembes.com.

Bar soaps

In order to determine the most usual packaging for bar soaps, a sample of 4 224 products has been analysed. As it can be seen in Table 13, the most common format is a flexible package (61%), followed by cardboard package (36%).

Table 13. Types of packaging used for bar soaps

Package	Percentage
Flexible	61%
Cardboard	36%
Rigid box	1%
Can	0.5%
Case /tray	1,0%
Cover	0.2%

The materials used for packaging of bar soaps are shown in Table 14 below:

Table 14. Materials used for packaging of bar soaps

Material	Percentage
Plastic (non specified)	31%
Cardboard with white coating	23%
Plain paper	14%
Laminated paper	10%
PP plastic	8%
Solid white cardboard	8%
PE	2%
Unlined Cardboard	2%
Laminated cardboard	1%
Cardboard coated with brown kraft	1%

If these data is aggregated, we find that 59% of solid soaps are packaged in paper or cardboard, whereas 41% are packaged with some kind of plastic. So as a base case a packaging made of packaging paper with a weight of 15 g is considered.

Regarding the printing process, the main technologies are lithography (46%), rotogravure (23%) and flexographic printing (20%).

From a sample of 4 234 products, only 401 soaps have secondary package, usually when a pack of two or more bars are sold together. This secondary package is made of cardboard (65%), flexible (27%) or rigid box (4%)[21].

[21] Mintel GNPD Database

8.8. Distribution

For the distribution phase, secondary and literature data has been used. It is assumed the same distribution process for all products included in the analysis. Normally in the European market products are distributed via lorry first to an intermediate storage, then to the storage facilities of direct customers (retailer) and from there to the point of sale (e.g. supermarket). The average distance from production site to the intermediate storage facility is approximately 420 km. It is assumed that additional 500 km as sufficient to cover the following two transportation steps. In total 920 km transportation via lorry is implemented in the material flow network[22] .Transport process parameters considered (distance and mean of transport) are shown in Table 15.

Table 15. Transport parameters

INPUTS		
Transport process	**Distance (km)**	**Means of transport**
Manufacturing plant to intermediate storage	420 km	Lorry
From intermediate storage to sale point	500 km	Lorry
TOTAL	920 km	Lorry

8.9. Use

In this stage, the inputs and outputs for the washing process have been gathered and are represented in Table 16. As input, water consumption will be accounted because it is a necessary resource for the washing. Other inputs, such as energy for heating the water and energy for drying hair will not be taken into account, as they are optional and not directly related to the product. The wastewater containing the product used will be considered in the disposal system.

Table 16. Use stage characteristics

Use description: Washing action				
	Liquid soap	**Solid soap**	**Shampoo**	**Hair condition.**
Dose product	5 g	4 g	8 g	14 g
Reference flow (functional unit)	255 g	100 g	255 g	255 g
Number of washings	51	25	32	28
Use phase inputs				
Water consumption / shower[23]	22 l	22 l	22 l	22 l
Water consumption / functional unit	1122 l	550 l	701 l	401 l

[22] Source: *CASE STUDY SHAMPOO BY HENKEL AG & CO. KGAA.* Case Study undertaken within the PCF Pilot Project Germany. 2008 (http://www.pcf-projekt.de/files/1236586214/pcf_henkel_shampoo.pdf)

[23] Water consumption of a shower is assumed to amount 45 l. It is considered that a shower usually includes washing the body and the hair, so half of consumption is assigned to each kind of product. Source: Bathroom Manufacturers Association (www. bathroom-association.org)

8.10. Disposal

In this phase, we differentiate the release of the product to water and the waste packaging generation.

For the release of product to water, it is considered that the whole product is rinsed-off, so 255 g of liquid soap/shampoo and hair conditioner or 100 g of solid soap are released to water. In this phase the treatment of residential wastewater (water consumed during washing) in plant is included.

For disposal of packaging waste, the percentage of recycling of each material for packaging use has been assumed based on statistical data of the report "Results of packaging recycling and recovery in the Member States and in the EU in 2008[24], where it is said that for plastic packaging a 30% of waste are recycled, 27% goes to recovery energy and 43% to disposal. For paper and cardboard packaging waste, 81% of waste is recycled, the 8% goes to recovery energy and only the 6% is disposed to landfill.

Data used for the assessment of the disposal phase are given in Table 17 below.

Table 17. Packaging waste data

2008 data	Packaging generated (t)	Recycled	Recovery energy	Disposal
Plastic packaging	14 960 705.30	30%	27%	43%
Paper / cardboard packaging	31 261 549	81%	8%	6%

[24] Results of packaging recycling and recovery in the Member States and in the EU in 2008. European Commission Environment.

9. Identification and analysis of alternatives for hazardous substances

9.1. Introduction

Parallel to the LCA study, the analysis of possibilities of using alternatives for hazardous substances with high environmental impact has been conducted. This technical analysis has specifically taken into account the substances most commonly used that perform the same function and the identification of chemicals of high concern. In particular, focus on substances of very high concern (Annex XIV of REACH Regulation[25]) and the candidate list for authorisation as referred to REACH Regulation was given.

Available data such as substitutions tools and previous work carried out by relevant entities (e.g. ECHA – the European Chemicals Agency) have been used.

On 20 January 2009 the Regulation on classification, labelling and packaging of substances and mixtures, CLP Regulation[26], entered into force. It aligns existing EU legislation to the United Nations Globally Harmonised System (GHS) [27]. The CLP Regulation will, after a transitional period, replace the current rules on classification, labelling and packaging of substances (Dangerous Substance Directive 67/548/EC[28]) and mixtures (Dangerous Preparations Directive 1999/45/EC[29]). The date from which substance classification and labelling must be consistent with the new rules is 1 December 2010 and 1 June 2015 - for mixtures. On 1 June 2015 the CLP Regulation will replace completely:

- the Dangerous Substance Directive (67/548/EC),
- the Dangerous Preparations Directive (1999/45/EC).

The classification criteria regarding CLP have changed in comparison with DSD, e.g. for many physical hazards where the tests methods which determine the classification criteria are often different from those of DSD[30]. For other hazards, the applicable concentration limits for taking into account the classification of its constituents, additives and impurities have changed, e.g. for the irritation and corrosive hazards. This means that in cases where there is no reliable test information on the

[25] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC; Official Journal of the European Union L 396 of 30 December 2006; available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:136:0003:0280:en:PDF.

[26] Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006, Official Journal of the European Union L353 of 31 December 2008, pp. 1–1355, available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:EN:PDF.

[27] http://ec.europa.eu/enterprise/sectors/chemicals/documents/classification/.

[28] Directive 67/548/EEC on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances, Official Journal of the European Union L196, 16.8.1967, pp. 1–98, available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31967L0548:EN:HTML.

[29] Directive 1999/45/EC of the European Parliament and of the Council of 31 May 1999 concerning the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations, Official Journal of the European Union L200, 30.7.1999, p. 1-68, available on line at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0045:en:NOT.

[30] http://echa.europa.eu/web/guest/support/faqs/clp-frequently-asked-questions.

substance and the bridging principles cannot be applied, use of the calculation rules apllying the concentrations limits may lead to a classification under CLP, even though the same substance was not classified under DSD.

Therefore, for the identification of hazardous substances we will focus on substances classified under CLP regulation since if a substance does not meet the classification criteria under DSD it can be classified under CLP.

The aim of the authorisation procedure under the REACH is to ensure good functioning of the internal market while assuring that risks from substances of very high concern are properly controlled and that these substances are progressively replaced by suitable alternative substances or different technologies where these are economically and technically viable[31]. Authorisations apply to substances of very high concern (SVHC) that are included in Annex XIV of REACH.

Obligations under REACH are determined by the company's role: manufacturer, importer, downstream user or even distributor. Mainly, cosmetic product manufacturers are defined as downstream users, because they use substances and/or preparations to formulate their products, or importers, because they import substances and/or preparations from outside the EU. Based on this, the highest REACH impact on cosmetic industry will be that if the cost of registration or authorization for substances of high concern is too high for manufacturers and/or importers of raws materials, certain ingredients will be not available and will disappear from the market.

On 17 February 2011, the European Commission named 6 chemicals as the first entrants on the Authorization List (Annex XIV)[32]. Currently, there are 73 substances on the candidate list[33] of substances of very high concern for authorisation.

This technical analysis has considered the availability of alternatives and risks related to them.

The analysis of alternatives provides the basis to assess whether alternative substances are available (with the information supplied by relevant tools[34]). It will be important to take all relevant aspects into account including whether the transfer to alternatives would result in reduced overall risks to the environment and human health taking into account the appropriateness and effectiveness of risk management measures and the technical feasibility of alternatives.

This analysis intends to identify the pool of possible alternative substances. Though it has a high detail level its output should not be regarded as a "white list" of better environmentally performing substitutes. Based on the output of this preliminary analysis – the pool of potential alternative substances should be further case by case investigated before substitution due to environmental performance can be recommended.

[31] Article 55, Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC; Official Journal of the European Union L 396 of 30 December 2006; available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:136:0003:0280:en:PDF.

[32] Commission Regulation No 143/2011 of 17 February 2011 amending Annex XIV to Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals ('REACH'); available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:044:0002:0006:EN:PDF.

[33] http://echa.europa.eu/web/guest/candidate-list-table.

[34] Global New Products Database: http://www.gnpd.com.

9.2. Methodology and information sources

The analysis follows the following stepwise approach:

Activity 1: Inventory of the formulation of products

Formulations have been defined from COLIPA frame formulations[35], from where the main functions for each product have been defined. In order to know more exact data (as frame formulations detail the type of ingredients and their maximum concentration for most cosmetic products on the European market), real formulations to which Leitat has access confidentially have been used and average concentration of each ingredient has been estimated[36].

Analysis of the most common chemical substances present in the products and their function has been carried out.

Information from products database: Information of the characteristics of different products existing on the market has been gathered in order to do a preliminary analysis of the most common substances used (both for content and packaging). For this analysis the Database DID-list[37] and GNPD[38] (Global Database of New Products) have been used.

Representativeness has been taken into account, so that different kinds of products included in the category has been studied: standard products, ecolabelled products, baby products, professional and household products.

The number of products analyzed of each kind of product (liquid soap, solid soap, shampoo and hair conditioner) is presented below:

Table 18. Number of products analysed

Product group	Number of products analysed
Liquid soap	**20 362**
Solid soap	**4 183**
Shampoo	**13 188**
Hair conditioner	**5 327**

Activity 2: Obtaining information on composition (Safety Data Sheets)

The Safety Data Sheets (SDS) contain information which can be used for considerations of substitution. Essential information includes chemical, physical and physicochemical data as well as toxicological and ecotoxicological information. All information relevant to the prevention of damage to human health and the environment must be included.

[35] COLIPA GUIDELINES. Cosmetic Frame Formulations. January 2000.
[36] For details see chapter 6 on raw materials.
[37] http://ec.europa.eu/environment/ecolabel/ecolabelled_products/categories/did_list_en.htm.
[38] http://www.gnpd.com.

The objective of the SDS is to ensure that manufacturers, importers and downstream users have enough information to use chemical substances safely. The supplier must provide a SDS if the substance or preparation is hazardous, PBT (persistent, bioaccumulative and toxic) or vPvB (very persistent and very bioaccumulative) or is on the candidate list of substances of very high concern (SHVC).

Exposure scenarios will be annexed to the SDS providing information to the users about the risk management measures that have to be implemented or recommended by the manufacturers for safe uses of the substance. The SDS must be updated if an authorisation is granted or refused, a restriction is imposed or even new information on hazards becomes available.

As until now different classifications of the same substances appeared in the safety data sheets, we chose to use a harmonized classification based on information from ESIS[39] and ECHA[40] and not Safety Data Sheets from manufacturers. The Classification & Labelling (C&L) Inventory[41] from ECHA is a database that will contain basic classification and labelling information on notified and registered substances received from manufacturers and importers. It will also contain the list of harmonized classifications (Table 3.1 of Annex VI to CLP). However, the Classification & Labelling (C&L) Inventory will not be available until early 2012. Classification of the different substances, therefore, is based on ESIS: European Chemicals Substance Information System and ECHA information about registered substances.

Activity 3: Describing the function

The process description comprises: the use of the process, limitations and quality specifications, alternative processes or process designs, description of the equipment, safety precautions and possible exposure of workers to hazards.

This will require an understanding of the exact use of the substance including a description and outcome of the process where the use is applied. Understanding of the specific process conditions for using the substance and of any conditions or requirements on possible end-products resulting from the process, may impose constraints under which the desired function must be performed and thereby influence which alternatives may be used.

A detailed and specific knowledge of the exact function for a particular use will allow looking for other ways of performing that function. This may be done using another substance or technology or by changing the process or end product.

Analysis of the most common chemical substances present in the products that may possibly fulfil an equivalent function to the uses applied for, has been carried out in the framework of this study.

39 European chemical substances information system: http://esis.jrc.ec.europa.eu/.
40 http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances.
41 http://echa.europa.eu/web/guest/regulations/clp/cl-inventory.

Activity 4: Assessing the risk

Based on the information provided by ESIS and ECHA[42], a **priority list of hazardous substances** which are determined to pose the most significant potential threat to human health and environment has been prepared.

It is important to remember that less dangerous chemicals are not necessarily harmless. Therefore, risk management measures are still needed in many cases.

Some other sources of information such as literature and/or databases have been taken into account, e.g. the hazardous substances database PRIO developed by KEMI[43] (Swedish Chemicals Agency).

Activity 5: Analysis of alternatives

The analysis of alternatives is the first step in the process of planning for substitution, where assessment is made on the availability of suitable alternative substances, their risks for human health and the environment and their technical feasibility. All relevant aspects must be taken into account, including whether the transfer to the alternative would result in reduced overall risks to human health and the environment bearing in mind risk management measures and the technical feasibility of alternatives for replacement.

The analysis of alternatives will conclude whether there is a suitable alternative available when an alternative substance or technology or their combination:

- Provide an equivalent function to that provided by the substance (a single alternative may not be suitable for all different processes or uses for which the original substance was suitable, thus the original substance could be substituted by more than one suitable alternative).
- Will result in reduced overall risks to human health and the environment, taking into account appropriateness of risk management measures,
- Are technically and economically feasible (for substitution in the uses applied for) and available.

For this analysis the Database GNPD[44] (Global Database of New Products) has been used. However stakeholder and trade/sector organisations΄ knowledge is also crucial in providing information on possible alternatives and evidence of (non)availability of (suitable) alternatives.

In this analysis the potential to substitute hazardous substances with safer components, whenever technically feasible, in particular with regard to substances of very high concern (SVHC) as referred to in Article 57 of the REACH Regulation (EC) No 1907/2006 has been taken into account.

[42] Website of the European Chemical Agency regarding substances of concern: http://echa.europa.eu/web/guest/addressing-chemicals-of concern/.

[43] Web reference: http://www.kemi.se/.

[44] http://www.gnpd.com.

9.3. Information sources

The main sources of information for the identification of hazardous substances and the analysis of alternatives are:

– Existing studies about similar products

An exhaustive search of published studies has been performed, in order to analyze and integrate data considered of value for the project. Existing risk assessments reports have been identified and integrated. Moreover, a wide screening of other existing ecolabel information related with the issue has been done. This information will be useful in order to complete the information gaps that may exist.

– Information from products Database

Information of the characteristics of different products existing in the market has been gathered in order to do a preliminary analysis of the most common substances used (both for content and packaging).

For this qualitative analysis the Database Mintel GNPD (GlobalDatabase of New Products[45]) has been used. Each kind of product, i.e. liquid soap, solid soap, shampoos and hair conditioner has been analyzed in terms of content and packaging.

Alternative comparison tools have been taken into account:

- Tool: P2Oasys Tool to Compare Materials. Developed by: TURI- Toxics Use Reduction Institute (University of Massachussetts Lowell USA)[46].
- Tool: Column Model. Developed by: Berufsgenossenschaftliches Institut für Arbeitsschutz – BGIA[47].
- Substitution experience Database: CatSub. Developed by: European Agency of Occupational Safety and Health, Danish Working Environment Authority[48].

9.4. Identification of existing studies

An analysis of existing studies, risk assessments studies, publications and data related to environmental and human health performance of soaps, shampoos and hair conditioners has been carried out.

Studies by Ecolabelling Norway (Ecolabel Criteria 2007)[49]

The following risk assessments studies were considered by Ecolabelling Norway to assess the Ecolabel criteria for soaps, shampoos and hair conditioners in 2007:

[45] http://www.gnpd.com.
[46] Web reference: http://www.turi.org/.
[47] Web reference: http://www.hvbg.de/e/bia/.
[48] Web reference: http://www.catsub.dk.
[49] Final report. EU Eco-label for shampoo and soaps. Ecolabelling Norway. Eskeland,, M.B, Svanes, E. May 2006.

- ✓ Risk assessment for shampoo ingredients carried out by Chalmers University of Technology (1997). The findings of the report could not demonstrate environmental safety for the following 5 substances: Cocoamido propyl betaine, Formic acid, hexyl cinnamic aldehyde, Dipropylene glycol and 2-bromo-2-nitropropane-1,3-diol.
- ✓ Risk analysis of the Medical Products Agency on the environmental effects of cosmetic products and medicines on behalf of the Swedish Government (Medical Products Agency, 2004). The analysis concluded that Butyl metoxydibenzoylmethane, EDTA, Cocoamide DEA, Isoparaffines, Polyquaternium-10, Resorcinol, Zink oxide and Zink Pyrithione were found to be environmentally harmful. Bronopol, sodium laureth sulphate and triclosan pose a high risk and cetrimonium salts a slight risk. Cocoamidopropyl betaine and Parabenes were found to pose little or no risk to the aquatic environment and sodium lauryl sulphate was not harmful to the environment.
- ✓ Risk Analysis commissioned by the Swedish County Jönköping: “Environmental impact of hygiene products”. The report concluded that quaternary ammonium compounds, cocoamido propyl betaine, triclosan, sodium cocoamphoacetate, sodium lauryl ether sulphate and cocoamide DEA were found to be environmentally harmful. Parabenes were prioritised for risk assessment but could not be studied because of lack of information.
- ✓ Analysis for the Swedish drinking water provider Stockholm Vatten. Kristina Johansson (Stockholm Vatten, 2002) studied the environmental effects of hair care products, on behalf of Stockholm Vatten. Environmentally harmful ingredients were: Ammonium hydroxide, Behentrimonium chloride, cetrimonium chloride, diazolidinyl urea, diethyl dimonium chloride, disodium laureth sulfosuccinate, distearyldimonium chloride, isothiazolinones (MIT and CMI) and thymol. Carbomer, some polyquaternium-compounds (2-, 4-, 6-, 7, 10-, 11-, 30- and 37-), quaternium-52 and some silicone oils and some colours were suspected of being harmful to the environment.
- ✓ The Danish study on solid soaps by CETOX contains an assessment of environmental impact by classification looking at the ingredients in relation to environmental risk phrases (1998). Environmentally harmful ingredients were: cocamide MEA, Cocoamide DEA, Triclosan, Imidazolidinyl urea and sodium olefin sulphonate.
- ✓ The “Substitution of surface-active compounds in cosmetic products” report commissioned by the Danish EPA. The result of the study concludes that the commonly employed cationic surfactant Cetrimonium Chloride can easily be substituted by the environmentally preferable alternative Behenyl PG-trimonium Chloride.
- ✓ Environmental guidance document by the Danish EPA (1999). The most problematic ingredients were those who are toxic to aquatic organisms, poorly biodegradable and prone to bio-concentrate. The study also concludes that since the products are rinse-off products, the exposure to the skin is low, but many people experience adverse health reactions, probably due to exposure to fragrances and preservatives.
- ✓ A Swedish Society for Conservation of Nature report on baby products (including soap and shampoo) (May 2011). Requirements on health and environment were set up. Many products failed because of perfume content, colouring agents, preservatives: Methyl dibromo glutaronitrile, Quaternium-15, imidazolidinyl urea, Cetrimonium chloride, methylchloroisothiazolinone and methylisothiazoloinone. MEA and DEA are singled out

because of warnings from the American government agency FDA regarding possible carcenogenic activity. Environmentally and/or healthy harmful ingredients were disodium EDTA, Tetrasodium EDTA and Cocoamide DEA.

9.5. Identification and analysis of alternatives for hazardous substances in liquid soaps

For the category of liquid soap, the goal and scope of the identification and analysis of alternatives is as defined in section 9.2, as they are common for all products included in this product category. **20 362 products** (liquid soaps) have been found and analyzed.

Raw materials

The top ingredients present in liquid soaps are presented in Table 19:

Table 19. Top ingredients present in liquid soaps

FUNCTION	NUMBER OF VARIANTS*
Surfactant	50.516
Viscosity controlling	45.910
Skin conditioning	40.936
Masking	39.362
Emulsifying	36.445
Solvent	36.052
Cleansing	35.582
Preservative	31.414
Antistatic	25.625
Perfuming	11.423

* Number of different substances that perform the same function

Source: Elaborated based on GNPD (Global Database of New Products) results for 2011

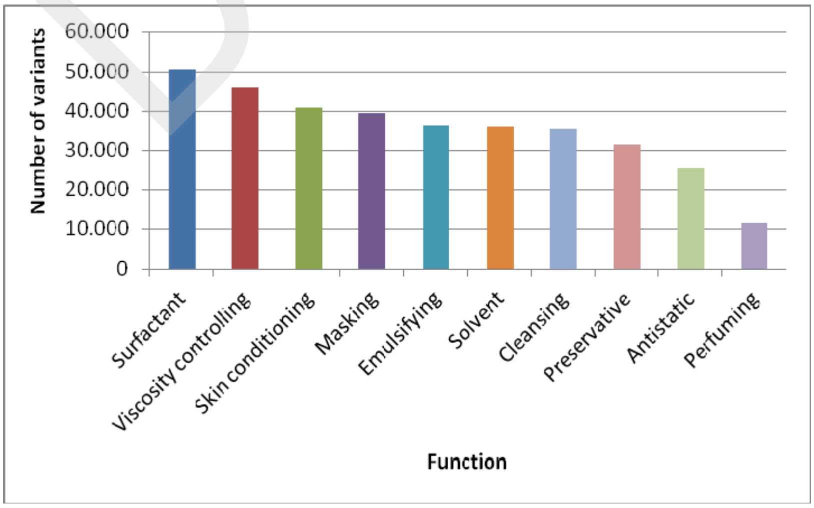


Figure 6. Top ingredients present in liquid soaps. Based on GNPD (Global Database of New Products) results (2011)

Identification of variants:

The substances most commonly used that perform the same function are indicated in the tables below with the aim to identify hazardous substances and help manufacturers to find an environmentally better alternative substance with a lower hazard level for a specific function. The substances marked in tables with red colour are the hazardous substances.

Surfactant

Table 20. Different variants that fulfill equivalent function: surfactant

VARIANTS (Function Surfactant)	Percentage of products containing this variant
Cocamidopropyl Betaine	18,73%
Sodium Laureth Sulfate	18,36%
Coco-glucoside	5,94%
PEG-7 Glyceryl Cocoate	5,55%
PEG-40 Hydrogenated Castor Oil	3,63%
Lauryl Glucoside	3,53%
Cocamide MEA	3,02%
Cocamide DEA	3,01%
Laureth-4	2,40%
Polysorbate 20	2,20%
Decyl Glucoside	1,84%
Disodium Laureth Sulfosuccinate	1,55%
Xanthan Gum	1,44%
Sodium Cocoamphoacetate	1,36%
Sodium Lauryl Sulfate	1,25%
Sodium C12-13 Pareth Sulfate	1,21%
Laureth-2	0,99%
Ammonium Lauryl Sulfate	0,96%
Disodium Cocoamphodiacetate	0,87%
Disodium Cocoyl Glutamate	0,83%
Laureth-10	0,82%
Lauramidopropyl Betaine	0,69%
Laureth-3	0,66%
PEG-150 Distearate	0,64%
Triethanolamine	0,63%
Sodium Cocoyl Glutamate	0,62%
Hexylene Glycol	0,62%
Sodium Lauroyl Glutamate	0,60%
Trideceth-9	0,54%
Coco-betaine	0,49%
Sodium Lauroamphoacetate	0,44%
Lauric Acid	0,42%
Cocamidopropylamine Oxide	0,40%
Hydrogenated Castor Oil	0,60%
Lauryl Betaine	0,35%
Poloxamer 124	0,35%
Hydroxypropyl Methylcellulose	0,34%
Glycol Stearate	0,33%
Sodium Lauroyl Sarcosinate	0,33%
Sodium Cocoyl Isethionate	0,33%
Sodium Lauryl Glucose Carboxylate	0,31%
Sodium Myreth Sulfate	0,31%

Sodium Lauryl Sulfoacetate	0,29%
TEA-lauryl Sulfate	0,28%
Cocamidopropyl Hydroxysultaine	0,28%
Caprylyl/Capryl Glucoside	0,27%
Stearic Acid	0,25%
Cocamide MIPA	0,25%
Sodium Coco-sulfate	0,24%
Trideceth-7	0,22%
Ceteareth-60 Myristyl Glycol	0,02%
Hydroxypropyl Guar	0,20%
Glycereth-2 Cocoate	0,19%
Potassium Cocoate	0,18%
PPG-5-ceteth-20	0,18%
Cetearyl Alcohol	0,17%
Sodium Palm Kernelate	0,17%
MIPA-laureth Sulfate	0,16%
Isostearic Acid	0,16%
Stearyl Alcohol	0,16%
PEG-60 Hydrogenated Castor Oil	0,16%
Linoleic Acid	0,16%
PEG-80 Sorbitan Laurate	0,16%
Sodium Methyl Cocoyl Taurate	0,15%
Ceteareth-6	0,14%
Sodium Stearate	0,13%
Sodium C14-16 Olefin Sulfonate	0,13%
PPG-1-PEG-9 Lauryl Glycol Ether	0,13%
Sodium Palmitate	0,12%

Magnesium Laureth Sulfate	0,11%
Sodium Lauroyl Isethionate	0,11%
Sodium Trideceth Sulfate	0,11%
Disodium Lauroamphodiacetate	0,10%
Sodium Coceth Sulfate	0,10%
Sodium Myristoyl Sarcosinate	0,10%
Potassium Olivate	0,10%
Potassium Oleate	0,09%
Lauramide DEA	0,08%
Ammonium Laureth Sulfate	0,08%
Beheneth-10	0,08%
Polysorbate 60	0,08%
Polysorbate 80	0,08%
Cetyl Alcohol	0,08%
Sodium Laureth-11 Carboxylate	0,08%
DATEM	0,08%
PEG-75 Lanolin	0,08%
Sodium Lauroyl Oat Amino Acids	0,08%
PEG-40 Sorbitan Peroleate	0,07%
Laureth-11 Carboxylic Acid	0,07%
Disodium Lauryl Sulfosuccinate	0,07%
PEG-100 Stearate	0,07%
Trisodium Sulfosuccinate	0,07%
Capryl/capramidopropyl Betaine	0,07%
Cetearyl Glucoside	0,07%
PEG-5 Cocamide	0,07%
Poloxamer 101	0,06%

Benzalkonium Chloride	0,06%
Lauramide MEA	0,06%
Ceteareth-20	0,06%
Sodium Olivamphoacetate	0,05%
Sodium Cocoate	0,05%
Sucrose Laurate	0,05%
TEA-dodecylbenzenesulfonate	0,05%
Ceteth-24	0,05%
Steareth-4	0,05%
Steareth-2	0,05%
Sodium Cocoyl Hydrolyzed Wheat Protein	0,05%
Oleamidopropyl Betaine	0,05%
Cocamide DIPA	0,05%
Cetrimonium Chloride	0,05%
Disodium PEG-5 Laurylcitrate Sulfosuccinate	0,04%
PPG-2 Hydroxyethyl Cocamide	0,04%
Zinc Coceth Sulfate	0,04%
Laureth-7 Citrate	0,04%
Sodium Tallowate	0,04%
PEG-35 Castor Oil	0,04%
Sodium Laureth-13 Carboxylate	0,04%
Sodium Palmate	0,04%
Bis-PEG/PPG-20/20 Dimethicone	0,04%
Sodium Oleth Sulfate	0,04%
Sodium Babassuamphoacetate	0,03%
Capryloyl Glycine	0,03%
Sorbitan Sesquicaprylate	0,03%
Laureth-11	0,03%
Magnesium Oleth Sulfate	0,03%
Oleth-20	0,03%
Cocamidopropyl Betainamide MEA Chloride	0,03%
Sodium Cocoyl Amino Acids	0,03%
Shea Butteramidopropyl Betaine	0,03%
Ceteth-20	0,03%
C11-15 Pareth-40	0,03%
Sodium Cetearyl Sulfate	0,03%
Sodium Coco-glucoside Tartrate	0,03%
Magnesium Laureth-8 Sulfate	0,03%
Sodium Laureth-8 Sulfate	0,03%
Lauramide MIPA	0,03%
Laureth-7	0,03%
Others	< 0,03%

Viscosity controlling

Table 21. Different variants that fulfill equivalent function: viscosity controlling

VARIANTS (Function viscosity controlling)	Percentage of products containing this variant
Cocamidopropyl Betaine	20,61%
Sodium Chloride	20,01%
Propylene Glycol	8,00%
Disodium EDTA	6,13%

Glycol Distearate	4,23%
Benzyl Alcohol	3,52%
Cocamide MEA	3,33%
Cocamide DEA	3,31%
Acrylates Copolymer	2,39%
Magnesium Chloride	1,97%
Xanthan Gum	1,59%
Alcohol Denat.	1,59%
PEG-120 Methyl Glucose Dioleate	1,51%
Guar Hydroxypropyltrimonium Chloride	1,49%
Butylene Glycol	1,13%
Alcohol	1,12%
Acrylates/C10-30 Alkyl Acrylate Crosspolymer	0,86%
Lauramidopropyl Betaine	0,76%
PEG-150 Distearate	0,71%
PEG-55 Propylene Glycol Oleate	0,69%
Dipropylene Glycol	0,59%
Polyethylene	0,00%
Sodium Sulfate	0,59%
Coco-betaine	0,56%
PEG-4 Rapeseedamide	0,54%
Isopropyl Alcohol	0,48%
Betaine	0,48%
Carbomer	0,48%
Silica	0,47%
Hydrogenated Castor Oil	0,46%
Triethylene Glycol	0,44%

Sodium Styrene/acrylates Copolymer	0,41%
Hydroxypropyl Methylcellulose	0,39%
Butyrospermum Parkii Butter	0,37%
Sodium Lauroyl Sarcosinate	0,37%
Cocamidopropyl Hydroxysultaine	0,37%
Magnesium Sulfate	0,30%
Cocamide MIPA	0,30%
Lanolin Alcohol	0,27%
Tin Oxide	0,26%
Gelatin	0,23%
Potassium Chloride	0,23%
Hydroxypropyl Guar	0,22%
Hydroxyethylcellulose	0,22%
Cetearyl Alcohol	0,20%
Sodium Palm Kernelate	0,19%
Stearyl Alcohol	0,07%
Calcium Chloride	0,07%
PEG-14M	0,07%
Tetrasodium Etidronate	0,07%
Cetyl Hydroxyethylcellulose	0,07%
Sodium Stearate	0,07%
Cellulose	0,07%
Alumina	0,07%
Hydroxypropyl Starch Phosphate	0,07%
Sodium Palmitate	0,07%
Isopentane	0,07%

Agar	0,07%
Disodium Lauroamphodiacetate	0,07%
Lauryl Alcohol	0,07%
Sodium Myristoyl Sarcosinate	0,07%
Microcrystalline Cellulose	0,07%
PEG-120 Methyl Glucose Trioleate	0,07%
Glycol	0,07%
Oxidized Polyethylene	0,07%
Lauramide DEA	0,07%
Cetyl Alcohol	0,07%
Synthetic Wax	0,07%
Capryl/capramidopropyl Betaine	0,07%
Acrylates/steareth-20 Methacrylate Copolymer	0,07%
Cera Microcristallina	0,07%
Lauramide MEA	0,07%
Cyamopsis Tetragonoloba Gum	0,07%
PEG/PPG-120/10 Trimethylolpropane Trioleate	0,07%
Acrylates/palmeth-25 Acrylate Copolymer	0,07%
Butylene/ethylene Copolymer	0,07%
Hydrated Silica	0,07%
Zea Mays Starch	0,07%
PEG-90M	0,06%
Potassium Palm Kernelate	0,06%
Starch Hydroxypropyltrimonium Chloride	0,06%
Algin	0,05%
Cocamide DIPA	0,05%
Paraffin	0,05%
Others	< 0,05%

Skin conditioning – Humectant

Table 22. Different variants that fulfill equivalent function: skin conditioning - humectant

VARIANTS (Function Sking conditioning Humectant)	Percentage of products containing this variant
Propylene Glycol	45,31%
Lactic Acid	15,04%
Sorbitol	10,67%
Maris Sal	4,24%
Urea	4,01%
Betaine	2,70%
Lactose	2,60%
Sodium PCA	2,31%
TEA-lactate	2,22%
Camellia Sinensis Leaf Extract	1,76%
Inulin	1,23%
Maris Aqua	0,80%
Mannitol	0,56%
Saccharomyces Lysate Extract	0,32%
Copper PCA	0,31%
Manganese PCA	0,22%
Hydrolyzed Wheat Starch	0,22%
Hydrolyzed Corn Starch	0,19%

Xylitol	0,17%
Magnesium P CA	0,14%
Camellia Sinensis Seed Oil	0,11%
Xylitylglucoside	0,10%
Anhydroxylitol	0,10%
Others	< 0,10%

Emulsifying

Table 23.Different variants that fulfill equivalent function: Emulsifying

VARIANTS (Function emulsifying)	Percentage of products containing this variant
Sodium Laureth Sulfate	25,45%
PEG-7 Glyceryl Cocoate	7,69%
Glyceryl Oleate	5,55%
Glycol Distearate	5,33%
PEG-40 Hydrogenated Castor Oil	5,04%
Cocamide MEA	4,19%
Cocamide DEA	4,17%
Laureth-4	3,32%
Polysorbate 20	3,05%
PEG-200 Hydrogenated Glyceryl Palmate	2,28%
Xanthan Gum	2,00%
PEG-120 Methyl Glucose Dioleate	1,90%
Sodium Lauryl Sulfate	1,73%
Sodium C12-13 Pareth Sulfate	1,68%
Laureth-2	1,37%
Laureth-10	1,13%
Laureth-3	0,92%
PEG-150 Distearate	0,89%
Triethanolamine	0,88%
Hexylene Glycol	0,86%
PEG-6 Caprylic/capric Glycerides	0,78%
PEG-18 Glyceryl Oleate/cocoate	0,75%
Trideceth-9	0,75%
Glyceryl Stearate	0,69%
Lauric Acid	0,59%
Hydrogenated Castor Oil	0,55%
PEG-150 Pentaerythrityl Tetrastearate	0,53%
Lecithin	0,51%
Glyceryl Laurate	0,50%
Poloxamer 124	0,48%
Glycol Stearate	0,46%
Sodium Lauroyl Sarcosinate	0,46%
Sucrose Cocoate	0,44%
Sodium Myreth Sulfate	0,43%
TEA-lauryl Sulfate	0,38%
Stearic Acid	0,35%
Cocamide MIPA	0,35%
Sodium Coco-sulfate	0,33%
Lanolin Alcohol	0,32%
PEG-3 Distearate	0,31%
Trideceth-7	0,31%
Glyceryl Cocoate	0,31%

Ceteareth-60 Myristyl Glycol	0,30%
Glycereth-2 Cocoate	0,27%
Potassium Cocoate	0,25%
PPG-5-ceteth-20	0,25%
Cetearyl Alcohol	0,24%
Sodium Palm Kernelate	0,23%
Isostearic Acid	0,23%
Stearyl Alcohol	0,22%
PEG-60 Hydrogenated Castor Oil	0,22%
PEG-60 Almond Glycerides	0,22%
Glyceryl Caprylate	0,22%
Ceteareth-6	0,19%
Sodium Stearate	0,19%
PPG-1-PEG-9 Lauryl Glycol Ether	0,18%
Sodium Palmitate	0,16%
Sodium Trideceth Sulfate	0,15%
PEG-75 Shea Butter Glycerides	0,15%
Lauryl Alcohol	0,14%
Potassium Olivate	0,13%
Sodium PEG-7 Olive Oil Carboxylate	0,13%
Glyceryl Stearate SE	0,13%
Potassium Oleate	0,12%
Others	< 0,12%

Solvent

Table 24. **Different variants that fulfill equivalent function: Solvent**

VARIANTS (Function solvent)	Percentage of products containing this variant
Aqua	33,97%
Glycerin	20,24%
Limonene	12,59%
Propylene Glycol	10,19%
Benzyl Alcohol	4,49%
PEG-200 Hydrogenated Glyceryl Palmate	2,31%
Alcohol Denat.	2,02%
Butylene Glycol	1,44%
Alcohol	1,43%
Benzyl Benzoate	1,16%
Isopropyl Palmitate	1,05%
Hexylene Glycol	0,87%
Olea Europaea Fruit Oil	0,77%
Dipropylene Glycol	0,75%
Isopropyl Alcohol	0,61%
Triethylene Glycol	0,53%
Paraffinum Liquidum	0,50%
Cocos Nucifera Oil	0,47%
PEG-8	0,36%
Pentylene Glycol	0,36%
Dicaprylyl Ether	0,34%
Caprylic/Capric Triglyceride	0,33%
Buteth-3	0,31%
Tributyl Citrate	0,31%
PEG-7	0,30%
PEG-40	0,22%

Ricinus Communis Seed Oil	0,20%
Isopentane	0,17%
Isopropyl Myristate	0,16%
Farnesol	0,15%
PEG-200	0,15%
Ethoxydiglycol	0,14%
Butyloctanol	0,14%
Glycol	0,12%
1,2-hexanediol	0,12%
PEG-6	0,11%
Octyldodecanol	0,09%
Methylpropanediol	0,07%
Gluconolactone	0,06%
PEG-4	0,06%
Triethyl Citrate	0,06%
PPG-2 Methyl Ether	0,05%
PEG-150	0,05%
Glycereth-26	0,05%
Phenoxyisopropanol	0,04%
PEG-18	0,04%
Cyclomethicone	0,03%
Benzyl Acetate	0,03%
Others	< 0,03%

Cleansing

Table 25. **Different variants that fulfill equivalent function: Cleansing**

VARIANTS (Function cleansing)	Percentage of products containing this variant
Cocamidopropyl Betaine	26,63%
Sodium Laureth Sulfate	26,11%
Coco-glucoside	8,45%
Lauryl Glucoside	5,02%
Decyl Glucoside	2,62%
PEG-200 Hydrogenated Glyceryl Palmate	2,34%
Disodium Laureth Sulfosuccinate	2,20%
Sodium Cocoamphoacetate	1,93%
Sodium Lauryl Sulfate	1,78%
Sodium C12-13 Pareth Sulfate	1,72%
Laureth-2	1,40%
Ammonium Lauryl Sulfate	1,37%
Disodium Cocoamphodiacetate	1,24%
Disodium Cocoyl Glutamate	1,18%
Lauramidopropyl Betaine	0,98%
Sodium Cocoyl Glutamate	0,89%
Coco-betaine	0,70%
Sodium Lauroamphoacetate	0,63%
Lauric Acid	0,60%
Cocamidopropylamine Oxide	0,57%
Lauryl Betaine	0,50%
Sodium Lauroyl Sarcosinate	0,47%
Sodium Cocoyl Isethionate	0,46%
Sodium Lauryl Glucose Carboxylate	0,44%

Sodium Myreth Sulfate	0,44%
Sodium Lauryl Sulfoacetate	0,41%
Cocamidopropyl Hydroxysultaine	0,39%
Caprylyl/Capryl Glucoside	0,39%
TEA-lauryl Sulfate	0,39%
Stearic Acid	0,36%
PEG-90 Glyceryl Isostearate	0,34%
Sodium Coco-sulfate	0,34%
Sodium Palm Kernelate	0,24%
Sodium Isethionate	0,24%
MIPA-laureth Sulfate	0,23%
Isostearic Acid	0,23%
Linoleic Acid	0,23%
Sodium Methyl Cocoyl Taurate	0,21%
Sodium Stearate	0,19%
Sodium C14-16 Olefin Sulfonate	0,18%
Sodium Palmitate	0,17%
Magnesium Laureth Sulfate	0,16%
Sodium Trideceth Sulfate	0,15%
Sodium Lauroyl Isethionate	0,15%
Citrus Aurantifolia Oil	0,15%
Disodium Lauroamphodiacetate	0,15%
Sodium Coceth Sulfate	0,15%
Sodium Myristoyl Sarcosinate	0,14%
PEG-120 Methyl Glucose Trioleate	0,13%
Ammonium Laureth Sulfate	0,12%
Sodium Laureth-11 Carboxylate	0,11%

Sodium Lauroyl Oat Amino Acids	0,11%
Laureth-11 Carboxylic Acid	0,10%
Disodium Lauryl Sulfosuccinate	0,10%
Capryl/capramidopropyl Betaine	0,10%
Sodium Cocoyl Glycinate	0,09%
Ceteareth-20	0,08%
Centella Asiatica Extract	0,08%
Potassium Palm Kernelate	0,08%
Sodium Olivamphoacetate	0,08%
TEA-dodecylbenzenesulfonate	0,08%
Citrus Aurantifolia Juice	0,08%
Sodium Cocoate	0,08%
Ceteth-24	0,07%
Oleamidopropyl Betaine	0,06%
Myristic Acid	0,06%
Laureth-7 Citrate	0,06%
Zinc Coceth Sulfate	0,06%
Sodium Tallowate	0,06%
Sodium Laureth-13 Carboxylate	0,05%
Sodium Oleth Sulfate	0,05%
Sodium Palmate	0,05%
Betula Alba Leaf Extract	0,05%
Capryloyl Glycine	0,05%
Others	<0,05%

Preservative

Table 26. **Different variants that fulfill equivalent function: Preservative**

VARIANTS (Function preservative)	Percentage of products containing this variant
Sodium Benzoate	17,77%
Phenoxyethanol	9,63%
Methylparaben	8,68%
Methylisothiazolinone	8,66%
Methylchloroisothiazolinone	7,66%
Propylparaben	6,70%
Potassium Sorbate	5,52%
Benzyl Alcohol	5,14%
DMDM Hydantoin	3,90%
Ethylparaben	3,84%
Butylparaben	3,55%
Sodium Salicylate	2,82%
Isobutylparaben	2,62%
Benzoic Acid	2,51%
2-bromo-2-nitropropane-1,3-diol	1,71%
Salicylic Acid	1,45%
Dehydroacetic Acid	0,90%
Imidazolidinyl Urea	0,86%
Sodium Methylparaben	0,84%
Sorbic Acid	0,74%
Triclosan	0,61%
Formic Acid	0,61%
Iodopropynyl Butylcarbamate	0,45%
Sodium Formate	0,36%
Diazolidinyl Urea	0,30%
Chlorphenesin	0,24%
Polyaminopropyl Biguanide	0,19%
Sodium Dehydroacetate	0,17%
Sodium Hydroxymethylglycinate	0,17%
Sodium Propylparaben	0,16%
Potassium Benzoate	0,13%
Formaldehyde	0,12%
Benzalkonium Chloride	0,10%
Piroctone Olamine	0,08%
Isopropylparaben	0,08%
Cetrimonium Chloride	0,07%
5-bromo-5-nitro-1,3-dioxane	0,07%
Benzylhemiformal	0,07%
Chloroxylenol	0,06%
Chlorhexidine Digluconate	0,05%
Phenoxyisopropanol	0,05%
Sodium Metabisulfite	0,04%
Quaternium-15	0,04%
Dimethyl Oxazolidine	0,04%
Sodium Ethylparaben	0,03%
Sodium Sulfite	0,03%
Isobutyl Benzoate	0,03%
Sodium Bisulfite	0,03%
Triclocarban	0,03%

Methyl Benzoate	0,02%
Undecylenic Acid	0,02%
O-cymen-5-ol	0,02%
Dichlorobenzyl Alcohol	0,01%
Silver Chloride	0,01%
Behentrimonium Chloride	0,01%
Benzethonium Chloride	0,01%
Chloroacetamide	0,01%
Glutaral	0,01%
Climbazole	0,01%
Ortho-phenylphenol	0,01%
Chlorhexidine	0,00%
Sodium Isobutylparaben	0,00%
TEA-salicylate	0,00%
Sodium Butylparaben	0,00%
Zinc Pyrithione	0,00%
Others	<0,00%

Antistatic

Table 27. Different variants that fulfill equivalent function: Antistatic

VARIANTS (Function antistatic)	Percentage of products containing this variant
Cocamidopropyl Betaine	36,98%
Polyquaternium-7	12,17%
Pantothenic Acid	5,05%
Panthenol	4,73%
Laureth-4	4,40%
Polyquaternium-10	4,40%
Acrylates Copolymer	4,30%
Guar Hydroxypropyltrimonium Chloride (682	2,66%
Hydroxypropyl Guar Hydroxypropyltrimonium Chloride	1,76%
Isopropyl Palmitate	1,47%
Lauramidopropyl Betaine	1,36%
Urea	1,27%
Sodium Lauroyl Glutamate	1,19%
Polyquaternium-39	0,99%
Coco-betaine	0,97%
Hydrolyzed Wheat Protein	0,89%
Betaine	0,86%
Sine Adipe Lac	0,84%
Serine	0,76%
Lecithin	0,73%
Sodium PCA	0,73%
Paraffinum Liquidum	0,71%
Lauryl Betaine	0,70%
Petrolatum	0,69%
Hydroxypropyl Methylcellulose	0,67%
Sodium Lauroyl Sarcosinate	0,66%
Niacin	0,65%
Sucrose Cocoate	0,62%
Cocamidopropyl Hydroxysultaine	0,54%

Hydrolyzed Milk Protein	0,47%
Lanolin Alcohol	0,46%
Hydroxypropyl Guar	0,40%
Hydrolyzed Silk	0,38%
Polyquaternium-22	0,37%
Hydrolyzed Keratin	0,37%
Sodium Isethionate	0,33%
Glycine (82)	0,32%
Linoleic Acid	0,32%
Polyquaternium-2	0,28%
Arginine	0,28%
Lauryl Aminopropylglycine	0,26%
Lauryl Methyl Gluceth-10 Hydroxypropyldimonium	0,25%
Laurdimonium Hydroxypropyl Hydrolyzed Wheat Protein	0,23%
Sodium Lauroyl Isethionate	0,21%
Disodium Lauroamphodiacetate	0,21%
Inositol	0,21%
Lauryl Diethylenediaminoglycine	0,20%
Sodium Myristoyl Sarcosinate	0,19%
Cocamidopropyl PG-dimonium Chloride Phosphate	0,18%
Lauramide DEA	0,16%
Sodium Lauroyl Oat Amino Acids	0,15%
Synthetic Wax	0,15%
Polyquaternium-43	0,15%
Calcium Pantothenate	0,13%
Capryl/capramidopropyl Betaine	0,13%
Hydrolyzed Oat Protein	0,13%

Benzalkonium Chloride	0,12%
Lauramide MEA	0,12%
Hydroxycetyl Hydroxyethyl Dimonium Chloride	0,12%
Hydrolyzed Rice Protein	0,12%
Hydrolyzed Soy Protein	0,12%
Quaternium-80	0,11%
Starch Hydroxypropyltrimonium Chloride	0,10%
Polyquaternium-11	0,10%
Myristamidopropyl PG-dimonium Chloride Phosphate	0,10%
Sodium Cocoyl Hydrolyzed Wheat Protein	0,09%
Lysine	0,09%
Oleamidopropyl Betaine	0,09%
Oryzanol	0,09%
Cetrimonium Chloride	0,09%
Hydrolyzed Sweet Almond Protein	0,09%
Polyquaternium-44	0,09%
Alanine	0,07%
Hyaluronic Acid	0,07%
Polyquaternium-67	0,07%
Sodium Cocoyl Amino Acids	0,06%
Valine	0,06%
Ricinoleamidopropyltrimonium Methosulfate	0,06%
Pyridoxine HCl	0,05%
Isostearamidopropyl Morpholine Lactate	0,05%
Lauramide MIPA	0,05%
Linoleamidopropyl PG-dimonium Chloride Phosphate	0,05%
Sodium Caseinate	0,05%

Carnitine	0,05%
Hydrolyzed Collagen	0,05%
Cyclomethicone	0,05%
Glutamic Acid	0,05%
Others	<0,05%

Perfuming

Table 28. Different variants that fulfill equivalent function: Perfuming

VARIANTS (Function perfuming)	Percentage of products containing this variant
Linalool	10,41%
Limonene	9,87%
Butylphenyl Methylpropional	6,23%
Hexyl Cinnamal	6,03%
Propylparaben	4,61%
Glyceryl Oleate	4,42%
Citronellol	3,95%
Benzyl Alcohol	3,53%
Benzyl Salicylate	3,32%
Geraniol	3,03%
Alpha-isomethyl Ionone	2,43%
Coumarin	2,29%
Quinoline	1,84%
Citral	1,44%
Hydroxyisohexyl 3-cyclo hexene Carboxaldehyde	1,35%
Hydroxycitronellal	0,00%
Benzyl Benzoate	0,92%
Isopropyl Palmitate	0,91%
Hexylene Glycol	0,83%
Eugenol	0,67%
Dipropylene Glycol	0,63%
Isopropyl Alcohol	0,59%
Olea Europaea Fruit Oil	0,48%
L-limonene	0,48%
Amyl Cinnamal	0,43%
Paraffinum Liquidum	0,43%
Caprylic/Capric Triglyceride	0,40%
Glycine Soja Oil	0,26%
Parfum	0,26%
Mentha Piperita Oil	0,22%
Olea Europaea Leaf Extract	0,18%
Cananga Odorata Flower Oil	0,16%
Calendula Officinalis Flower Extract	0,16%
D-limonene	0,16%
Cinnamyl Alcohol	0,15%
Levulinic Acid	0,13%
Anthemis Nobilis Flower Extract	0,13%
Isopropyl Myristate	0,12%
Farnesol	0,12%
Cinnamal	0,12%
Ethoxydiglycol	0,11%

Cananga Odorata Flower extr.	0,11%
Melaleuca Alternifolia Leaf Oil	0,10%
Propyl Gallate	0,10%
Pogostemon Cablin Leaf Extract	0,09%
Zingiber Officinale Root Oil	0,08%
Cera Alba	0,07%
Octyldodecanol	0,07%
Vanilla Planifolia Bean Extract	0,07%
Isoeugenol	0,07%
Zingiber Officinale Root Extract	0,07%
Eucalyptus Globulus Leaf Oil	0,07%
Anthemis Nobilis Flower Oil	0,06%
Citronellyl Methylcrotonate25	0,05%
Myristic Acid	0,05%
2-benzylheptanol	0,05%
Mentha Piperita Herb Oil	0,05%
Aniba Rosaeodora Wood Oil	0,05%
Jasminum Officinale Flower Extract	0,05%
Anise Alcohol	0,05%
Litsea Cubeba Fruit Oil	0,05%

PPG-2 Methyl Ether	0,04%
Pinus Sylvestris Twig Leaf Oil	0,04%
Ethyl Linoleate	0,04%
Aniba Rosaeodora Wood Extract	0,04%
Cymbopogon Citratus Leaf Oil	0,04%
Pelargonium Graveolens Oil	0,04%
Ethyl Oleate	0,04%
Calendula Officinalis Flower Oil	0,03%
Heliotropine	0,03%
Arnica Montana Flower Extract	0,03%
Evernia Prunastri Extract	0,03%
Humulus Lupulus Extract	0,03%
Guaiacum Officinale Wood Extract	0,03%
Ionone	0,03%
Eucalyptus Globulus Leaf Extract	0,03%
Eugenia Caryophyllus Bud Oil	0,02%
Benzyl Acetate	0,02%
Linolenic Acid	0,02%
Others	<0,02%

Identification of hazardous substances and analysis of alternatives

Based on the most commonly used substances that perform the same function in each category, the identification of hazardous substances is based on ingredients inherent properties. The study is focused on the effects of the ingredients on health and environment measured by the classification status according to CLP regulation.

The main hazardous substances found in liquid soaps are highlighted in **red colour**. They are present mainly in preservatives, solvent and perfuming.

Perfume ingredients are the most problematic ingredients regarding health (sensitizing substances)[50]. Most frequently recognised allergens fund are: geraniol, coumarin, citral and amyl cinnamal.

The different substances in the tables show that there are other environmentally preferable alternatives. See paragraph 9.10 on conclusion for the justification about the hazardousness of the substances.

9.6. Identification and analysis of alternatives for hazardous substances in solid soaps

For the category of solid soaps, the goal and scope of the analysis of alternatives are the defined in section 9.2, as they are common for all products included in this product category. **4 183 products** has been found and analyzed.

Raw materials

The top ingredients present in solid soaps are given in Table 29:

Table 29. Top ingredients present in solid soaps

FUNCTION	NUMBER OF VARIANTS*
Viscosity Controlling	7.621
Emulsifying	6.192
Cleansing	6.001
Surfactant	5.951
Solvent	5.580
Skin Conditioning	4.856
Masking	3.857
Cosmetic Colorant	3.193
Chelating	3.171
Perfuming	1.812

*Number of different substances that perform the same function

Source: Based on GNPD (Global Database of New Products) results from 2011

[50] Nordic Ecolabelling of cosmetic products Version 2.1 • 12 October 2010 – 31 December 2014

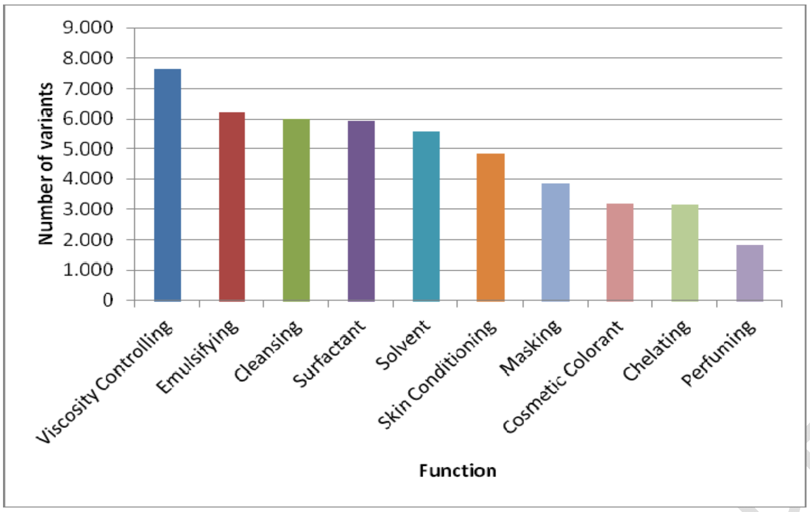


Figure 7. Top ingredients present in solid soaps. Based on GNPD

Source: Based on GNPD (Global Database of New Products) results from 2011

Identification of variants:

The substances most commonly used that perform the same function are analyzed in the tables below with the aim to identify hazardous substances and help manufacturers to find an environmentally better alternative substance:

Viscosity Controlling

Table 30. **Different variants that fulfill equivalent function: Viscosity controlling**

VARIANTS (Function viscosity controlling)	Percentage of products containing this variant
Sodium Palm Kernelate	15,27%
Sodium Palmate	13,65%
Sodium Cocoate	9,81%
Sodium Tallowate	8,88%
Sodium Palmitate	2,22%
Sodium Stearate	1,69%
Sodium Olivate	1,15%
Sodium Oleate	0,54%
Sodium Laurate	0,52%
Zinc Stearate	0,34%
TEA-cocoate	0,29%
Sodium Castorate	0,13%
Potassium Palm Kernelate	0,13%
Sodium Rapeseedate	0,12%
Potassium Stearate	0,12%
Potassium Palmate	0,10%
Sodium Lardate	0,09%
Sodium Myristate	0,09%
Potassium Myristate	0,07%
Potassium Palmitate	0,07%
Potassium Laurate	0,07%
Potassium Cocoate	0,05%
Potassium Tallowate	0,04%
Sodium Sweet Almondate	0,03%
Sodium Linoleate	0,03%
Sodium Grapeseedate	0,03%
Sodium Rosinate	0,01%
Sodium Ricinoleate	0,01%
Others	< 0,01%

Chelating agent

Table 31. **Different variants that fulfill equivalent function: Chelating agent**

VARIANTS (Function chelating agent)	Percentage of products containing this variant
Tetrasodium EDTA	33,68%
Tetrasodium Etidronate	31,91%
Citric Acid	8,89%
Pentasodium Pentetate	7,73%
Etidronic Acid	7,00%
Sodium Citrate	1,77%
EDTA	1,55%
Disodium EDTA	1,51%
Disodium Etidronate	1,17%
Tetrasodium Glutamate Diacetate	1,07%
Phytic Acid	0,79%
Trisodium EDTA	0,66%
Sodium Gluconate	0,60%
Pentetic Acid	0,25%
Cyclodextrin	0,19%
Trisodium HEDTA	0,13%
Trisodium Etidronate	0,03%
Trisodium NTA	0,03%
Citrus Medica Vulgaris Fruit Extract	0,03%
Others	< 0,03%

Humectant

Table 32. Different variants that fulfill equivalent function: Humectant

VARIANTS (Function Humectant)	Percentage of products containing this variant
Glycerin	31,78%
Propylene Glycol	6,20%
Sorbitol	4,06%
Sodium Lactate	1,57%
Sucrose	1,40%
Mel	1,17%
PEG-8	0,89%
Butylene Glycol	0,74%
Lactic Acid	0,56%
Sodium PCA	0,47%
PEG-9	0,41%
Camellia Sinensis Leaf Extract	0,39%
Aloe Barbadensis Leaf Extract	0,35%
PEG-12	0,27%
Glucose	0,25%
Hydrolyzed Keratin	0,21%
Others	< 0,21%

Emulsifying

Table 33. Different variants that fulfill equivalent function: Emulsifying

VARIANTS (Function Emulsifying)	Percentage of products containing this variant
Sodium Palm Kernelate	17,62%
Sodium Palmate	15,28%
Sodium Cocoate	10,66%
Sodium Tallowate	10,29%
Palm Kernel Acid	5,96%
Coconut Acid	3,31%
Palm Acid	2,92%
Stearic Acid	2,65%
Sodium Palmitate	2,52%
Sodium Stearate	1,92%
Sodium Laureth Sulfate	1,63%
Lauric Acid	1,07%
Tallow Acid	0,97%
Triethanolamine	0,89%
Lanolin	0,81%
Sodium Olivate	0,78%
Cetearyl Alcohol	0,60%
Sodium Laurate	0,55%
Sodium Lauryl Sulfate	0,48%
Lanolin Alcohol	0,48%
Sodium Oleate	0,47%
Palmitic Acid	0,42%
Cocamide DEA	0,42%

Trideceth-9	0,40%
PEG-40 Hydrogenated Castor Oil	0,37%
TEA-cocoate	0,36%
Glyceryl Stearate	0,31%
Trilaureth-4 Phosphate	0,29%
Cera Alba	0,24%
Hexylene Glycol	0,24%
Polysorbate 20	0,23%
Hydrogenated Castor Oil	0,21%
Ceteareth-20	0,18%
Cocamide MEA	0,16%
Potassium Stearate	0,15%
TEA-lauryl Sulfate	0,13%
PEG-60 Hydrogenated Castor Oil	0,10%
Sodium Lardate	0,10%
Sodium Dodecylbenzenesulfonate	0,10%
Sodium Rapeseedate	0,10%
Sodium Trideceth Sulfate	0,10%
Potassium Laurate	0,08%
Potassium Myristate	0,08%
Sodium Myristate	0,08%
PEG-7 Glyceryl Cocoate	0,08%
Potassium Palmitate	0,08%
Glyceryl Linoleate	0,08%
Others	< 0,08%

Perfuming

Table 34. Different variants that fulfill equivalent function: Perfuming

VARIANTS (Function Perfuming)	Percentage of products containing this variant
Glycerin	17,03%
Linalool	6,90%
Limonene	5,91%
Hexyl Cinnamal	4,77%
Butylphenyl Methylpropional	4,55%
Citronellol	4,30%
Geraniol	3,12%
Benzyl Salicylate	2,99%
Coumarin	2,80%
Alpha-isomethyl Ionone	2,59%
Paraffinum Liquidum	1,36%
Citral	1,29%
Eugenol	1,17%
Hydroxyisohexyl 3-cyclohexene Carboxaldehyde	0,99%
Olea Europaea Fruit Oil	0,91%
Benzyl Alcohol	0,79%
Benzyl Benzoate	0,79%
Amyl Cinnamal	0,76%
Hydroxycitronellal	0,66%
Propylparaben	0,62%
Octyldodecanol	0,56%

Glycine Soja Oil	0,56%
L-limonene	0,44%
Cinnamyl Alcohol	0,40%
Dipropylene Glycol	0,34%
Isopropyl Myristate	0,34%
D-limonene	0,18%
Cinnamal	0,18%
Cera Alba	0,17%
Isoeugenol	0,17%
Hexylene Glycol	0,17%
Pogostemon Cablin Leaf Extract	0,13%
Cananga Odorata Flower Extract	0,12%
Ethylhexyl Palmitate	0,12%
Paeonia Lactiflora Root Water	0,10%
Melaleuca Alternifolia Leaf Oil	0,10%
Methyl Benzoate	0,09%
Olea Europaea Leaf Extract	0,09%
Parfum	0,09%
Anthemis Nobilis Flower Extract	0,09%
Farnesol	0,08%
Mentha Piperita Oil	0,07%
TBHQ	0,06%
Cinnamomum Zeylanicum Leaf Extract	0,06%
Calendula Officinalis Flower Extract	0,04%
Zingiber Officinale Root Oil	0,04%
Citrus Aurantium Dulcis Peel Extrac	0,04%
Citrus Aurantifolia Peel Extract	0,04%
Others	< 0,04%

Colorants

Table 35. Different variants that fulfill equivalent function: Colorants

VARIANTS (Function Perfuming)	Percentage of products containing this variant
CI 77891	35,52%
CI 11680	3,95%
CI 47005	3,79%
CI 19140	3,66%
CI 14700	3,54%
CI 77492	3,41%
CI 12490	3,38%
CI 17200	3,23%
CI 42090	3,10%
CI 77491	2,76%
CI 77499	2,54%
CI 77007	2,51%
CI 15510	2,22%
CI 74160	2,19%
CI 73360	2,10%
CI 74260	1,94%
Others	< 1,94%

Identification of hazardous substances and analysis of alternatives

Based on the most commonly used substances that perform the same function in solid soaps, the identification of hazardous substances is based on ingredients inherent properties. The study is focused on the effects of the ingredients on health and environment. The environmental effects are measured by the classification status according to CLP regulation.

The main hazardous substances found in solid soaps are highlighted in **red colour** and are mainly found among ingredients fulfilling perfuming function. Generally, solid soaps were found to contain fewer ingredients harmful to the health and the environment than liquid soaps.

Health assessment is focused on known problematic substances such as perfumes. Perfume ingredients are the most problematic ingredients regarding health (allergies)[51]. The following most frequently recognised allergens are: linalool, hexyl cinnamal, citronellol, geraniol, coumarin, amyl cinnamal and farnesol.

One of the results of the study is that there are other environmentally preferable alternatives.

See paragraph 9.10 on conclusions for the justification about the hazardouness of the substances.

9.7. Identification and analysis of alternatives for hazardous substances in shampoos

For the category of shampoos, the goal and scope of the analysis of alternatives are the defined in section 9.2, as they are common for all products included in this product category. **13 188** products has been found and analyzed.

Raw materials

The top ingredients present in shampoos are given in Table 36:

[51] Nordic Ecolabelling of cosmetic products Version 2.1 • 12 October 2010 – 31 December 2014

Table 36. **Top ingredients present in shampoos**

FUNCTION	NUMBER OF VARIANTS
Skin Conditioning	46.621
Viscosity Controlling	39.183
Surfactant	38.600
Perfuming	35.378
Masking	30.283
Emulsifying	29.265
Preservative	27.426
Antistatic	26.116
Cleansing	24.275
Hair Conditioning	23.392

*Number of different substances that perform the same function

Source: Based on GNPD (Global Database of New Products) results from 2011

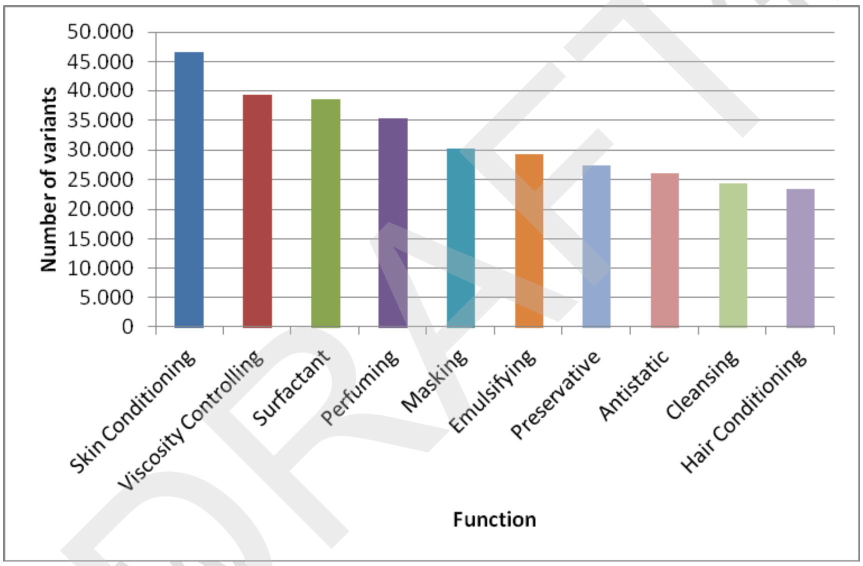


Figure 8. Top ingredients present in shampoos

Source: Based on GNPD (Global Database of New Products) results from 2011

Identification of variants:

The substances most commonly used in shampoos that perform the same function are analyzed in the tables below with the aim to identify hazardous substances and help manufacturers to find an environmentally better alternative substance with a lower hazard level for a specific function:

Skin Conditioning

Table 37. Different variants that fulfill equivalent function: Skin conditioning

VARIANTS	Percentage of products containing this variant
Skin Conditioning EMOLLIENT	
Glycol Distearate	18,47%
Dimethicone	10,78%
Cetyl Alcohol	6,10%
Glyceryl Oleate	5,91%
Dimethiconol	4,41%
Hydrogenated Castor Oil	2,87%
Paraffinum Liquidum	2,11%
Methyl Cocoate	1,94%
Dicaprylyl Ether	1,59%
Hydrogenated Polydecene	1,58%
Simmondsia Chinensis Seed Oil	1,51%
2-oleamido-1,3-octadecanediol	1,51%
Cetearyl Alcohol	1,39%
Glyceryl Stearate	1,37%
Others	< 1,37%

VARIANTS	Percentage of products containing this variant
Skin Conditioning OCCLUSIVE	
Glycol Distearate	34,78%
Dimethicone	20,29%
Tocopherol	9,88%
Hydrogenated Castor Oil	5,40%
Distearyl Ether	3,06%
Simmondsia Chinensis Seed Oil	2,85%
Prunus Armeniaca Kernel Oil	2,25%
Butyrospermum Parkii Butter	1,96%
Trimethylolpropane Tricaprylate/tricaprate	1,92%
Persea Gratissima Oil	1,72%
Prunus Amygdalus Dulcis Oil	1,48%
Citrus Medica Limonum Fruit Extrac	1,06%
Argania Spinosa Kernel Oil	1,02%
Chamomilla Recutita Flower Extract	1,00%
Others	< 1,00%

VARIANTS	Percentage of products containing this variant
Skin Conditioning HUMECTANT	
Propylene Glycol	60,05%
Lactic Acid	8,55%
Betaine	4,56%
Sorbitol	4,30%
Camellia Sinensis Leaf Extract	4,01%
Sodium PCA	3,66%
Maris Sal	3,20%
Hydrolyzed Wheat Starch	2,54%
Urea	1,43%
Inulin	1,15%
Xylitol	0,89%
Lactitol	0,64%
Maris Aqua	0,62%
Mannitol	0,28%
Polyquaternium-51	0,28%
Acetamide MEA	0,24%
Magnesium PCA	0,23%
Xylitylglucoside	0,23%
Anhydroxylitol	0,23%
Manganese PCA	0,19%
Others	< 0,19%

Viscosity Controlling

Table 38. Different variants that fulfill equivalent function: Viscosity Controlling

VARIANTS (Function viscosity controlling)	Percentage of products containing this variant
Sodium Chloride	16,94%
Cocamidopropyl Betaine	12,84%
Propylene Glycol	8,11%
Glycol Distearate	7,34%
Guar Hydroxypropyltrimonium Chloride	6,38%
Disodium EDTA	4,86%
Cocamide MEA	4,40%
Benzyl Alcohol	4,23%
Carbomer	3,42%
Cetyl Alcohol	2,43%
Cocamide MIPA	2,21%
Cocamide DEA	1,89%
Magnesium Chloride	1,51%
Coco-betaine	1,34%
Hydrogenated Castor Oil	1,14%
Butylene Glycol	1,12%
Ammonium Xylenesulfonate	1,09%

PEG-55 Propylene Glycol Oleate	1,09%		Magnesium Sulfate	0,51%
Alcohol Denat.	0,89%		PEG-14M	0,49%
Sodium Lauroyl Sarcosinate	0,65%		Isopropyl Alcohol	0,46%
Xanthan Gum	0,64%		PEG-150 Distearate	0,45%
PEG-120 Methyl Glucose Dioleate	0,63%		PEG-7M	0,43%
Betaine	0,62%		Behenyl Alcohol	0,43%
Dipropylene Glycol	0,56%		Magnesium Carbonate Hydroxide	0,42%
Cetearyl Alcohol	0,55%		Butyrospermum Parkii Butter	0,41%
Alcohol	0,54%		PEG-4 Rapeseedamide	0,38%
Acrylates Copolymer	0,54%		Others	< 0,38%

Surfactant

Table 39. Different variants that fulfill equivalent function: Surfactant

VARIANTS (Function surfactant)	Percentage of products containing this variant			
			Ammonium Laureth Sulfate	1,95%
			Cocamide DEA	1,92%
			Hexylene Glycol	1,85%
Sodium Laureth Sulfate	15,87%		Laureth-2	1,80%
Cocamidopropyl Betaine	13,03%		TEA-dodecylbenzenesulfonate	1,44%
Cocamide MEA	4,47%		PPG-5-ceteth-20	1,39%
Coco-glucoside	3,15%		Coco-betaine	1,36%
PEG-7 Glyceryl Cocoate	2,92%		Sodium Cocoamphoacetate	1,28%
Cetyl Alcohol	2,47%		Polysorbate 20	1,26%
Disodium Cocoamphodiacetate	2,40%		Decyl Glucoside	1,22%
Ammonium Lauryl Sulfate	2,31%		Hydrogenated Castor Oil	1,16%
Cocamide MIPA	2,25%		Disodium Laureth Sulfosuccinate	1,15%
Laureth-4	2,25%		Ammonium Xylenesulfonate	1,11%
PEG-40 Hydrogenated Castor Oil	2,15%		Others	< 1,11%
Sodium Lauryl Sulfate	2,00%			

Perfuming

Table 40. Different variants that fulfill equivalent function: Perfuming

VARIANTS (Function perfuming)	Percentage of products containing this variant
Linalool	9,54%
L-limonene	7,97%
Glycerin	7,92%
Hexyl Cinnamal	7,37%
Butylphenyl Methylpropional	7,02%
Benzyl Alcohol	4,69%
Benzyl Salicylate	4,17%
Citronellol	4,05%
Propylparaben	3,91%
Glyceryl Oleate	2,61%
Geraniol	2,43%
Alpha-isomethyl Ionone	2,14%
Hexylene Glycol	2,02%
Hydroxyisohexyl 3-cyclohexene Carboxaldehyde	1,41%
Coumarin	1,07%
Amyl Cinnamal	0,98%
Paraffinum Liquidum	0,93%
Hydroxycitronellal	0,75%
Benzyl Benzoate	0,74%
Dipropylene Glycol	0,62%
Isopropyl Alcohol	0,51%
Others	< 0,51%

Masking

Table 41. Different variants that fulfill equivalent function: Masking

VARIANTS (Function masking)	Percentage of products containing this variant
Sodium Chloride	21,92%
Citric Acid	20,30%
Sodium Benzoate	13,66%
Salicylic Acid	3,77%
Sodium Citrate	3,45%
Cetyl Alcohol	3,15%
Butylparaben	2,99%
Laureth-4	2,86%
Tocopherol	2,69%
Benzoic Acid	1,57%
Butylene Glycol	1,45%
Alcohol Denat.	1,15%
BHT	1,02%
Triethanolamine	0,87%
Menthol	0,83%
Caramel	0,81%
Dipropylene Glycol	0,73%
Others	< 0,73%

Emulsifying

Table 42. Different variants that fulfill equivalent function: Emuslifying

VARIANTS (Function emulsifying)	Percentage of products containing this variant
Sodium Laureth Sulfate	20,93%
Glycol Distearate	9,83%
Cocamide MEA	5,89%
PEG-7 Glyceryl Cocoate	3,85%
Cetyl Alcohol	3,26%
Glyceryl Oleate	3,15%
Cocamide MIPA	2,96%
Laureth-4	2,96%
PEG-40 Hydrogenated Castor Oil	2,84%
Sodium Lauryl Sulfate	2,64%
Cocamide DEA	2,53%
Hexylene Glycol	2,44%
Laureth-2	2,38%
PPG-5-ceteth-20	1,84%
Polysorbate 20	1,66%
Hydrogenated Castor Oil	1,53%
PEG-3 Distearate	1,17%
Cetrimonium Chloride	1,11%
Sodium Cocoate	1,05%
Triethanolamine	0,90%
Trideceth-12	0,90%
Sodium Lauroyl Sarcosinate	0,87%
Others	< 0,87%

Preservative

Table 43. Different variants that fulfill equivalent function: Preservative

VARIANTS (Function preservative)	Percentage of products containing this variant
Sodium Benzoate	15,08%
Methylisothiazolinone	8,94%
Methylchloroisothia-zolinone	8,51%
DMDM Hydantoin	7,88%
Methylparaben	6,70%
Phenoxyethanol	6,11%
Benzyl Alcohol	6,05%
Proylparaben	5,04%
Ethylparaben	4,17%
Salicylic Acid	4,16%
Potassium Sorbate	3,60%
Butylparaben	3,30%
Sodium Methylparaben	2,83%
Isobutylparaben	2,63%
Benzoic Acid	1,73%
Zinc Pyrithione	1,71%
Sodium Salicylate	1,45%
Cetrimonium Chloride	1,18%

Piroctone Olamine	0,94%
2-bromo-2-nitropropane-1,3-diol	0,91%
Formic Acid	0,86%
Imidazolidinyl Urea	0,83%
Diazolidinyl Urea	0,63%
Sodium Formate	0,58%
Sorbic Acid	0,54%
Iodopropynyl Butylcarbamate	0,51%
Dehydroacetic Acid	0,50%
Climbazole	0,43%
Sodium Hydroxymethylglycinate	0,37%
Behentrimonium Chloride	0,21%
Chlorphenesin	0,20%
Quaternium-15	0,15%
Formaldehyde	0,12%
Benzalkonium Chloride	0,11%
Others	< 0,11%

Antistatic

Table 44. Different variants that fulfill equivalent function: Antistatic

VARIANTS (Function antistatic)	Percentage of products containing this variant
Cocamidopropyl Betaine	19,26%
Pantothenic Acid	10,78%
Panthenol	10,51%
Polyquaternium-10	10,05%
GuarHydroxypropyltrimoniumChloric	9,58%
Polyquaternium-7	4,07%
Niacin	3,62%
Laureth-4	3,32%
Hydrolyzed Wheat Protein	2,24%
Hydroxypropyl GuarHydroxypropyltrimonium Chloride	2,03%
Coco-betaine	0,00%
Panthenyl Ethyl Ether	2,01%
Amodimethicone	1,37%
Paraffinum Liquidum	1,36%
Cetrimonium Chloride	1,24%
Pyridoxine HCl	1,17%
Quaternium-80	1,13%
Hydrolyzed Silk	1,05%
Laurdimonium Hydroxypropyl Hydrolyzed Wheat Protein	0,99%
Sodium Lauroyl Sarcosinate	0,97%
Hydrolyzed Keratin	0,95%
Betaine	0,93%
Others	< 0,93%

Cleansing

Table 45. **Different variants that fulfill equivalent function: Cleansing**

VARIANTS (Function cleansing)	Percentage of products containing this variant
Sodium Laureth Sulfate	25,23%
Cocamidopropyl Betaine	20,73%
Coco-glucoside	5,01%
Disodium Cocoamphodiacetate	3,82%
Ammonium Lauryl Sulfate	3,67%
Sodium Lauryl Sulfate	3,18%
Ammonium Laureth Sulfate	3,09%
Laureth-2	2,87%
TEA-dodecylbenzenesulfonate	2,28%
Coco-betaine	2,17%
Sodium Cocoamphoacetate	2,04%
Decyl Glucoside	1,94%
Disodium Laureth Sulfosuccinate	1,83%
Lauryl Glucoside	1,72%
Sodium Cocoate	1,26%
Sodium Lauroyl Sarcosinate	1,05%
PEG-200 Hydrogenated Glyceryl Palmate	1,01%
Sodium C12-13 Pareth Sulfate	0,80%
Laureth-23	0,76%
Sodium Lauroamphoacetate	0,74%
Laureth-5 Carboxylic Acid	0,67%
Sodium Cocoyl Glutamate	0,65%
Magnesium Laureth Sulfate	0,55%
Cocamidopropyl Hydroxysultaine	0,54%
Sodium Oleth Sulfate	0,47%
TEA-lauryl Sulfate	0,47%
Sodium Methyl Cocoyl Taurate	0,44%
Sodium Cocoyl Isethionate	0,42%
Sodium Laureth-8 Sulfate	0,42%
Magnesium Oleth Sulfate	0,42%
Disodium Cocoyl Glutamate	0,40%
Magnesium Laureth-8 Sulfate	0,40%
Others	< 0,40%

Hair Conditioning

Table 46. **Different variants that fulfil equivalent function: Hair conditioning**

VARIANTS (Function hair conditioning)	Percentage of products containing this variant
Cocamidopropyl Betaine	21,51%
Pantothenic Acid	12,04%
Panthenol	11,74%
Salicylic Acid	4,88%
Disodium Cocoamphodiacetate	3,96%
Hydrolyzed Wheat Protein	2,51%
Magnesium Nitrate	2,42%
HydroxypropylGuarHydroxypropyl Trimonium Chloride	2,27%

Coco-betaine	0,00%
Sodium Cocoamphoacetate	2,25%
Zinc Pyrithione	2,12%
Panthenyl Ethyl Ether	2,00%
Amodimethicone	1,53%
PEG-12 Dimethicone	1,52%
Pyridoxine HCl	1,31%
Quaternium-80	1,27%
Hydrolyzed Silk	1,17%
Laurdimonium Hydroxypropyl HydrolyzedWheat Protein	1,11%
Sodium Lauroyl Sarcosinate	0,00%
Hydrolyzed Keratin	1,09%

Betaine	1,06%
Simmondsia Chinensis Seed Oil	1,03%
Glycine	1,00%
Magnesium Sulfate	0,96%
Sodium PCA	0,85%
Sodium Lauroamphoacetate	0,83%
Arginine	0,77%
Silk Amino Acids	0,76%
Panax Ginseng Extract	0,76%
Biotin	0,73%
Others	0,72%

Identification of hazardous substances and analysis of alternatives

Based on the most commonly used substances that perform the same function in shampoos, the identification of hazardous substances is based on ingredients inherent properties. The study is focused on the effects of the ingredients on health and environment. The environmental and human health effects are measured by the classification status according to CLP regulation.

The main hazardous substances found in shampoos are highlighted in **red colour**. They are present mainly in perfuming, masking and preservatives.

Perfume ingredients are the most problematic ingredients regarding health (sensitizing substances)[52]. The following most frequently recognised allergens are: geraniol, coumarin and amyl cinnamal.

The different substances in the tables show that there are other environmentally preferable alternatives. See paragraph 9.10 on conclusions for the justification about the hazardousness of the substances.

[52] Nordic Ecolabelling of cosmetic products Version 2.1 • 12 October 2010 – 31 December 2014

9.8. Identification and analysis of alternatives for hazardous substances in hair conditioners

For the category of hair conditioners, the goal and scope of the analysis of alternatives are the defined in section 9.2, as they are common for all products included in this product category. **5 327** products has been found and analyzed.

Raw materials

The top ingredients present in hair conditioners are below:

Table 47. Top ingredients present in hair conditioners

FUNCTION	NUMBER OF SUBSTANCES*
Skin Conditioning	24.596
Perfuming	16.944
Viscosity Controlling	12.757
Preservative	12.608
Antistatic	12.151
Hair Conditioning	11.912
Solvent	11.510
Surfactant	11.423
Emulsifying	11.048
Masking	9.449

*Number of different substances that perform the same function

Source: Based on GNPD (Global Database of New Products) results from 2011

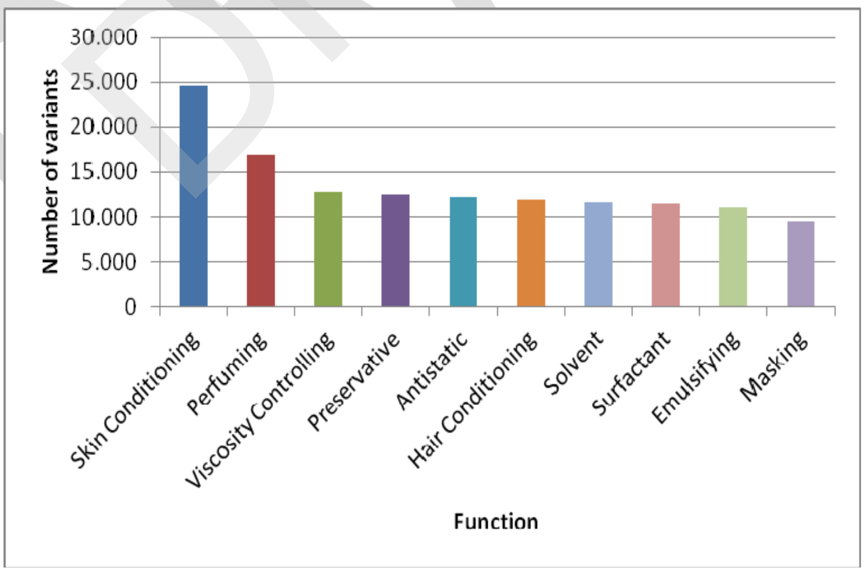


Figure 9. Top ingredients present in hair conditioners

Source: Based on GNPD (Global Database of New Products) results from 2011

Identification of variants:

The substances most commonly used that perform the same function are analyzed in the tables below with the aim to identify hazardous substances and help manufacturers to find an environmentally better alternative substance with a lower hazard level for a specific function:

Skin Conditioning

Table 48. Different variants that fulfil equivalent function: Skin conditioning

VARIANTS (Function skin conditioning emollient)	Percentage of products containing this variant
Skin Conditioning EMOLLIENT	
Cetearyl Alcohol	16,91%
Cetyl Alcohol	9,74%
Dimethicone	7,12%
Stearyl Alcohol	6,08%
Glyceryl Stearate	4,91%
Dimethiconol	4,00%
Cyclopentasiloxane	3,49%
Cetyl Esters	2,82%
Isopropyl Myristate	2,46%
PPG-1 Trideceth-6	1,72%
Simmondsia Chinensis Seed Oil	1,70%
Paraffinum Liquidum	1,70%
Propylene Glycol Dicaprylate/dicaprate	1,45%
Cyclomethicone	1,15%
Myristyl Alcohol	1,14%
Helianthus Annuus Seed Oil	1,09%
Olea Europaea Fruit Oil	0,90%
Cyclohexasiloxane	0,86%
Others	< 0,86%

VARIANTS (Function skin conditioning occlusive)	Percentage of products containing this variant
Skin Conditioning OCCLUSIVE	
Dimethicone	29,21%
Tocopherol	11,02%
Simmondsia Chinensis Seed Oil	6,98%
Butyrospermum Parkii Butter	6,05%
Prunus Armeniaca Kernel Oil	4,57%
Persea Gratissima Oil	4,26%
Prunus Amygdalus Dulcis Oil	3,49%
Cocos Nucifera Oil	2,19%
Rosmarinus Officinalis Leaf Extract	2,07%
Glycine Soja Oil	2,07%
Triticum Vulgare Germ Oil	1,91%
Argania Spinosa Kernel Oil	1,88%
Glycol Distearate	1,85%
Caprylic/Capric Triglyceride	1,76%

Chamomilla Recutita Flower Extract	1,51%
Phenyl Trimethicone	1,39%
Citrus Medica Limonum Fruit Extract	1,39%
Camelina Sativa Seed Oil	1,33%
Cetyl Palmitate	1,11%
Sesamum Indicum Seed Oil	0,74%
Eucalyptus Globulus Leaf Extract	0,56%
Linum Usitatissimum Seed Oil	0,52%
Others	< 0,52%

VARIANTS (Function skin conditioning humectant)	Percentage of products containing this variant
Skin Conditioning HUMECTANT	
Propylene Glycol	53,45%
Lactic Acid	20,22%
Sorbitol	5,03%
Camellia Sinensis Leaf Extract	4,29%
Hydrolyzed Wheat Starch	4,17%
Sodium PCA	2,61%
Betaine	2,14%
Maris Sal	1,29%
Maris Aqua	0,82%
Urea	0,70%
Inulin	0,62%
Acetamide MEA	0,51%
Morus Alba Leaf Extract	0,19%
Lactose	0,19%
Mannitol	0,16%
Glycyrrhiza Glabra Root Extract	0,16%
Polyquaternium-51	0,16%
Others	< 0,16%

Perfuming

Table 49. Different variants that fulfil equivalent function: Perfuming

VARIANTS (Function perfuming)	Percentage of products containing this variant
Linalool	9,30%
Hexyl Cinnamal	8,26%
Butylphenyl Methylpropional	7,64%
Glycerin	7,07%
Limonene	6,88%
Benzyl Alcohol	5,72%
Propylparaben	4,58%
Benzyl Salicylate	4,23%
Citronellol	3,39%
Isopropyl Alcohol	3,02%
Isopropyl Myristate	1,91%

Geraniol	1,84%
Alpha-isomethyl Ionone	1,63%
Dipropylene Glycol	1,50%
Paraffinum Liquidum	1,32%
Coumarin	1,20%
Quinoline	1,19%
Hydroxyisohexyl 3-cyclohexene Carboxaldehyde	1,16%
Hydroxycitronellal	0,97%
Amyl Cinnamal	0,86%
Benzyl Benzoate	0,73%
Olea Europaea Fruit Oil	0,70%
Citral	0,44%
Glyceryl Oleate	0,44%
Glycine Soja Oil	0,39%
Isopropyl Palmitate	0,38%
Caprylic/Capric Triglyceride	0,32%
Eugenol	0,31%
L-limonene	0,30%
Octyldodecanol	0,27%
Hexylene Glycol	0,27%
Parfum	0,21%
Calendula Officinalis Flower Extract	0,19%
Levulinic Acid	0,12%
Zingiber Officinale Root Extract	0,12%
Others	< 0,12%

Viscosity controlling

Table 50. Different variants that fulfil equivalent function: Viscosity controlling

VARIANTS (Function viscosity controlling)	Percentage of products containing this variant
Cetearyl Alcohol	17,43%
Propylene Glycol	10,69%
Cetyl Alcohol	10,03%
Benzyl Alcohol	7,60%
Stearyl Alcohol	6,28%
Hydroxyethylcellulose	5,27%
Disodium EDTA	4,78%
Magnesium Chloride	4,16%
Isopropyl Alcohol	4,01%
Sodium Chloride	3,65%
Dipropylene Glycol	2,00%
Butylene Glycol	1,72%
Guar Hydroxypropyltrimonium Chloride	1,58%
Butyrospermum Parkii Butter	1,52%
Cyclomethicone	1,19%
Myristyl Alcohol	1,16%
Oleyl Alcohol	0,85%
Hydrolyzed Wheat Starch	0,84%
Alcohol Denat.	0,82%

Dodecene	0,80%
Hydroxypropyl Guar	0,71%
Alcohol	0,65%
Cetyl Hydroxyethylcellulose	0,60%
Hydroxypropyl Methylcellulose	0,55%
Potassium Chloride	0,53%
Silica	0,51%
Xanthan Gum	0,50%
Glycol Distearate	0,47%
Cocamidopropyl Betaine	0,46%
Lauryl Alcohol	0,43%
PEG-2m	0,43%
Betaine	0,42%
Coco-betaine	0,38%
Sodium Sulfate	0,35%
PEG-150 Distearate	0,35%
Cocamide MEA	0,34%
PVP	0,33%
Behenyl Alcohol	0,31%
Paraffin	0,31%
PEG-14M	0,27%
Triethylene Glycol	0,24%
Potato Starch Modified	0,24%
Hydroxypropyl Starch Phosphate	0,23%
Sodium Polyacrylate	0,15%
Dextrin	0,14%
Others	< 0,14%

Preservatives

Table 51. Different variants that fulfil equivalent function: Preservatives

VARIANTS (Function preservatives)	Percentage of products containing this variant
Cetrimonium Chloride	11,60%
Phenoxyethanol	10,46%
Methylparaben	9,98%
Behentrimonium Chloride	8,23%
Benzyl Alcohol	7,69%
Methylisothiazolinone	7,35%
Methylchloroisothiazolinone	6,96%
Propylparaben	6,15%
Sodium Benzoate	4,54%
Potassium Sorbate	3,62%
DMDM Hydantoin	3,29%
Ethylparaben	3,27%
Butylparaben	2,59%
Isobutylparaben	2,24%
Chlorhexidine Dihydrochloride	1,67%
Chlorhexidine Digluconate	1,03%
Sodium Methylparaben	1,03%

Imidazolidinyl Urea	1,02%
Diazolidinyl Urea	0,86%
Iodopropynyl Butylcarbamate	0,78%
Stearalkonium Chloride	0,75%
Benzoic Acid	0,64%
Salicylic Acid	0,48%
Zinc Pyrithione	0,48%
Sorbic Acid	0,44%

Dehydroacetic Acid	0,39%
2-bromo-2-nitropropane-1,3-diol	0,36%
Steartrimonium Chloride	0,23%
Chlorphenesin	0,21%
Cetrimonium Bromide	0,20%
Piroctone Olamine	0,18%
Others	< 0,18%

Antistatic

Table 52. Different variants that fulfil equivalent function: Antistatic

VARIANTS (Function antistatic)	Percentage of products containing this variant
Cetrimonium Chloride	12,15%
Pantothenic Acid	11,04%
Panthenol	10,79%
Behentrimonium Chloride	8,66%
Stearamidopropyl Dimethylamine	8,44%
Amodimethicone	5,32%
Niacin	3,12%
Distearoylethyl Hydroxyethylmonium Methosulfate	2,94%
Hydrolyzed Wheat Protein	2,58%
Polyquaternium-37	2,43%
Glutamic Acid (	2,15%
Paraffinum Liquidum	1,86%
Panthenyl Ethyl Ether	1,74%

Guar Hydroxypropyltrimonium Chloride	1,66%
Quaternium-18	1,47%
Hydrolyzed Keratin	1,41%
Behentrimonium Methosulfate	1,32%
Quaternium-80	1,28%
Cyclomethicone	1,26%
Others	< 1,26%

Hair conditioning

Table 53. Different variants that fulfil equivalent function: Hair conditioning

VARIANTS (Function hair conditioning)	Percentage of products containing this variant
Pantothenic Acid	11,26%
Panthenol	11,01%
Behentrimonium Chloride	8,83%
Stearamidopropyl Dimethylamine	8,61%
Amodimethicone	5,42%
Magnesium Nitrate	4,52%
Cyclopentasiloxane	3,89%
Distearoylethyl Hydroxyethylmonium Methosulfate	3,00%
Hydrolyzed Wheat Protein	2,64%
Glutamic Acid	2,19%
Simmondsia Chinensis Seed Oil	1,90%
Panthenyl Ethyl Ether	1,78%
Bis-aminopropyl Dimethicone	1,75%
Quaternium-87	1,75%
Quaternium-18	1,50%
Hydrolyzed Keratin	1,44%
Behentrimonium Methosulfate	1,34%
Quaternium-80	1,30%
Others	< 1,30%

Surfactant

Table 54. Different variants that fulfil equivalent function: Surfactant

VARIANTS (Function surfactant)	Percentage of products containing this variant
Cetearyl Alcohol	19,65%
Cetrimonium Chloride	12,92%
Cetyl Alcohol	11,32%
Stearamidopropyl Dimethylamine	8,98%
Stearyl Alcohol	7,07%
Ceteareth-20	4,48%
Trideceth-12	2,43%
PPG-1 Trideceth-6	2,00%
Quaternium-87	1,82%
Trideceth-6	1,63%
Quaternium-18	1,57%
Polysorbate 60	1,47%
TEA-dodecylbenzenesulfonate	1,44%
Behentrimonium Methosulfate	1,40%
PEG-40 Hydrogenated Castor Oil	1,06%
Poloxamer 407	0,91%
Trideceth-10	0,87%
Stearalkonium Chloride	0,82%
Others	< 0,82%

Emulsifying

Table 55. Different variants that fulfil equivalent function: Emulsifying

VARIANTS (Function emulsifying)	Percentage of products containing this variant
Cetearyl Alcohol	20,32%
Cetrimonium Chloride	13,36%
Cetyl Alcohol	11,70%
Stearamidopropyl Dimethylamine	9,29%
Stearyl Alcohol	7,31%
Glyceryl Stearate	5,90%
Ceteareth-20	4,63%
Trideceth-12	2,52%
Trideceth-6	1,68%
Polysorbate 60	1,52%
PEG-40 Hydrogenated Castor Oil	1,10%
Oleyl Alcohol	0,99%
Poloxamer 407	0,94%
Lecithin	0,72%
Polysorbate 20	0,71%
Dicetyldimonium Chloride	0,71%
Glyceryl Oleate	0,70%
Behenamidopropyl Dimethylamine	0,70%
Xanthan Gum	0,58%

Glyceryl Stearate SE	0,55%		Triethanolamine	0,52%
Trideceth-9	0,55%		Others	< 0,52%
Glycol Distearate	0,54%			

Masking

Table 56. **Different variants that fulfil equivalent function: Emulsifying Masking**

VARIANTS (Function masking)	Percentage of products containing this variant
Citric Acid	21,19%
Cetyl Alcohol	13,68%
Stearyl Alcohol	8,55%
Sodium Benzoate	6,11%
Sodium Chloride	4,94%
Tocopherol	3,78%
Butylparaben	3,49%
Dipropylene Glycol	2,70%
Butylene Glycol	2,34%
Prunus Armeniaca Kernel Oil	1,57%
Helianthus Annuus Seed Oil	1,53%
Sodium Citrate	1,39%
Camellia Sinensis Leaf Extract	1,16%
Alcohol Denat.	1,13%
Dodecene	1,11%
BHT	1,09%
Arginine	1,07%
Aspartic Acid	0,96%
Ascorbic Acid	0,93%
Others	< 0,93%

Identification of hazardous substances and analysis of alternatives

Based on the most commonly used substances that perform the same function in hair conditioners, the identification of hazardous substances is based on ingredients inherent properties. The study is focused on the effects of the ingredients on health and environment. The environmental and human health effects are measured by the classification status according to CLP regulation.

The main hazardous substances found in shampoos are highlighted in **red colour**. They are present mainly in perfuming, masking and preservatives.

Perfume ingredients are the most problematic ingredients regarding health (sensitizing substances) [53].

[53] Nordic Ecolabelling of cosmetic products Version 2.1 • 12 October 2010 – 31 December 2014

The different substances in the tables show that there are other environmentally preferable alternatives. See paragraph 9.10 on conclusions for the justification about the hazardousness of the substances.

9.9. Identification and analysis of alternatives for hazardous substances in packaging

For the packaging a sample of 13 700 products has been analysed in GNPD Mintel Database to determine the most used materials and formats of packaging. The most usual shape of the primary packaging is a bottle (83% of products). The shares of various materials used are presented in Table 58.

Related to materials used, the following data has been found:

Table 57. Shares of materials used for primary packaging of liquid soaps, shampoos and hair conditioners

Material	Percentage
PE plastic	34.74%
PET plastic	25.38%
PP plastic	14.67%
PVC plastic	1.18%
HDPE plastic	4.04%
Plastic (generic)	17.20%
Others materials	2.79%

For liquid soaps, shampoos and hair conditioners, packaging is made usually of different kinds of plastics. Therefore, a comparative assessment of different materials: PVC[54], PET[55], PE[56] , PP[57] and biopolymer has been done[58]. For solid soaps products, packaging is usually made of paper.

In accordance with the information given at the PlasticsEurope website the following substances included in the Candidate list are used in plastic materials[59]:

[54] PVC: Polyvinyl chloride
[55] PET: Polyethylene terephthalate
[56] PE: Polyethylene
[57] PP: Polypropylene
[58] See paragraph 10.9 of the document
[59] http://www.plasticseurope.org/plastics-sustainability/consumer-protection/reach.aspx

Table 58. Substances included in the Candidate list used in plastic materials

Name of substance	Plastics involved	EC number	CAS number	Reason for inclusion in Candidate List
2,4-Dinitrotoluene	Monomer	204-450-0	121-14-2	Carcinogenic (article 57a)
4,4'- Diaminodiphenylmethane (MDA)	Monomer	202-974-4	101-77-9	Carcinogenic (article 57a)
Acrylamide	PA Monomer	201-173-7	79-06-1	Carcinogenic and mutagenic (articles 57 a and 57 b)
Alkanes, C10-13, chloro (Short Chain Chlorinated Paraffins)	PVC	287-476-5	85535-84-8	PBT and vPvB (articles 57 d and 57 e)
Benzyl butyl phthalate (BBP)	PVC PP catalysts	201-622-7	85-68-7	Toxic for reproduction (article 57c)
Bis (2-ethylhexyl)phthalate (DEHP)	PVC PP catalysts	204-211-0	117-81-7	Toxic for reproduction (article 57c)
Chromium trioxide	HDPE catalysts	215-607-8	1333-82-0	CMR
Dibutyl phthalate (DBP)	PVC PP catalysts	201-557-4	84-74-2	Toxic for reproduction (article 57c)
Diisobutyl phthalate	PVC PP catalysts	201-553-2	84-69-5	Toxic for reproduction (article 57c)
Hexabromocyclododecane (HBCDD) and all major diastereoisomers	Flame Retardant EPS, XPS	247-148-4 221-695-9	25637-99-4	PBT (article 57d)
Lead chromate	Pigment	231-846-0	7758-97-6	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Lead chromate molybdate sulphate red (C.I. Pigment Red 104)	Pigment	235-759-9	12656-85-8	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Lead sulfochromate yellow (C.I. Pigment Yellow 34)	Pigment	215-693-7	1344-37-2	Carcinogenic and toxic for reproduction (articles 57 a and 57 c)
Tris(2-chloroethyl)phosphate	Flame Retardant, plasticiser	204-118-5	115-96-8	Toxic for reproduction (article 57c)

Based on this list, requirements regarding plastic materials used are as follows:

- **Plastic packaging**: shall not contain any substances included in the candidate list of Substances of Very High Concern (SVHC) for authorization: benzyl butyl phthalate, bis (2-ethylhexyl)phthalate, Dibutyl phthalate and Diisobutyl phthalate, monomers such as: 2,4-Dinitrotoluene, 4,4'-Diaminodiphenylmethane, Acrylamide, flame retardants: Hexabromocyclododecane (HBCDD) and all major diastereoisomers, Tris(2-chloroethyl)phosphate, Short Chain Chlorinated Paraffins: Alkanes, C10-13, chloro, Chromium trioxide, pigments: Lead chromate, Lead chromate molybdate sulphate red (C.I. Pigment Red 104) and Lead sulfochromate yellow (C.I. Pigment Yellow 34).

Stakeholders´feedback is asked to determine if some of these substance are used in the packaging of the products under study.

Further, a requirement regarding paper packaging is given:

- **Paper/carboard packaging**: Chlorine should not be used to bleach. Chlorine gas is classified as[60] H400 (very toxic to aquatic life), H315 (causes skin irritation), H319 (causes serious eye irritation), H331 (Toxic if inhaled) and H335 (may cause

[60] http://apps.echa.europa.eu/registered/data/dossiers/DISS-a6516d11-7da2-57f1-e044-00144f67d249/AGGR-585ca394-3912-4434-bd0f-a9a1fddbe4e8_DISS-a6516d11-7da2-57f1-e044-00144f67d249.html#section_1.1

respiratory irritation). Chlorine bleaching process produces highly toxic and persistent organochlorines such as dioxin. Dioxins are recognized as a persistent environmental pollutant, regulated internationally by the Stockholm Convention on Persistent Organic Pollutants[61].

9.10. Conclusions on identification and analysis of alternatives for hazardous substances

In this analysis information on some of the most commonly used substances in soaps, shampoos, hair conditioners and packaging have been provided. Based on the information obtained from ESIS, ECHA, CLP, scientific literature[62] and other ecolabels, a priority list of hazardous substances which are determined to pose the most significant potential threat to human health and environment has been prepared.

The identification of hazardous substances is based on ingredients inherent properties. The environmental and human health effects are measured by the classification status according to CLP regulation.

In conclusion, the main hazardous substances that should be considered to be excluded from ecolabelled products are:

- **Hazardous substances:** According to the Article 6(6) of EU Ecolabel legislation EC/66/2010[63], the product or any part of it thereof shall not contain substances or mixtures meeting the criteria for classification as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction (CMR), in accordance with CLP Regulation (EC) No 1272/2008, nor to goods containing substances referred to in Article 57 of REACH Regulation.

  Hazardous substances can be classified through the hazard statements provided in Annex I.

- **Substances considered PBT (persistent, bioaccumulativ and toxic) and vPvB (very persistent and very bioaccumulativ) and/or those having endocrine disrupting properties** according to article 57 of REACH regulation should be prohibited.

- **Substances included in the candidate list[64] of Substances of Very High Concern (SVHC) for authorization** should be prohibited. Currently there are 73 substances in the candidate list.

Some specific substances that should be restricted are:

- **Triclosan** (5-chloro-2-(2,4-dichlorophenoxy)phenol) - Triclosan[65] is a preservative added to soaps, hair conditioners and shaving cream products. Triclosan is classified as an agent that may cause adverse environmental effects[66]. Based on its classification[67], triclosan should be

[61] http://chm.pops.int/Convention/ThePOPs/ListingofPOPs/tabid/2509/Default.aspx.
[62] Risk Assessments reports
[63] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:027:0001:0019:EN:PDF.
[64] 73 substances in the Candidate List http://echa.europa.eu/chem_data/authorisation_process/candidate_list_table_en.asp#download.
[65] http://ec.europa.eu/health/ph_risk/committees/04_sccp/docs/sccp_o_166.pdf.
[66] http://vkm.no/dav/117573d6c4.pdf.

prohibited: H410: very toxic to aquatic life with long lasting effects, H315: causes skin irritation and H319: causes serious eye irritation. Some other studies[68] have shown that the use of triclosan in cosmetic products from a toxicological point of view is also a matter of concern.

- **Formaldehyde** - Formaldehyde is used as a preservative. Formaldehyde is a known sensitizer and a known carcinogen, based on its classification[69] should be prohibited: H351: suspected of causing cancer, H301: toxic if swallowed, H311: toxic in contact with skin, H331: toxic if inhaled; H314: causes severe skin burns and eye damage and H317: may cause an allergic skin reaction.

  Formaldehyde is already regulated and specifically excluded in Ecolabelling criteria for Thai Green Label.

- **Formaldehyde releasers: Bronopol (2-Bromo-2-Nitropropane-1, 3-Diol), 5-bromo-5-nitro-1, 3-dioxane, sodium hydroxyl methyl glycinate, DMDM Hydantoin, Diazolidinyl Urea and Imidazolidinyl Urea** – Formaldehyde releasers are used as preservatives that decompose to form formaldehyde upon degradation. The amount of formaldehyde released can be above the classification limits for formaldehyde[70]. There are some studies that demonstrate that people exposed to formaldehyde releasers may experience an allergic reaction[71].

- **Fragrance** - Fragrance is a sensitizer and a known trigger of allergic reactions such as asthma and contact dermatitis[72]. In 1999, the Scientific Commitee on Cosmetic Products and Non Food products intended for consumers (SCCP) based on criteria restricted to dermatological data reflecting the clinical experience[73], identified a list with the 13 most frequently reported contact allergens**.**

  Sensitizing substances classified as H334 (R42): respiratory sensitization and/or H317 (R43): skin sensitization or is one of the 13 fragances mentioned in the following table, are proposed to be restricted to 0.01% (100 ppm) in rinse-off products.

[67] http://apps.echa.europa.eu/registered/data/dossiers/DISS-9ea3b5cc-80fb-15ea-e044-00144f67d031/AGGR-09e9b0f0-bf29-4975-8fbe-a3a2dd0ac2be_DISS-9ea3b5cc-80fb-15ea-e044-00144f67d031.html#L-137752f6-fbea-4638-b8d8-acce5e212979.

[68] http://vkm.no/dav/117573d6c4.pdf.

[69] http://apps.echa.europa.eu/registered/data/dossiers/DISS-9d8ad2a1-0d51-13f7-e044-00144f67d249/AGGR-aa1957ab-42e8-43c6-856d-09b14245e171_DISS-9d8ad2a1-0d51-13f7-e044-00144f67d249.html#L-9cf4f64b-5725-4012-aad3-657063a4f5b6.

[70] Final report. EU Eco-label for shampoo and soaps. Ecolabelling Norway. Eskeland,, M.B, Svanes, E. May 2006.

[71] http://share.eldoc.ub.rug.nl/FILES/root2/2010/Formretof/de_Groot_2010_Contact_Dermatitis.pdf

[72] http://www.rivm.nl/bibliotheek/rapporten/320025001.pdf

[73] http://ec.europa.eu/health/archive/ph_risk/committees/sccp/documents/out93_en.pdf.

Table 59. Fragrances chemicals most frequently reported as contact allergens

SUBSTANCES	CAS No
Amyl cinnamal	122-40-7
Amylcinnamyl alcohol	101-85-9
Benzyl alcohol	100-51-6
Benzyl salicylate	118-58-1
Cinnamyl alcohol	104-54-1
Cinnamal	104-55-2
Citral	5392-40-5
Coumarin	91-64-5
Eugenol	97-53-0
Geraniol	106-24-1
Hydroxycitronellal	107-75-5
Hydroxymethylpentylcyclohexenecarboxaldehyde	31906-04-4
Isoeugenol	97-54-1

Nordic Swan[74] restricts the use of multiple fragrances in their criteria for shampoo, conditioners, body shampoo, liquid and solid soap.

- **Phthalates** - Some phthalates can be found in rinse-off cosmetic formulations. It is assumed that they are added in the perfume mix. Phthalates such as Bis(2-methoxyethyl) phthalate, diisobutyl phthalate, dibutyl phthalate (DBP), benzyl butyl phthalate (BBP) and bis (2-ethylhexyl)phthalate (DEHP), should be prohibited because they are classified as toxic for reproduction and present in the candidate list of Substances of Very High Concern for authorisation according to REACH regulation.

  On February 17, 2011 the European Comission named 6 chemicals as the first entrants on the Authorization list[75], known as Annex XIV, which means that the next substances: dibutyl phthalate (DBP), benzyl butyl phthalate (BBP) and bis (2-ethylhexyl)phthalate (DEHP) were moved from the candidate list to the authorisation list under the EU´s REACH regulation.

[74] Nordic Ecolabelling of cosmetic products Version 2.1 • 12 October 2010 – 31 December 2014

[75] COMMISSION REGULATION (EU) No 143/2011 of 17 February 2011 amending Annex XIV to Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (‘REACH’) http://eur lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2011R0143:20110221:EN:PDF

Table 60. Substances subjected to authorization, Annex XIV of REACH regulation

Substance name	EC Number	CAS Number	Classification
Bis(2-methoxyethyl) phthalate[76]	204-212-6	117-82-8	Toxic for reproduction (article 57 c)
Diisobutyl phthalate[77]	201-553-2	84-69-5	Toxic for reproduction (article 57c)
Dibutyl phthalate (DBP)[78]	201-557-4	84-74-2	Toxic for reproduction (article 57c)
Benzyl butyl phthalate (BBP)[79]	201-622-7	85-68-7	Toxic for reproduction (article 57c)
Bis (2-ethylhexyl)phthalate (DEHP)[80]	204-211-0	117-81-7	Toxic for reproduction (article 57c)

- **Ethyl-, methyl-, propyl- and butyl-Parabens** - Parabens are used as preservatives. In 1999, the European Union adopted a Strategy on Endocrine Disrupters and committed significant resources to develop and classifiy a priority list of suspected endocrine disrupting chemicals[81]. A candidate list with 553 substances with evidence of endocrine disruption was reviewed and classified in three categories: Category 1- evidence of endocrine disrupting activity in at least one species using intact animals; Category 2 - at least some in vitro evidence of biological activity related to endocrine disruption; Category 3 - no evidence of endocrine disrupting activity or no data available. Ethyl-, methyl-, propyl- and butyl-parabens are all categorised as potential endocrine disrupters (Category 1) under the EU strategy for endocrine disrupters. Safer alternatives to parabens exist[82], and around 5,4% of products are now marketed as "paraben-free".

[76] Support document for identification of Bis(2-methoxyethyl) phthalate as a substance of very high concern: http://echa.europa.eu/documents/10162/d60da5c8-85de-4cb2-b95a-fada9451373b
[77] Support document for identification of Bis(2-methoxyethyl) phthalate as a substance of very high concern: http://echa.europa.eu/documents/10162/d418f8b0-ba93-402a-97fd-1e340d22c541
[78] Support document for identification of Bis(2-methoxyethyl) phthalate as a substance of very high concern: http://echa.europa.eu/documents/10162/5196d655-7b11-41b2-acba-c8709064fac8
[79] Support document for identification of Bis(2-methoxyethyl) phthalate as a substance of very high concern: http://echa.europa.eu/documents/10162/19fd114d-eb69-4012-a107-8ceb97787733
[80] Support document for identification of Bis(2-methoxyethyl) phthalate as a substance of very high concern: http://echa.europa.eu/documents/10162/b8395d41-b6d5-427c-8294-d46997e8835d
[81] http://ec.europa.eu/environment/endocrine/strategy/short_en.htm
[82] See table with different variants that fulfil equivalent function: preservatives

Ethyl-, methyl-, propyl- and butyl- Parabens are proposed to be prohibited or restricted based on precautionary principle.

- **D4 (octamethylcyclotetrasiloxane)** CAS 556-67-2 is used as an emollient or solvent although is not in the list of most commonly used substances. Based on its classification[83] H413: may cause long lasting harmful effects to aquatic life, H361: suspected of damaging fertility or the unborn child and H226: flammable liquid and vapour, should be prohibited. It is prohibited from Nordic Ecolabelled products since they are generally considered to be persistent in the environment. In Canada, D4 has been added to "List of Toxic Substances in Schedule 1 of CEPA 1999", which means they are considered toxic and are subject to governmental regulation.

- **Butylated Hydroxy Toluene (BHT, CAS 128-37-0)** – Butylated Hydroxy Toluene (BHT) is used as an antioxidant in cosmetic products. BHT is classified as H410 (R50/53) very toxic to aquatic life with long lasting effects[84].

  Based on their classification, it should be prohibited.

- **Packaging requirements in function of the material used:** plastic, metal, paper, cardboard and related to the environmental performance of the material:

  - **Plastic:** shall not contain the next substances included in the candidate list of Substances of Very High Concern (SVHC) for authorization: phthalates: benzyl butyl phthalate, bis (2-ethylhexyl)phthalate, Dibutyl phthalate and Diisobutyl phthalate, monomers such as: 2,4-Dinitrotoluene, 4,4'-Diaminodiphenylmethane, Acrylamide, flame retardants: Hexabromocyclododecane (HBCDD) and all major diastereoisomers, Tris(2-chloroethyl)phosphate, Short Chain Chlorinated Paraffins: Alkanes, C10-13, chloro, Chromium trioxide, pigments: Lead chromate, Lead chromate molybdate sulphate red (C.I. Pigment Red 104) and Lead sulfochromate yellow (C.I. Pigment Yellow 34).
  - **Paper/carboard packaging**: Chlorine shall not be used to bleach. Chlorine gas is classified as[85] H400 (very toxic to aquatic life), H315 (causes skin irritation), H319 (causes serious eye irritation), H331 (Toxic if inhaled) and H335 (may cause respiratory irritation). Chlorine bleaching process produces highly toxic and persistent organochlorines such as dioxin. Dioxins are recognized as a persistent environmental pollutant, regulated internationally by the Stockholm Convention on

[83] http://apps.echa.europa.eu/registered/data/dossiers/DISS-9d9d2de7-dd46-653e-e044-00144f67d249/AGGR-d50b7533-2f91-4049-9110-98ba0524a880_DISS-9d9d2de7-dd46-653e-e044-00144f67d249.html#L-03cd909b-6f8e-4aee-9d90-52aa86e337e2.

[84] http://apps.echa.europa.eu/registered/data/dossiers/DISS-9d82f461-e7b6-3a89-e044-00144f67d249/AGGR-51b3c77a-ec07-4b3e-a1e2-870ae9e21d5e_DISS-9d82f461-e7b6-3a89-e044-00144f67d249.html#L-abb9496c-aaa4-455b-8305-187c411b237d.

[85] http://apps.echa.europa.eu/registered/data/dossiers/DISS-a6516d11-7da2-57f1-e044-00144f67d249/AGGR-585ca394-3912-4434-bd0f-a9a1fddbe4e8_DISS-a6516d11-7da2-57f1-e044-00144f67d249.html#section_1.1.

Persistent Organic Pollutants[86]. According to EU Ecolabel for tissue paper[87] and for copying and graphic paper[88], chlorine gas shall not be use as a bleaching agent.

[86] http://chm.pops.int/Convention/ThePOPs/ListingofPOPs/tabid/2509/Default.aspx.
[87] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:197:0087:0095:EN:PDF.
[88] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:149:0012:0024:EN:PDF.

10. Life Cycle Impact Assessment

With data obtained in inventory stage and the analysis of alternatives of substances for different product the life cycle impact assessment step has been conducted.

10.1. General considerations on existing LCA studies

In general terms, LCA studies consulted previously indicated that for all soap products included in this category, the use phase together with packaging manufacturing and the elaboration of raw chemicals were the stages with major environmental impacts in life cycle of these products. Regarding the main environmental impact, results from studies consulted showed that fossil feedstock, energy consumption and associated impacts are the most influencing in the life cycle phases of all products[89].

On the other hand results for ecotoxicity categories presented limitations in most existing LCA studies since for most substances there are no characterisation factors allocated. This means that the quantification of the environmental impact is not possible directly via the software tool but the LCA practitioner should try manually to determine and integrate this. Hence, aquatic ecotoxicity values are considered underestimated. This difficulty was also faced in the performed LCA. Therefore it was considered for important to compliment the investigation on aquatic pollution with a more detailed analysis. A similar approach was followed in the previous EU Ecolabel criteria development, in which regarding environmental impact methods like CDVTox (Critical Dilution Volume toxicity) and the DPD (former Dangerous Preparations Directive) to assess the aquatic pollution were used[90].

10.2. Impact assessment method used

The impact assessment method used is the IMPACT 2002+[91]. The IMPACT 2002+ methodology proposes a feasible implementation of a combined midpoint categories and damage approach, linking all types of life cycle inventory results (elementary flows and other interventions) via midpoint categories to four damage categories. This method has been chosen because it incorporates advanced methodologies for assessment of human toxicity and ecotoxicity. Other midpoint categories are adapted from existing characterizing methods (Eco-indicator 99 and CML 2002 and IPCC).

All midpoint scores are expressed in units of a reference substance and related to the four damage categories human health, ecosystem quality, climate change, and resources. Normalization can be performed either at midpoint or at damage level. The IMPACT 2002+ method provides characterization factors for almost 1500 different LCI-results.

Midpoints are used for a more specific and detailed analysis, whereas damage endpoints are useful to communicate the results obtained to breader audience. The pre-defined (mathematical) weighting of the different midpoint score within the Impact 2002+ assessment method allow us to come to a

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[89] Comparing the Environmental Footprints of Home-Care and Personal-Hygiene Products: The Relevance of Different Life-Cycle Phases. Annette Koehler* and Caroline Wildbolz. ETH Zurich, Institute of Environmental Engineering, 8093 Zurich, Switzerland. *Environ. Sci. Technol.*, 2009, *43* (22), pp 8643–8651. DOI: 10.1021/es901236.
CASE STUDY SHAMPOO BY HENKEL AG & CO. KGAA. Case Study undertaken within the PCF Pilot Project Germany.
Final report. EU Eco-label for shampoo and soaps. Ecolabelling Norway. Eskeland,, M.B, Svanes, E. May 2006.
[90] Colipa good sustainability practice (GSP) for the cosmetics industry. COLIPA – The European Cosmetic Association
[91] http://www.sph.umich.edu/riskcenter/jolliet/impact2002+.htm.

single score. However, as previously mentioned, this should be used more for communication than for analysis, as weighting is not standardised and it is generally considered more relevant for the experts groups to hold discussions in greater detail – on midpoints level.

For the midpoints categories the environmental categories recommended by ILCD handbook International Reference Life Cycle Data System have been selected [92]. Human toxicity and ecotoxicity categories have been included due to the necessity of access these impacts of soaps, shampoos and hair conditioners, are they are in contact directly with human skin and they are release directly to water after use.

Table 61. Midpoint categories used and link to damage category

Midpoint category	Midpoint reference substance	Damage category	Damage unit
Human toxicity (carcinogens + non-carcinogens)	kg_{eq} chloroethylene into air	Human health	DALY
Respiratory (inorganics)	kg_{eq} PM2.5 into air		
Ozone layer depletion	kg_{eq} CFC-11 into air		
Photochemical oxidation	kg_{eq} ethylene into air	Ecosystem quality	PDF * m^2 * yr
Aquatic ecotoxicity	kg_{eq} triethylene glycol into water		
Terrestrial ecotoxicity	kg_{eq} triethylene glycol into water		
Terrestrial acidification/nutrification	kg_{eq} SO_2 into air		
Aquatic acidification	kg_{eq} SO_2 into air		
Aquatic eutrophication	kgeq PO_4^{3-} into water		
Land occupation	m^2_{eq} organic arable land·year		
Global warming	kg_{eq} CO_2 into air	Climate change (life support system)	*(*kg_{eq} CO_2 into air)
Non-renewable energy	MJ Total primary non-renewable or kg_{eq} crude oil (860 kg/m^3)	Resources	MJ
Mineral extraction	MJ additional energy or kg_{eq} iron (in ore)		

Source: Scheme of the IMPACT 2002+ framework, with midpoint categories used linked to damage categories. Based on Jolliet et al. (2003a)

[92] European Commission-Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook, unpublished.

10.3. General environmental profile of products

In Figure 10 it the general environmental impact of the four kinds of products studied: liquid soap, solid soap, shampoo and hair conditioners, can be seen. Environmental impact is presented as a single score, where all midpoints impact categories have been weighted and aggregated to a unique valued, done with 2002+ impact method. It is useful to have a general vision of the contribution of each life stage to the environmental impact of the whole product and to identify the hot spots. The four products analysed show similar environmental profiles, with some differences which are detailed in sections below.

Graphics below show that for all kind of products, the **use phase** (washing action) has a big impact, counting for a 33% for liquid soaps, a 34% for solid soaps, a 27% for shampoos and a 17% for hair conditioners. Hair conditioner has a lower percentage for the use phase because the dose is major, and therefore for the same amount of product a lower number of washing actions are done. In use phase, only water has been considered as an input, as energy used for heating waster was excluded from the system. The input of products has been assessed as raw materials. Nevertheless, some aspects, like e.g. hot water use, are difficult to be regulated by the Ecolabel criteria, as these are more user bahevious and habits dependant. Nevertheless, it is important to remember it and i to communicate it to the consumers.

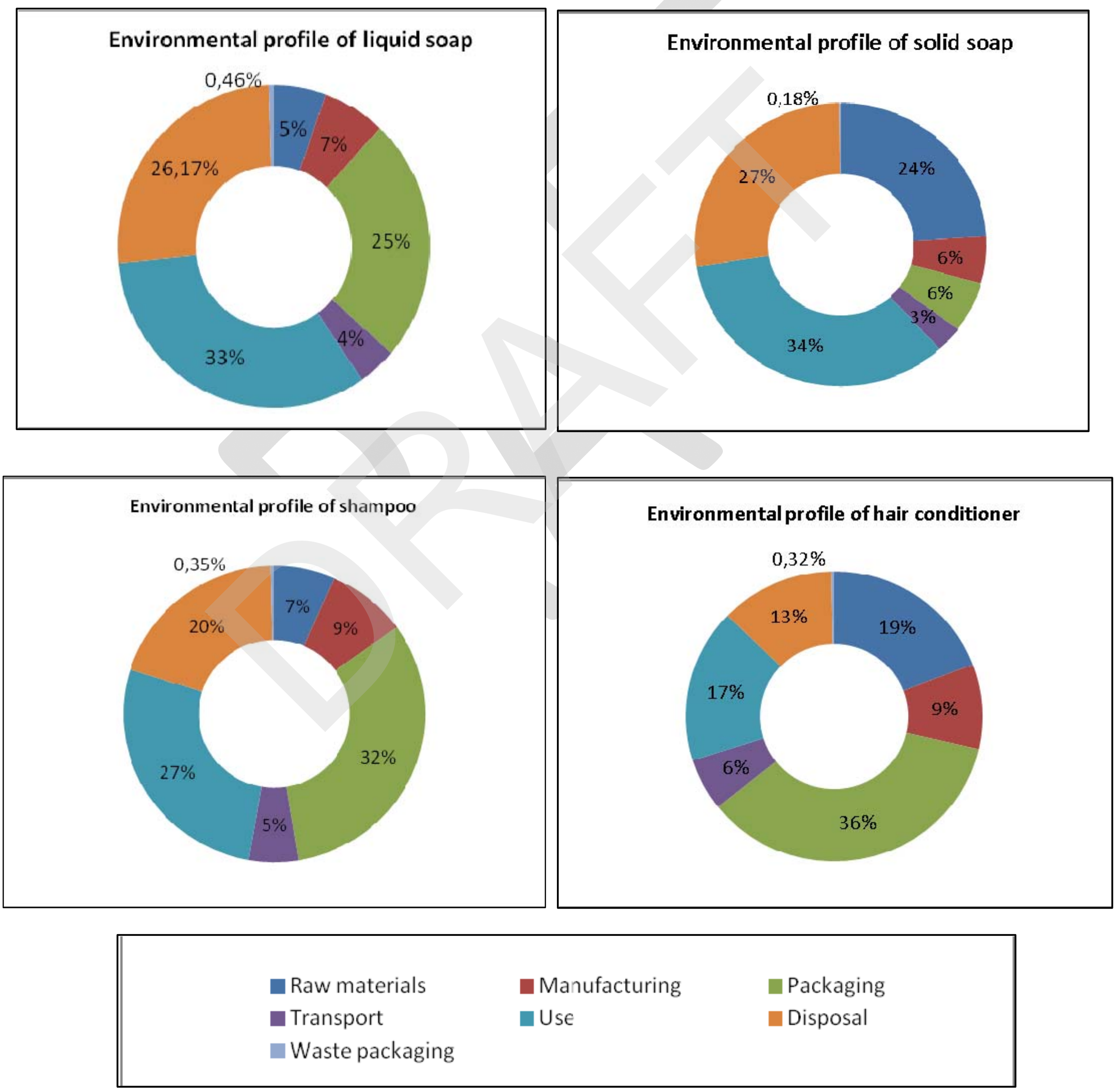
Packaging manufacturing has also a relevant load, especially bottle packages have an important contribution: 25% for liquid soaps, 6% for solid soaps, 32% for shampoos and 36% for hair conditioners. The same packaging is considered for the three ilquid products, so differences in percentage load respect global environmental impact are due to contribution of the rest of stages. It has to be taken into account that the weight considered for packaging is quite high (taken from current limit weight of EU Ecolabel criteria), and average weight of product may be lower. For solid soaps, packaging have less importance because of a minor weight and because the material taken as standard is packaging paper instead of plastic. Detailed analyses of packaging environmental impact are showed in section 10.9.

Raw material extraction life cycle phase has also an impact, of 5% for liquid soaps, 24% for solid soaps, 7% for shampoos and 19% for hair conditioners. The process of extraction of raw materials, manufacturing of ingredients are included in this stages. Impacts are due to energy and resources needed to sinthetize these substances and the potential toxicity impacts that these ingredient may have if they are released to the environment. For solid soaps the impact coming from raw materials is higher than in liquid products because the amount of water is significally lower, moreover the relative contribution of other stages such packaging is lower than the rest of products. For hair conditioners the environmental impact is higher than other liquid products due to substances such as silicones or waxes. Environmental impacts for raw chemicals are further assessed in sections 10.4, 10.5, 10.6, 10.7 and 10.8. Other stages with a minor environmental impact are commented in detail in the following sections.

Release of product to water stage has also relevant load in the general environmental impact of products. In this stage the generation of wastewaster after use and the treatment of this wastewater in a sewage treatment plant of household water have been considered. It is considered that rinse-off products are totally released to wastewater after use, so wastewater would contain all product ingredients. This wastewater is treated so it is considered taht outputs of this stage are purified water and the resulting sludges that go to final disposal. This analysis has been done considering and average process for household wastewater conaining chemicals. Specific analysis of what occur to substances of studied products in wastewater has not been done due to lack of data.

Waste derived from packaging has a minor impact, as it is considered that a part goes to recycling processes, according to current European recycling rates (See inventory section). Impacts from recycling have been included in a system but balanced with environmental benefits occurring due to avoidance of use of virgin materials (LCA processes pre-defined products life cycles allocation rule). Recycling process has then low environmental impact. Most of the impacts coming from this stage are due to the fraction of waste that goes to landfill disposal.

Figure 10. Environmental impact distribution for studied products (unique punctuation)



Contribution of life stages potentially regulated by Ecolabel

In order to see the impacts from stages potentially regulated by Ecolabel the stages of use and distribution have been withdrawn. Relative contribution to environmental product impact for stages potentially regulated by Ecolabel (raw materials, manufacturing, packaging, disposal to water and waste packaging) are represented in Figures below. These impacts are shown distributied for impact categories.

In figures 11, 12, 13 and 14 below it can be seen the contribution of each product stage disclosed in different midpoint impact categories. This representation is done for each kind of product. In tables 63, 64, 65 and 66 numeric values for each category impact and life stage are represented for each kind of product.

Environmental impacts for liquid soaps

Figure 11. Distribution of environmental impact for midpoints impact categories (liquid soap)

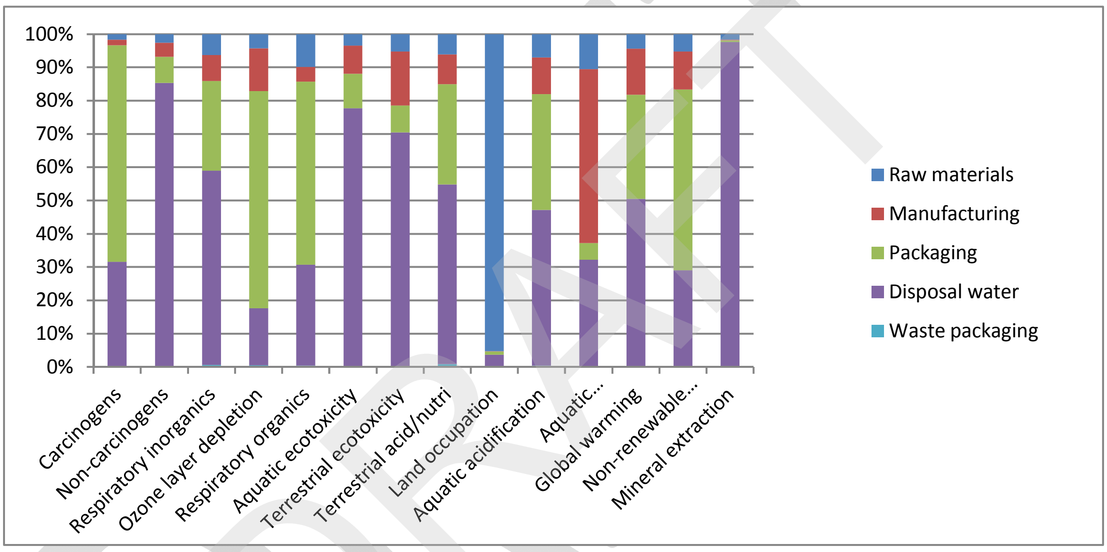


Table 62. Impact category values for liquid soaps

Impact category	Units	Total	Raw materials	Manufacturing	Packaging	Disposal to water	Waste packaging
Carcinogens	kg C_2H_3Cl eq	**0,041908**	0,000613	0,000628	0,023944	0,011623	2,39E-05
Non-carcinogens	kg C_2H_3Cl eq	**0,020813**	0,000322	0,000542	0,000991	0,010764	1,47E-05
Respiratory inorganics	kg PM2.5 eq	**0,000783**	2,9E-05	3,51E-05	0,000123	0,000266	3,97E-06
Ozone layer depletion	kg CFC-$_{11}$ eq	**1,12E-07**	3,68E-09	1,12E-08	5,66E-08	1,49E-08	6,51E-10
Respiratory organics	kg C_2H_4 eq	**0,000512**	4,07E-05	1,81E-05	0,000226	0,000124	2,83E-06
Aquatic ecotoxicity	kg TEG water	**5296,44**	1,727884	4,295198	5,177123	39,06853	0,123174
Terrestrial ecotoxicity	kg TEG soil	**15,4376**	0,494836	1,537403	0,771706	6,645243	0,046731
Terrestrial acid/nutri	kg SO_2 eq	**0,015789**	0,000553	0,000797	0,002703	0,004844	0,000106
Land occupation	m^{2}org.arable	**0,142921**	0,121979	0,000114	0,001165	0,004677	0,000113
Aquatic acidification	kg SO_2 eq	**0,004324**	0,00017	0,000265	0,000838	0,001127	1,61E-05
Aquatic eutrophication	kg PO_4 P-lim	**9,03E-05**	7,81E-06	3,85E-05	3,71E-06	2,36E-05	1,82E-07
Global warming	kg CO2 eq	**1,094416**	0,03122	0,098739	0,222622	0,358561	0,002074
Non-renewable energy	MJ primary	**21,58696**	0,774052	1,660908	7,96485	4,208543	0,060533
Mineral extraction	MJ surplus	**0,059245**	0,0009	9E-05	0,000283	0,052065	1,75E-05

In Figure 11 and Table 63 it can be seen that in all categories, disposal to water has the biggest impact in the majority of impact categories. This stage includes the treatment of wastewater generated after use (water and product used) Packaging have also relevant values in almost all impact categories, especially in carcinogens, ozone layer depletion, respiratory organics and non-renewable use. Raw materials have especial big load in land occupation.

Environmental impacts for solid soaps

Figure 12. Distribution of environmental impact for midpoints impact categories (solid soap)

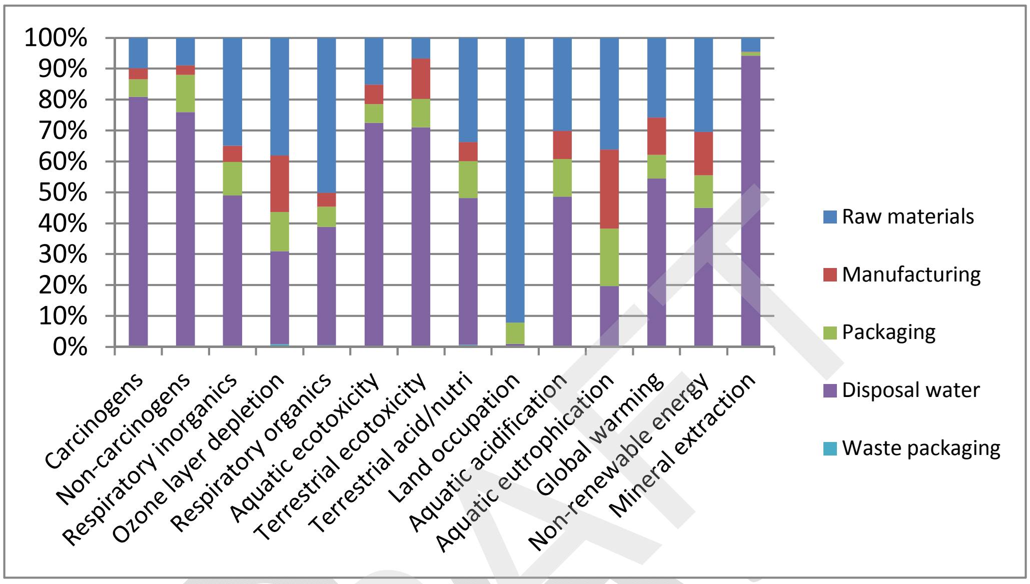


Table 63. Impact category values for solid soaps

Impact category	Units	Total	Raw materials	Manufacturing	Packaging	Disposal to water	Waste packaging
Carcinogens	kg C_2H_3Cl eq	0,009499	0,000698	0,000246	0,000404	0,005698	7,72E-06
Non-carcinogens	kg C_2H_3Cl eq	0,010906	0,000621	0,000213	0,00084	0,005276	4,74E-06
Respiratory inorganics	kg PM2.5 eq	0,000421	9,4E-05	1,38E-05	2,95E-05	0,00013	1,28E-06
Ozone layer depletion	kg CFC_{-11} eq	3,55E-08	9,27E-09	4,41E-09	3,1E-09	7,32E-09	2,1E-10
Respiratory organics	kg C_2H_4 eq	0,000204	7,98E-05	7,09E-06	1,03E-05	6,09E-05	9,14E-07
Aquatic ecotoxicity	kg TEG water	2597,752	3,999156	1,684391	1,613939	19,15124	0,039728
Terrestrial ecotoxicity	kg TEG soil	7,306634	0,307027	0,602903	0,427992	3,257472	0,015072
Terrestrial acid/nutri	kg SO_2 eq	0,008078	0,001684	0,000313	0,000597	0,002375	3,43E-05
Land occupation	m^2org.arable	0,241159	0,215341	4,48E-05	0,016185	0,002292	3,64E-05
Aquatic acidification	kg SO_2 eq	0,002045	0,000345	0,000104	0,000139	0,000553	5,19E-06
Aquatic eutrophication	kg PO_4 P-lim	6,68E-05	2,14E-05	1,51E-05	1,1E-05	1,16E-05	5,86E-08
Global warming	kg CO2 eq	0,505399	0,083801	0,038721	0,024822	0,175765	0,000669
Non-renewable energy	MJ primary	7,929437	1,40647	0,651337	0,485302	2,063011	0,019524
Mineral extraction	MJ surplus	0,029925	0,001232	3,53E-05	0,0003	0,025522	5,65E-06

In Figure 12 and Table 64 it can be seen that for all categories, disposal to water (which include wastewater treatment) have the biggest impact for all categories. Raw materials have also important impacts in all impact categories, especially in land occupation. Packaging and manufacturing have also impacts in almost all categories, but with lower values.

Figure 13. Distribution of environmental impact for midpoints impact categories (hair conditioners)

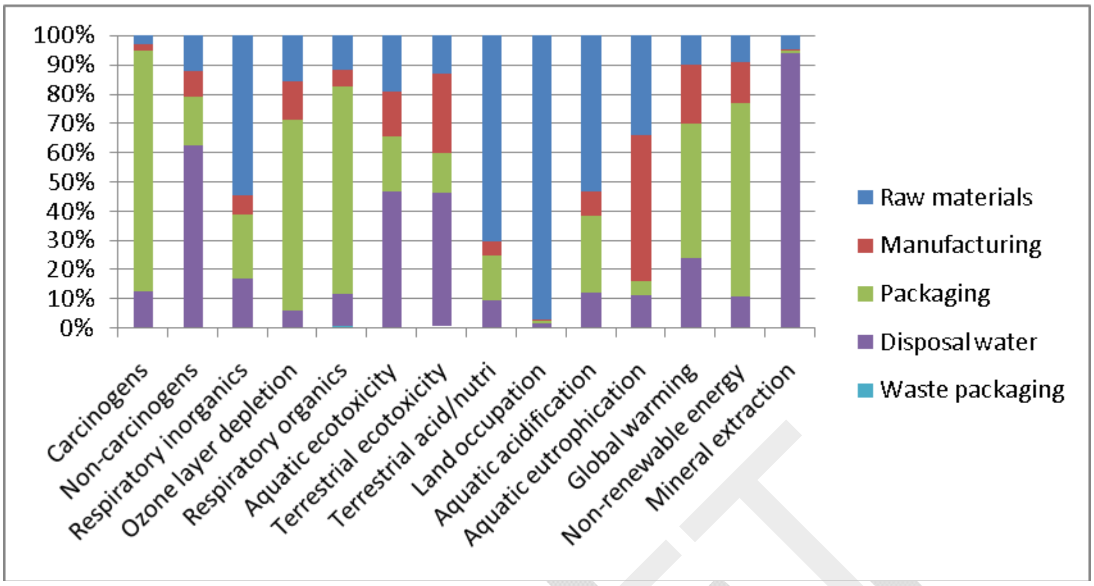


Table 64. Impact category values for hair conditioners

Impact category	Units	Total	Raw materials	Manufacturing	Packaging	Disposal to water	Waste packaging
Carcinogens	kg C2H3Cl eq	0,031161	0,000851	0,000628	0,023944	0,003688	2,39E-05
Non-carcinogens	kg C2H3Cl eq	0,00922	0,000723	0,000542	0,000991	0,003747	1,47E-05
Respiratory inorganics	kg PM2.5 eq	0,000715	0,000306	3,51E-05	0,000123	9,17E-05	3,97E-06
Ozone layer depletion	kg CFC-11 eq	1E-07	1,37E-08	1,12E-08	5,66E-08	4,97E-09	6,51E-10
Respiratory organics	kg C2H4 eq	0,000377	3,79E-05	1,81E-05	0,000226	3,57E-05	2,83E-06
Aquatic ecotoxicity	kg TEG water	1904,184	5,270384	4,295198	5,177123	12,80607	0,123174
Terrestrial ecotoxicity	kg TEG soil	8,798557	0,732227	1,537403	0,771706	2,564378	0,046731
Terrestrial acid/nutri	kg SO2 eq	0,02102	0,012208	0,000797	0,002703	0,001557	0,000106
Land occupation	m2org.arable	0,108546	0,099785	0,000114	0,001165	0,00183	0,000113
Aquatic acidification	kg SO2 eq	0,004059	0,001698	0,000265	0,000838	0,000379	1,61E-05
Aquatic eutrophication	kg PO4 P-lim	8,54E-05	2,64E-05	3,85E-05	3,71E-06	8,54E-06	1,82E-07
Global warming	kg CO2 eq	0,649394	0,048962	0,098739	0,222622	0,115337	0,002074
Non-renewable energy	MJ primary	15,01958	1,126745	1,660908	7,96485	1,292117	0,060533
Mineral extraction	MJ surplus	0,026386	0,001125	9E-05	0,000283	0,022495	1,75E-05

In Figure 13 and Table 65 it can be seen that packaging has important loads in the majority of impact categories. Raw materials have important loads in categories of respiratory inorganics, terrestrial and aquatic acidification and land occupation.

Figure 14. Distribution of environmental impact for midpoints impact categories (shampoo)

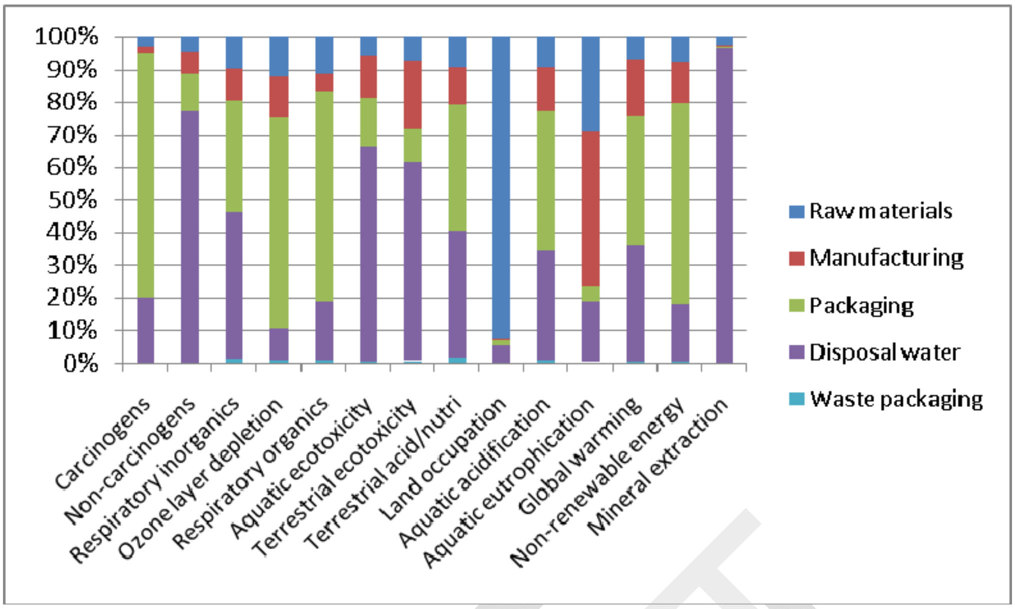


Table 65. Impact category values for shampoos

Impact category	Units	Total	Raw materials	Manufacturing	Packaging	Disposal to water	Waste packaging
Carcinogens	kg C2H3Cl eq	0,035354	0,001011	0,000628	0,023944	0,006446	2,39E-05
Non-carcinogens	kg C2H3Cl eq	0,013788	0,000413	0,000542	0,000991	0,00655	1,47E-05
Respiratory inorganics	kg PM2.5 eq	0,000585	3,51E-05	3,51E-05	0,000123	0,00016	3,97E-06
Ozone layer depletion	kg CFC-11 eq	1,06E-07	1,08E-08	1,12E-08	5,66E-08	8,7E-09	6,51E-10
Respiratory organics	kg C2H4 eq	0,000424	3,99E-05	1,81E-05	0,000226	6,24E-05	2,83E-06
Aquatic ecotoxicity	kg TEG water	3312,605	2,055355	4,295198	5,177123	22,38667	0,123174
Terrestrial ecotoxicity	kg TEG soil	11,68793	0,528722	1,537403	0,771706	4,482865	0,046731
Terrestrial acid/nutri	kg SO2 eq	0,011972	0,000664	0,000797	0,002703	0,002723	0,000106
Land occupation	m2org.arable	0,071681	0,05764	0,000114	0,001165	0,003199	0,000113
Aquatic acidification	kg SO2 eq	0,003271	0,000187	0,000265	0,000838	0,000663	1,61E-05
Aquatic eutrophication	kg PO4 P-lim	9,23E-05	2,34E-05	3,85E-05	3,71E-06	1,49E-05	1,82E-07
Global warming	kg CO2 eq	0,818108	0,039545	0,098739	0,222622	0,201623	0,002074
Non-renewable energy	MJ primary	17,52683	0,986965	1,660908	7,96485	2,258788	0,060533
Mineral extraction	MJ surplus	0,044649	0,001091	9E-05	0,000283	0,039325	1,75E-05

In Figure 14 and Table 66 it can be seen that packaging has big load in the majority of impact categories. Disposal to water has also important impacts in some categories such as mineral occupation, non-carcinogens, and ecotoxicity. It has to be highligted that raw materials have special load in land occupation.

General discussion for all products studied:

Packaging has a high contribution in many impact categories, especially in some categories such as carcinogens, non-renewable energy and respiratory of organics. Therefore, it is important to regulate the constituent materials and substances used as additives in soap packaging. Weight of packaging will also have high importance, as the lower amount of material used the lower will be the impact not only in productin but also in the transportation phase of the product. Sensitivity analyses done with different kinds of plastics do not show big differences in the relative contribution of this stage in the general product profile. Nevertheless, more specific analyses for packaging materials are shown in 10.9

It can be seen that **raw materials** have a high contribution in most of categories, especially in categories related to resources depletion such as mineral extraction and land occupation. Raw materials also take into account the potential environmental impacts that they can cause if they are released to the environment. These data show that it is important to work for more sustainable and less dangerous substances in formulations, including their origin.

Release to water, which includes the sewage water treatment, has also important contribution in most impact categories.

Manufacturing stage is also relevant in some categories, specially related to the energy used as heat and electricity. Although primary data is not available to deeper analyse this stage, results show the need of promoting energy efficiency in production processes.

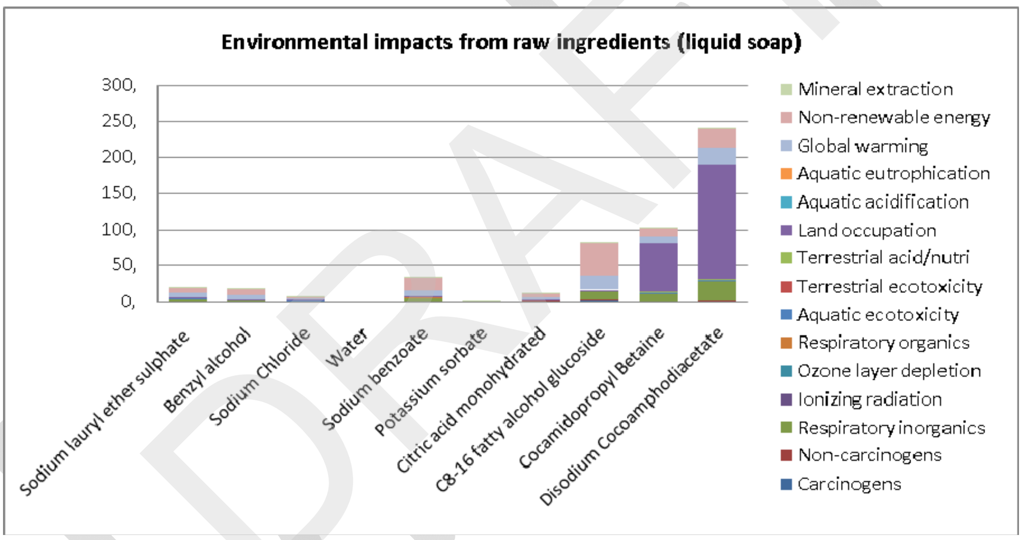
Finally, **waste treatment of packaging** has a low impact. Impacts from recycling have been included in a system but balanced with environmental benefits occurring due to avoidance of use of virgin materials (LCA processes pre-defined products life cycles allocation rule).Impacts of this stage are mainly due to the fraction of waste that is considered to be disposed (70% according to European statistics).

10.4. Impact assessment for liquid soap ingredients

As seen in the previous sector, raw materials have an important environmental load in the majority of categories (average of 5% of total environmental impact) in liquid soap's profile, in the formulation for base case.

In Figure 15 the environmental impact distribution among different ingredients is analysed. It can be seen that in general surfactants and preservatives are posing the biggest impacts. Oils and fatty alcohols coming from vegetable have a high contribution in land occupation and energy consumption. Nevertheless, some impacts related to human toxicity and ecotoxicity were not always quantifiable and underestimation could be expected. Moreover, the availability of substances in LCA databases is quite limited. However, whenever possible, an approximation of impacts of specific substances could be modelled based on the characterisation factors of similar reference substances, inline with the guidelines of ILCD Handbook and common LCA practice (see inventory section).

Figure 15. Environmental impact from raw ingredients (liquid soaps)



The sensitivity of the results related to changes to the ingredients was investigated. A comparative analysis has also been conducted with a modelling of worse case formulation by varying some ingredients (see Table 67), substances which are thought to cause more ecotoxicity and which are available in LCA Databases. The purpose of this was to receive an indication how distanced is the environmental performance between a considered well performing product for which the ecolabel could be awarded compared to a product which could be found in the market and could be perceived to be rather bad performing. It should be emphasized that the modelled worse cases were drafted with the aim of the above mentioned camparison. An identification of the real, existing at the market worse performing products and their composition needs a more detailed analysis, which was not within the scope of the project and therefore the modelled worse cases should be handled in the above described context. This is also valid for the similar section for each kind of product investigated (solid soap, shampoo and hair conditioner, as described later).

Table 66. Ingredients for base case and worst case comparison (liquid soap)

Function	Ingredients for base case	Ingredients for worst case	Percentage (%)	Amount (g) in 255 g of product
Water	Water	Water	84 %	215.1
Surfactants	Sodium lauryl ether sulfate with 2 mole EO	Sodium lauryl ether sulfate with 2 mole EO	6.87 %	17.53
	Disodium Cocoamphodiacetate	Disodium Cocoamphodiacetate	2.55 %	6.503
	Sodium Chloride	Sodium Chloride	0.55 %	1.403
	Cocamidopropyl Betaine	Cocamidopropyl Betaine	1.05 %	2.678
	C8-16 fatty alcohol glucoside	C8-16 fatty alcohol glucoside	1.20 %	3.060
Emollients	Polyol coconut fatty acid ester	Polyol coconut fatty acid ester	0.50 %	1.275
pH adjustment	Citric acid monohydrated	Citric acid monohydrated	0.50 %	1.275
Preservatives	Benzyl alcohol	Benzyl alcohol	0.20 %	0.510
	Sodium benzoate	Sodium benzoate	0.19 %	0.501
	Potassium sorbate	Potassium sorbate	0.03 %	0.085
Inorganic salt	Sodium Chloride	Sodium Chloride	2 %	5.100

In Figure 16 is can be seen that for the formulation of worst case scenario has higher values for almost all impact categories than in the base case formulation.
With the exception of the environmental impact of land occupation the performances of the base case products increases by 10 to 20%. Land occupation impacts have no difference as the source of raw materials is the same (the incredients which were modelled are not directly linked via the supply chain to biobased sources).

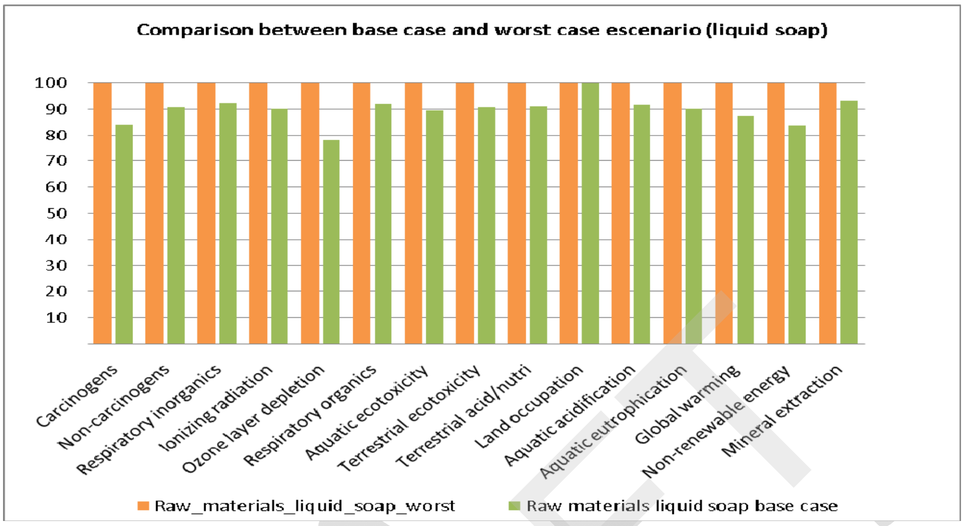
This difference in the light of the EU Ecolabel criteria and its ambition level could be interpreted in two ways.

1) The requirements set in substances are quite strict and the potential of achieving environmental savings is not outstanding - as the difference is 10-20% in this case. On the contrary, in the case of solid soaps the differences were found to be much higher up to 50%. Based on this it can be argued that the requirements on substances are strict enough and proposing stricter requirements would not necessarily lead to significant environmental savings.

2) Another interpretation of the results is that the differences are not outstanding because the focus and the related restrictions in the criteria do not address the ingredients which have a high environmental impact. Therefore, the scope of criteria related to ingredients should be further discussed and may be redefined in order to achieve higher environmental savings. This could lead to argue on making the criteria requirements stricter.

Comments from stakeholders on the above described points, which are also relevant for other products kinds covered by the product group under study and their respective outcomes of the sensitivity analyses, are welcome.

Figure 16. Comparison between environmental impact of base case and worst case formulations (liquid soap)

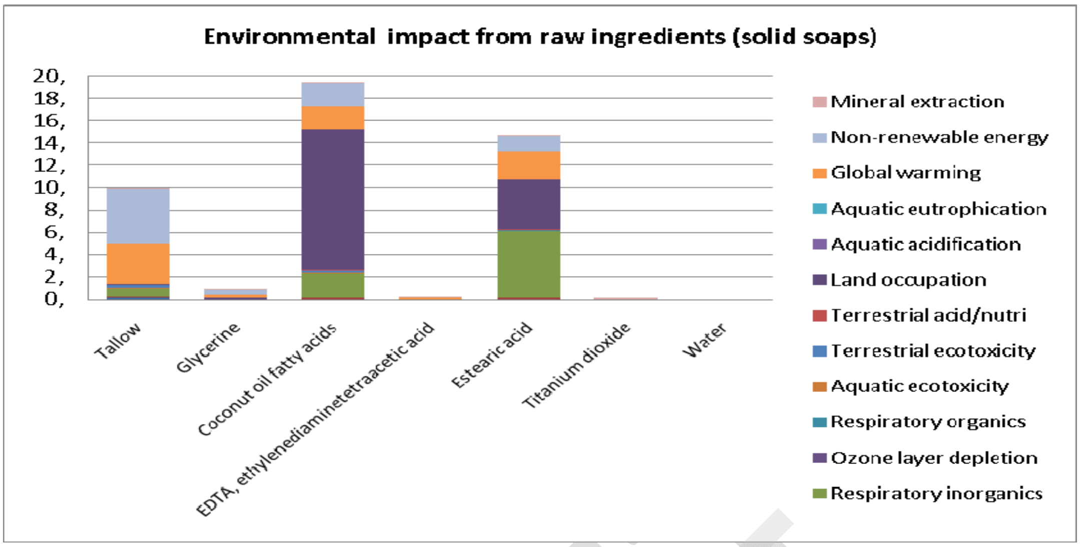


10.5. Impact assessment for solid soap ingredients

For solid soaps, raw chemicals used as ingredients have a relative impact of 24%. If impacts coming from each ingredient are analysed, it can be seen in Figure 17 that major impacts are coming from the ingredients with a higher percentage in the formulation, namely saponified oils. Glycerine has also relevant impact, followed by EDTA and Titanium dioxide which are used in lower concentrations. For all substances, land occupation, global warming and non-renewable energy are the impact categories with higher values.

For solid soaps, perfumes and colorants have been not included due to lack of data.

Figure 17. Environmental impact from raw ingredients (solid soaps)



A comparative analysis has been done with a worst case formulation by some ingredients (see Table 68), adding the substances which are thought to cause more ecotoxicity and which are available in LCADatabases.

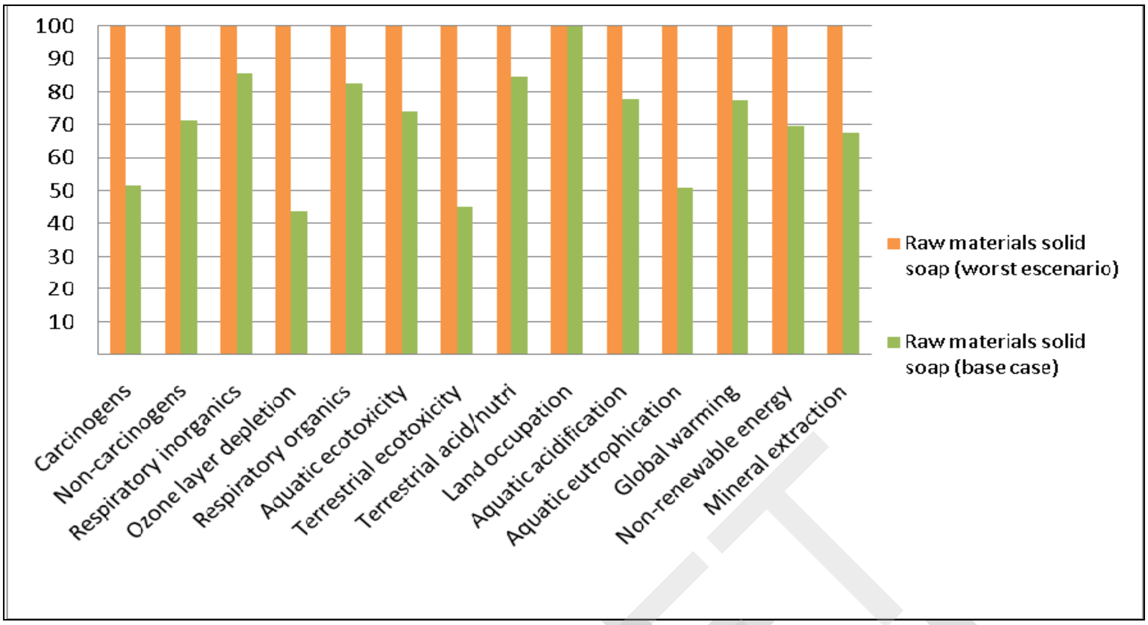
Table 67. Ingredients for base case and worst case comparison (solid soap)

Function	Ingredients for base case	Ingredients for worst case	Percentage (%)	Amount (g) in 100 g of product
Saponified oils (92%)	Tallow	Tallow		57
	Coconut oil fatty acids	Coconut oil fatty acids	92%	14
	Stearic acid	Stearic acid		14
Emulsifying / humectant	Glycerine	Propylene glycol	6%	5.52
Perfuming	Perfume	Benzyl alcohol	1%	1.38
Colorant	Colorants	Colorants	0,1%	0.092
Chelating agent	EDTA	EDTA	0,2%	0.184
Bleaching agent	Titanium dioxide	Titanium dioxide	0,1%	0.092
Water	Water	Water	8%	8

From results showed in Figure 18 it can be seen that worst scenario formulation poses a greatest impact in all categories (except in land occupation, as the use of land do not vary with the undertaken change of the ingredients content). In general, the environmental impact is significantly higher for worst scenario than for the base case (ranging from 20 to 55%).

This is very different for the first case of the liquid soap described above. The same discussion point as presented for this case should be considered (see section 10.4). The improvement savings as modelled in this investigation are considered to significant.

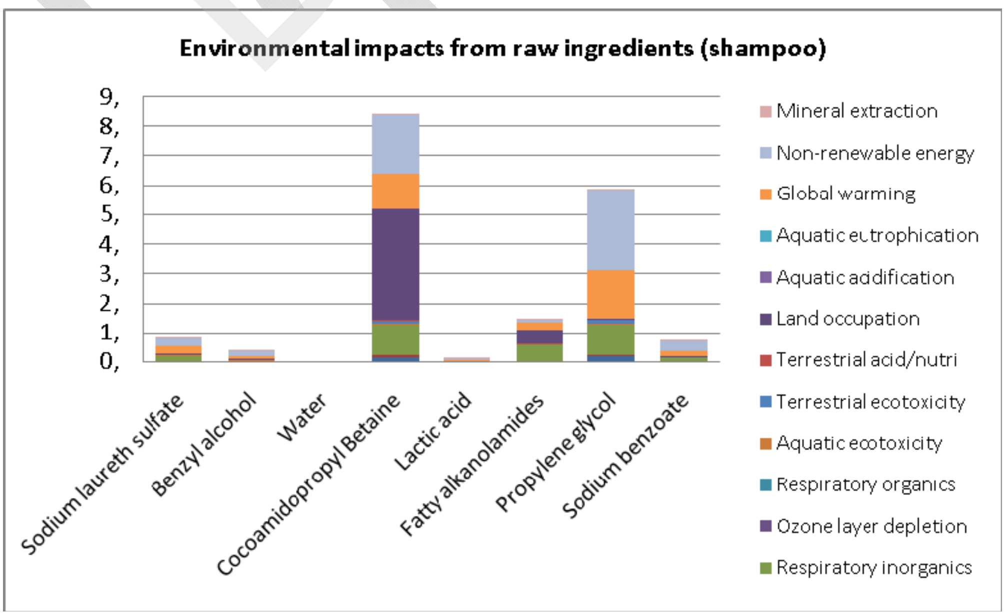
Figure 18. Comparison between environmental impact of base case and worst case formulations (solid soap)



10.6. Impact Assessment for shampoo ingredients

In Figure 19 it is represented envioronemntal impact (all impact categories aggregated) distribution among ingredients. Ingredients with a major environmental load are surfactants such as cocoamidopropyl betaine and fatty alkanolamides, and also the controlling viscosity agent (in this case propylene glycol) and finally sodium benzoate and sodium laureth sulphate. For all substances, global warming, non-renewable energy and land occupation are the impact categories with higher values. Respiratory inorganics have also relevant contribution of environmental impact for most substances.

Figure 19. Environmental impact from raw ingredients (shampoo)



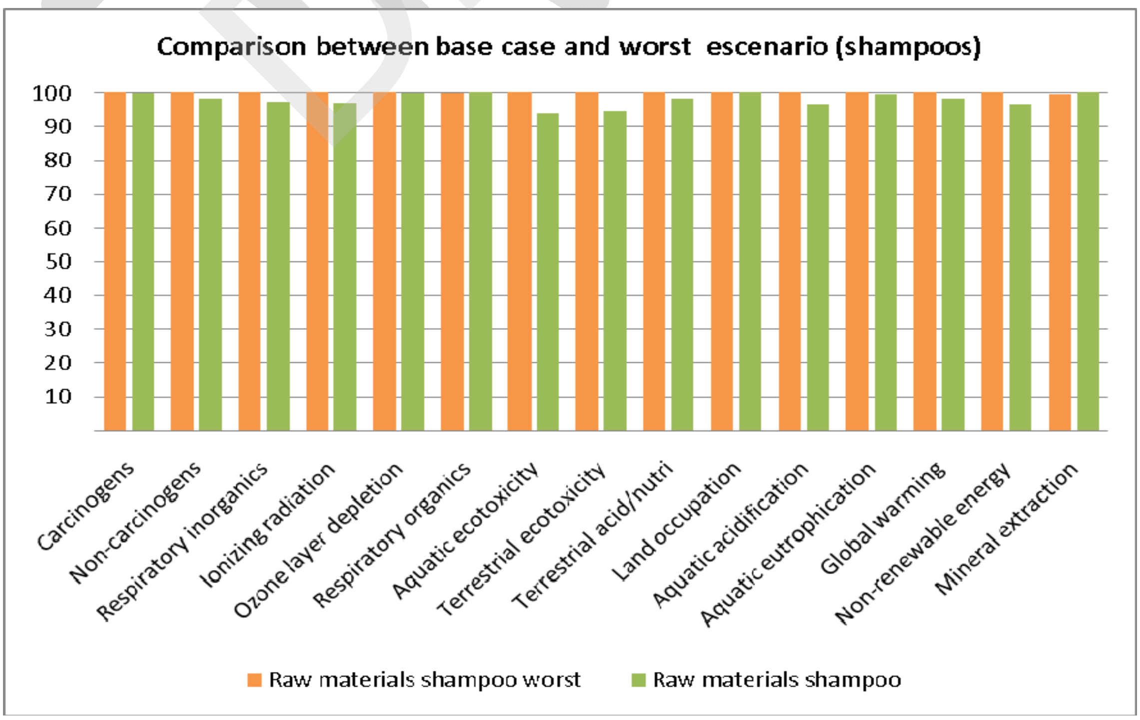
A comparative analysis has been done with a worst case formulation by changing preservatives (see Table 69), as they are the substances which are thought to cause more ecotoxicity and there are some substances available in Databases. In Figure 20 it can be seen how environmental impact increases in all categories, but in little percentage.

This is very different for the case of solid soap and liquid soap. The same discussion point as presented for the case of liquid soap should be considered (see section 10.4). The improvement savings as modelled in this investigation are considered to be very low.

Table 68. Ingredients for base case and worst case comparison (shampoo)

Function	Ingredients for base case	Ingredients for wost case	Percentage (%)	Amount (g) in 255 g of product
Anionic surfactants	Sodium laureth sulfate	Sodium laureth sulfate	7 %	17.85
Amphoteric surfactant	Cocoamidopropyl Betaine	Cocoamidopropyl Betaine	2.5 %	6.375
Non ionic surfactants	Fatty alkanolamides	Fatty alkanolamides	0.5 %	1.275
Viscosity controlling agents	Propylene glycol	Propylene glycol	1.5 %	3.825
Preservatives	Sodium benzoate Benzyl alcohol	Parabens (Benzoic compounds)	0.1 % 0.1 %	0.127 0.127
PH adjustment	Lactic acid	Lactic acid	0.08 %	0.204
Water	Water	Water	11.78 %	225.22

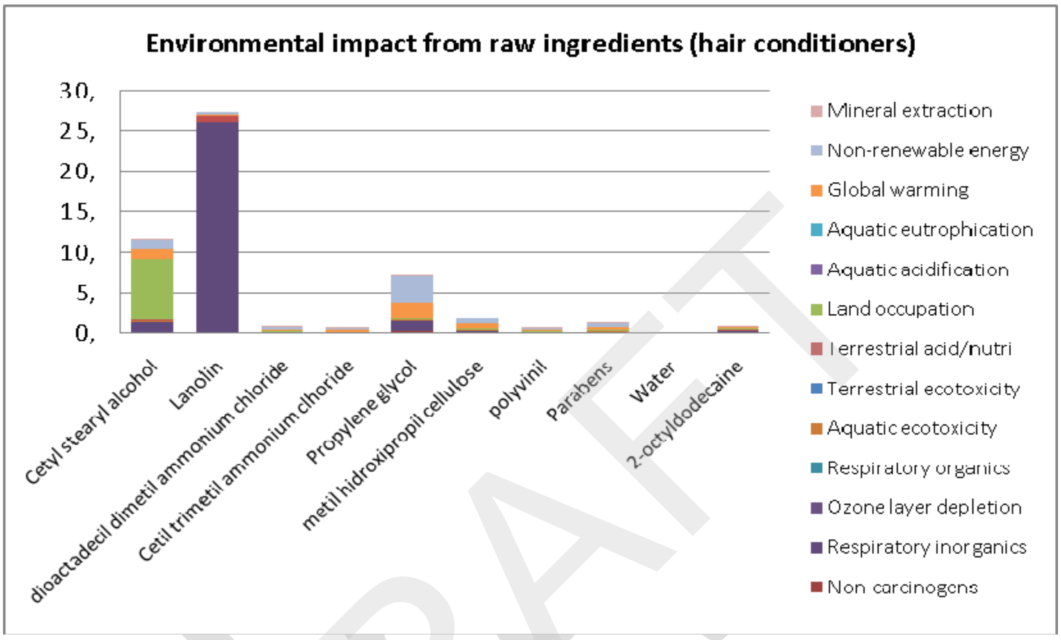
Figure 20. Comparison between environmental impact of base case and worst case formulations (shampoo)



10.7. Impact Assessment for hair conditioners ingredients

In this analysis, perfume and proteins have not been included due to lack of data. According to the analysis done, oils silicones and waxes have the major impacts, in this case lanolin (due to respiratory inorganics) and cetyl stearyl alcohol (due to land occupation).

Figure 21. Environmental impact from raw ingredients (hair conditioners)



A comparative analysis has been done with a worst case formulation by some ingredients (see Table 70), adding the substances which are thought to cause more ecotoxicity and available in Databases.

Table 69. Ingredients for base case and worst case comparison (hair conditioners)

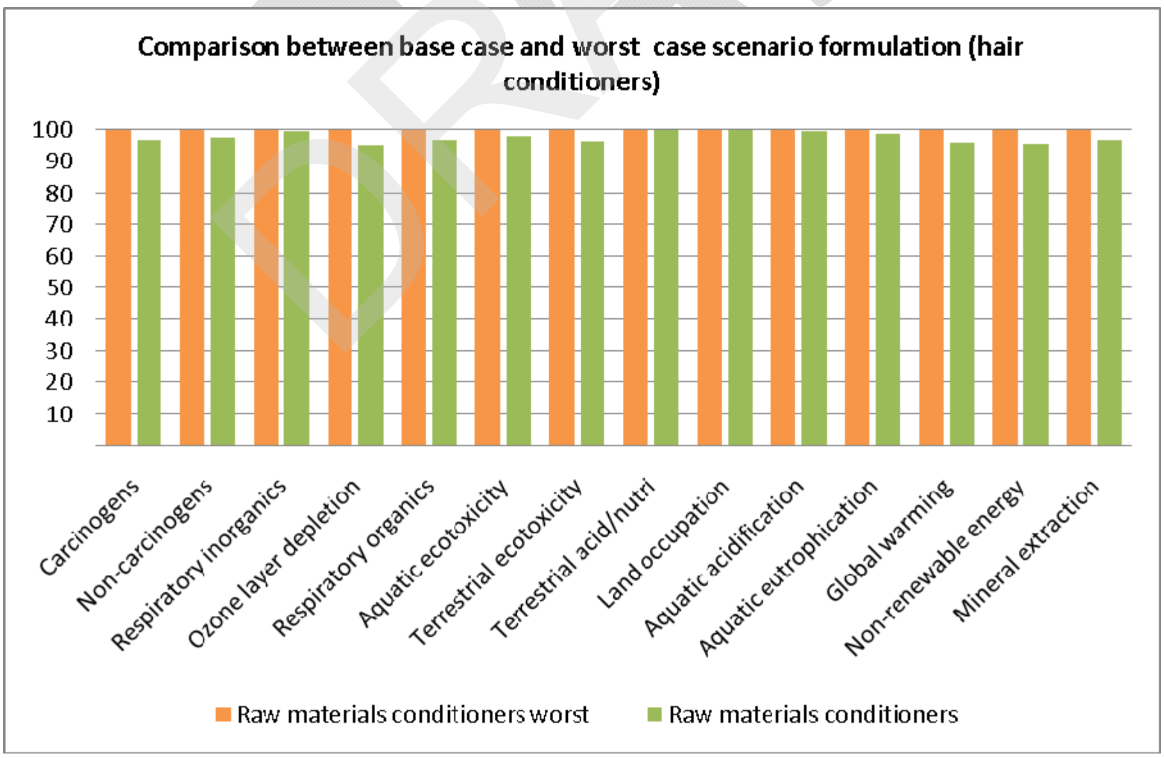
Function	Ingredients for base case	Ingredients for wost case	Percentage	Amount (g) in 255 g of product
Oils, waxes, silicones	Cetyl stearyl alcohol	Cetyl stearyl alcohol	3.3 %	8.42
	2-octyldocecaine	2-octyldocecaine	0.3 %	0.77
	Lanoline	Lanoline	0.3 %	0.77
Proteins	Provit B5	Provit B5	0.4 %	1.02
	Nutrilan keratine	Nutrilan keratine	0.02 %	0.05
Cationic surfactants	Dioactadecyl dimethyl ammonium chloride	Dioactadecyl dimethyl ammonium chloride	1 %	2.55

	Cetyl trimethyl ammonium chloride	Cetyl trimethyl ammonium chloride	0.8 %	2.04
Emollient, humectants	Propylene glycol	Propylene glycol	2 %	5.10
Viscosity controlling agents	Methyl hydroxypropyl cellulose	Methyl hydroxypropyl cellulose	0.6 %	1.53
Polymers, resins	Polyvinyl	Polyvinyl	0.062 %	0.16
Perfume	-	-	0.2 %	0.51
Preservatives	Parabens	Parabens	0.2 %	0.51
Water	Water	Water	90.818 %	231.59

In figure 22 it can be seen that environmental impact for the worst case scenario is quite similar to base case, which already contains problematic preservatives, silicones and other substances.

This is very different for the case of solid soap and liquid soap, but similar to the case of shampoos. The same discussion point as presented for the case of liquid soap should be considered (see section 10.4). The improvement savings as modelled in this investigation are considered to be very low and action addressing the use of lanoline (see Figure 21) seems to be more relevant.

Figure 22. Comparison between environmental impact of base case and worst case formulations (hair conditioners)



10.8. Comparative analysis of ingredients

Comparative environmental assessments have been done for functional groups of ingredients present in soaps, shampoos and hair conditioners products. The aim of this analysis is to compare ecotoxicity of different substances which fulfil the same function.

This analysis complements the investigations undertaken within the LCA especially regarding potential underestrimated impacts in the category of ecotoxicity.

For this analysis it has been used the Database USEtox, which has characterization factor for 3128 substances. USEtox is a model approved from the UNEP-SETAC[93].

The group of ingredients of preservatives and perfuming have been assessed with USEtox method. Other functional groups such as surfactants or solvents have been not analysed due to the lack of Ecotoxicity data of the most used substances.

Preservatives

Preservatives are included in cosmetic formulations to ensure that products are safe to use for a long time. They protect cosmetics from contamination by micro-organisms present in the air, in water and on our own skin.

The ten most used substances as preservatives, and those which are proposed to be limited for its human toxicity (fomaldehyde, formaldehyde releasers and parabens) or its ecotoxicity (triclosan) have been compared in terms of USEtox ecotoxicity characterisation factor (see table 71).

Table 70. Ecotoxicity factors for preservatives substances

	VARIANTS	CAS Number	Ecotoxity characterisation factor USETOX Freshwater ecotoxicity effect factor [PAF m3.kg-1_emitted]*
Preservatives proposed to limit	Triclosan	3380-34-5	2,74E+03
	Formaldehyde	50-00-0	1,62E+01
	Bronopol (2-Bromo-2-Nitropropane-1,3-Diol)	52-51-7	1,33E+02
	5-bromo-5-nitro-1,3-dioxane	30007-47-7	n.a.
	sodium hydroxyl methyl glycinate	70161-44-3	n.a.
	DMDM Hydantoin	6440-58-0	n.a.
	Diazolidinyl Urea	78491-02-8	n.a.
	Imidazolidinyl Urea	39236-46-9	n.a.
	Methylparaben	99-76-3	n/a
	ethylparaben	120-47-8	n.a.

[93] USEtox – the UNEP-SETAC toxicity model: recommended characterisation factors for human toxicity and freshwater ecotoxicity in life cycle impact assessment. Rosenbaum, R.K. et al. Int J Life Cycle Asess (2008) 13:532-546

	butylparaben	94-26-8	n/a
	Propylparaben	94-13-3	n.a.
Most widely used preservatives in liquid soaps	Sodium Benzoate	532-32-1	7,74E+00
	Phenoxyethanol	122-99-6	2,94E+00
	Methylparaben	99-76-3	n/a
	Methylisothiazolinone	2682-20-4	9,75E+03
	Methylchloroisothiazolinone	26172-55-4	1,39E+03
	Propylparaben	94-13-3	n.a.
	Potassium Sorbate	24634-61-5	n.a.
	Benzyl Alcohol	100-51-6	1,09E+01
	DMDM Hydantoin	6440-58-0	n.a.
	Ethylparaben	120-47-8	n.a.
Most widely used preservatives in Shampoos	Sodium Benzoate	532-32-1	7,74E+00
	Methylisothiazolinone	2682-20-4	9,75E+03
	Methylchloroisothia-zolinone	26172-55-4	1,39E+03
	DMDM Hydantoin	6440-58-0	n.a.
	Methylparaben	99-76-3	n/a
	Phenoxyethanol	122-99-6	2,94E+00
	Benzyl Alcohol	100-51-6	1,09E+01
	Proylparaben	94-13-3	n.a.
	Ethylparaben	120-47-8	n.a.
	Salicylic Acid	69-72-7	8,49E+00
Most widely used preservatives in HAIR CONDITIONER	Cetrimonium Chloride	112-02-7	1,81E+03
	Phenoxyethanol	122-99-6	2,94E+00
	Methylparaben	99-76-3	n/a
	Behentrimonium Chloride	17301-53-0	n.a.
	Benzyl Alcohol	100-51-6	1,09E+01
	Methylisothiazolinone	2682-20-4	9,75E+03
	Methylchloroisothiazolinone	26172-55-4	1,39E+03
	Propylparaben	94-13-3	n.a.
	Sodium Benzoate	532-32-1	7,74E+00
	Potassium Sorbate	24634-61-5	n.a.

* Potentially Affected Fraction of species (PAF), n.a = substance non available, n/a= ecotoxicity factor not available

From table 71 it can be said that Triclosan has the highest value for ecotoxicity comparing to most other preservatives. Two preservatives which are widely used in all liquid products and which have hight ecotoxicity are: Methylisothiazolinone (9,75E+03 PAF $m^3.kg^{-1}$ emitted) and Methylchloroisothiazolinone (1,39E+03 PAF $m^3.kg^{-1}$ emitted)

Surfactants

Surfactants are a large group of surface active substances with a great number of (cleaning) applications. Most surfactants have degreasing or wash active abilities. They reduce the surface tension of the water so it can wet the fibres and surfaces, they loosen and encapsulate the dirt and in that way ensure that the soiling will not re-deposit on the surfaces.

Due to their surface active nature surfactants have toxic effects on some (aquatic) organisms. Most surfactants are more or less toxic to aquatic organisms due to their surface activity which will react with the biological membranes of the organisms. The biological degradability varies according to the nature of the carbohydrate chain. Generally the linear chains are more readily degradable than branched chains. Also the toxic effects vary with the chain structure. Generally an increase of the chain length in the range of 10 to 16, leads to an increase in toxicity to aquatic organisms.

Related to substances origin, comparisons between synthetic and petrochemical surfactants have been reported in a commissioned by industry (e.g. or Procter&Gamble) investigation. In this study[94] it is argued that there are reasons for not shifting towards general substitution of petrochemical by oleochemical substances. The conclusions of this study are presented below:

- The wide range in consumer needs (wash conditions) would be more difficult to meet with oleochemical surfactants alone.
- Data from biodegradation, removal by sewage treatment, toxicity and LCA studies support that petrochemical and oleochemical surfactants are of comparable environmental quality.
- Replacement of petrochemical by oleochemical surfactants would not lead to any significant reductions in water or air emissions, nor would it reduce energy consumption across the life-cycle of the surfactants.
- Colder wash temperatures will result in energy savings during the consumer use phase of the surfactant life-cycle. This will have positive consequences for the environment: reduced air emissions, conservation of petroleum stocks, reduced waste.

A further investigation is necessary to evaluate these conclusions. The project team did not focus on this issue so far but can be investigate if considered necessary in a later phase.

Perfuming

Fragrance is a very important element of cosmetics. It contributes to overall self-esteem, making it more pleasurable to use and enjoy products. Ingredients derived from nature — rose, jasmine and lavender, for example — and synthetic substances provide the wide range of fragrances offered in cosmetics products.

All products that contain fragrances have the word “perfume” listed among the ingredients. In addition, any ingredient considered more likely to cause a reaction in a susceptible person must be declared as a separate ingredient. This labelling method, introduced in 2005, helps consumers with a diagnosed allergy to make informed choices and supports dermatologists working to identify the source of a patient’s reaction[95].

Perfuming substances available on LCA Databases are quite limited. Moreover, allergic and sensitizing effects of substances are not assessed in LCA Human toxicity categories. In order to compare the ecotoxicity effects of these substances, the 10 most commonly used substances in studied products have been analysed with USEtox method. From the substances analysed, only few of them have Eoctoxicity factor available USEtox database (See Table 72).

[94] Procter & Gamble (http://www.scienceinthebox.com/en_UK/programs/natural_synthetic_en.html)
[95] COLIPA (http://www.colipa.eu/)

Table 71.Ecotoxicity factors for perfuming substances

	VARIANTS (Function perfuming)	Number of products containing this variant	CAS number	Ecotoxity characterisation factor USETOX
LIQUID SOAPS	Linalool	4758	78-70-6	2,45E+01
	Limonene	4508	5989-27-5	6,90E+01
	Butylphenyl Methylpropional	2847	80-54-6	n.a.
	Hexyl Cinnamal	2756	101-86-0	n.a.
	Propylparaben	2105	94-13-3	n.a.
	Glyceryl Oleate	2020	111-03-5	n.a.
	Citronellol	1803	106-22-9	n.a.
	Benzyl Alcohol	1612	100-51-6	1,09E+01
	Benzyl Salicylate	1515	118-58-1 Y	n.a.
	Geraniol	1386	106-24-1	n.a.
SOLID SOAPS	Glycerin	1.543	56-81-5	n.a.
	Linalool	625	78-70-6	n.a.
	Limonene	535	5989-27-5	n.a.
	Hexyl Cinnamal	432	101-86-0	n.a.
	Butylphenyl Methylpropional	412	80-54-6	n.a.
	Citronellol	390	106-22-9	n.a.
	Geraniol	283	106-24-1	2,71E+02
	Benzyl Salicylate	271	118-58-1	n.a.
	Coumarin	254	91-64-5	n.a.
	Alpha-isomethyl Ionone	235	127-51-5	n.a.
SHAMPOOS	Linalool	3.374	78-70-6	n.a.
	L-limonene	2.818	5989-27-5	n.a.
	Glycerin	2.801	56-81-5	1,86E-02
	Hexyl Cinnamal	2.609	101-86-0	n.a.
	Butylphenyl Methylpropional	2.484	80-54-6	n.a.
	Benzyl Alcohol	1.659	100-51-6	1,09E+01
	Benzyl Salicylate	1.474	118-58-1 Y	n.a.
	Citronellol	1.434	106-22-9	n.a.
	Propylparaben	1.382	94-13-3	n.a.
	Glyceryl Oleate	922	111-03-5	n.a.
HAIR CONDITIONERS	Linalool	3.374	78-70-6	2,45E+01
	L-limonene	2.818	5989-27-5	6,90E+01
	Glycerin	2.801	56-81-5	1,86E-02
	Hexyl Cinnamal	2.609	101-86-0	n.a.
	Butylphenyl Methylpropional	2.484	80-54-6	n.a.
	Benzyl Alcohol	1.659	100-51-6	1,09E+01
	Benzyl Salicylate	1.474	118-58-1 Y	n.a.
	Citronellol	1.434	106-22-9	n.a.
	Propylparaben	1.382	94-13-3	n.a.
	Glyceryl Oleate	922	111-03-5	n.a.

* Potentially Affected Fraction of species (PAF), n.a = substance non available, n/a= ecotoxicity factor not available

In Table 72 it can be seen Eocotoxicity factor of perfuming substances. Substances highlighted in red have high ecotoxicity factors, substances highlighted in yellow have medium ecotocicity values whereas substances highlighted in green have lower values. In table it can be seen that the perfuming substance with the highest ecotoxicity value is Geraniol (2,71E+02 PAF m3.kg-1 emitted), which is one of the perfuming substances proposed to be restricted due to its sensitizing characteristics.

10.9. Environmental impact assessment of packaging

Packaging has a relevant contribution to the general environmental impact of soaps, shampoos and hair conditioners, since an average of the 27% of products' impact comes from packaging and waste packaging (according to Life cycle assessment carried out in the report, see section 10). This indicates that efforts have to be done in order to regulate this parameter in EU Ecolabel criteria.

In the first part of this section more detailed information gathered from available literature is presented. In the conducted LCA the focus was on the life cycle of the particular products hence impacts related to selecting different materials are addressed in a lower detail level.

A simplified LCA analysis has been performed by Leitat comparing different packaging materials as well as other packaging elements such as labelling. A comparative LCA of different packaging materials would principally need a separate LCA study only on packaging which goes beyond the scope of the criteria revision. Nonetheless, the following review allows us to obtain better insight related to packaging.

Packaging has to be assessed in a life cycle approach, not only in terms of material origin or w eight. Criteria such as raw materials origin, consumption of resources during manufacturing material, refilling systems or recyclability have to be taken into account. As only small difference exists on soaps, shampoos and hair conditioners packaging, this stage has been assessed commonly. Only solid soaps present relevant differences which have been treated separately.

The study "Life Cycle Assessment of PVC and of principal competing materials[96] analysed different studies done for packaging materials and concluded that results of packaging LCA studies were dependent upon the intended function of the packaging (e.g. protective or decorative), the take-back or disposal system available for the packaging and the content to be packaged.

According to the report "Life Cycle Assessment of PVC and of principal competing materials[97] plastic as packaging material for non-reusable applications is favourable to other materials such as glass, but there is no consensus in defining which plastic is preferable. Each material has individual strengths and weaknesses. There is consensus throughout the studies that for single-use applications glass is the worst material.

Some conclusions related to the advantages and disadventages of different packaging materials, as presented in the study of Unilever[98] based on WRAP data, follows in Table 73 in order to obtain a general overview.

[96] Life Cycle Assessment of PVC and of principal competing materials. PE Europe GmbH, Institut für Kunststoffkunde und Kunststoffprüfung (IKP), Instituttet for Produktudvikling (IPU), DTU, RANDA GROUP. Commissioned by the European Commission, July 2004.

[97] Life Cycle Assessment of PVC and of principal competing materials. PE Europe GmbH, Institut für Kunststoffkunde und Kunststoffprüfung (IKP), Instituttet for Produktudvikling (IPU), DTU, RANDA GROUP. Commissioned by the European Commission, July 2004.

[98] Sustainable Packaging?" by Unilever (http://www.unilever.com/images/sd_Sustainable%20Packaging%20(2009)_tcm13-212667.pdf)

Table 72. Environmental comparison among different packaging materials

Material	Advantages	Drawbacks
Glass	• Strong • Suitable for reuse and recycling • Can use high recycled content	• Heavier than other materials, which causes higher impacts in transportation • Energy intensive to make
Paper and board	• Easy to recycle • Uses naturally occurring, renewable materials • Lightweigh	• Cannot be recycled indefinitely • Produces methane if sent to landfill • Only a third of paper comes from sustainably managed forest • Poor moisture resistance
Metal	• Suitable for recycling • Uses high recycled content • High strength to weigh ratio	• Energy intensive to mine raw materials and to manufacture • Steel corrodes • Lack of standardised recycling procedures for aerosols • Aerosols can only be made of virgin materials for safety reasons
Conventional plastics	• Suitable for recycling • Can use high recycled content • Lightweight and strong	• Made from oil, a non renewable resource • Requires sorting in the waste stream due to wide variety plastic used • No unified global standard for recycling • Often burnt on open fires damaging health and environment damage if it contents chlorine
Degradable plastics	• Decomposes back to natural elements • Lightweight and strong	• Makes poor fertilizer when composted • Can contaminate recycling stream as easily confused with conventional plastics • May use metal compound which could contaminate the contents or damage environment
Biopolymers	• Uses naturally occurring, renewable raw material • Can reduce fossil fuel use	• Could compete with food for use of crops, raisin prices • Inefficient use of biomass • Produces methane if sent to landfill • Can be confused with conventional plastics potentially contaminating that recycling stream if not compatible • Poor barrier properties compared with traditional plastics • Large amounts of water needed to grow biomass

Source: Document "Sustainable Packaging?" by Unilever[99]. Original source of data is WRAP*(Waste & Resources Action Programme, United Kingdom)*

<u>Materials used for soaps, shampoos and hair conditioners packaging</u>

Information of different kinds of packaging materials used for soap products category have been gathered in order to determine the most problematic aspects of each material. For liquid soaps, shampoos and hair conditioners products, packaging is made usually of different kind of plastics.

[99] Sustainable Packaging?" by Unilever (http://www.unilever.com/images/sd_Sustainable%20Packaging%20(2009)_tcm13-212667.pdf)

Therefore, a preliminary comparative assessment of different materials: PVC, PET, PE and PP and biopolymer is presented. For solid soaps, flexible plastic and packaging paper and cardboard are used as packaging materials.

In Table 74 it can be observed the most widely used materials for packaging of studied products. For liquid soaps, shampoos and hair conditioners bottles are normally made of PE plastic (34.74%), followed by PET plastic (25.38%) and PP plastic (14.67%). Other polymers like PVC are less used. It can be said that for some products, generic plastic is indicated as the material where the kind of plastic use is not available in Database. For solid soaps, packaging made of different types of cardboards and paper represent 59% of products.

Table 73. Materials used for packaging of studied products.

Liquid soaps, shampoos and conditioners packaging

Material	Percentage
PE plastic	34.74%
PET plastic	25.38%
PP plastic	14.67%
PVC plastic	1.18%
HDPE plastic	4.04%
Plastic (generic)	17.20%
Others materials	2.79%

Solid soaps packaging

Material	Percentage
Plastic (non specified)	31%
Cardboard with white coating	23%
Plain paper	14%
Laminated paper	10%
PP plastic	8%
Solid white cardboard	8%
PE	2%
Unlined Cardboard	2%
Laminated cardboard	1%
Cardboard coated with brown kraft	1%

Source. Mintel GNPD Databases (liquid soaps, solid soaps, shampoos and hair conditioners, 2011)

The plastic materials used for packaging of the soaps, shampoos and hair conditioners are described briefly below.

Polyvinyl chloride (PVC)

Polyvinyl chloride (PVC) is a synthetic polymer material (or resin), which is built up by the repetitive addition of the monomer vinyl chloride (VCM). The chlorine in PVC represents 57% of the weight of the pure polymer resin and 35% of chlorine ends up in PVC, which thus constitutes the largest single use.

PVC has been at the centre of a controversial debate during much of the last two decades. A number of diverging scientific, technical and economic opinions have been expressed on the question of PVC and its effects on human health and the environment. Some Member States have recommended or adopted measures related to specific aspects of the PVC life cycle. However, these measures vary widely[100]. PVC is discussed in terms of environmental impact and health and environment issues mainly due to the use of vinyl chloride monomer (VCM) and additives such as phthalates. In packaging, though, PVC bottles are of minor importance. Hard PVC is more commonly used than soft PVC for soaps packaging.

[100] http://ec.europa.eu/environment/waste/pvc/index.htm

From a PVC life cycle perspective[101], the production of intermediates, particularly the processes from the resource extraction of crude oil and rock salt up to the VCM production, play a major role for the environmental impacts. Most of the impacts are caused by emissions to air and water, especially by hydrocarbons, nitrogen oxide and sulphur dioxide emissions to air.

We shall nevertheless .highlight that in this study are used data which is currently outdated and an investigation on uncontrolled incineration which leads to dioxins formation is not included.

Production of stabilisers and plasticizers plays a significant role, whereas the production of pigments offers a comparatively low optimisation potential, because of the small volumes involved. The most commonly used plasticisers are phthalates, of which di-2-ethylhexyl phthalate (DEHP) has traditionally accounted for 50% of European phthalate use. Others include diisononyl phthalate (DINP), di-isodecyl phthalate (DIDP), di-butyl phthalate (DBP) and butylbenzyl phthalate (BBP). These phthalates are classified as toxic for reproduction.
PVC is also difficult to recycle given the presence of additives including heavy metals such as lead and cadmium; in fact it is considered a contaminant in other recycling streams. Currently only a small amount of PVC post consumer waste is being recycled, whereas the 82% of PVC post-consumer waste is landfilled, and 15% is incinerated. Incineration, in conjunction with municipal waste disposal, is a simple option that allows for the partial recovery of energy and substances, if state-of-the-art technology is applied. In case of uncontrolled incineration (or incineration under non-BAT conditions) concerns related to dioxins formation are raised. From an LCA point of view, PVC shows the obvious disadvantages within a mixed waste fraction in the packaging sector. If mixed packaging waste contains PVC, the usability of the waste is limited. Moderate recycling potentials can be attributed PVC (25% rates) in mixed packaging wastes.[102]

Polyethylene-Terephthalate (PET)

PET is made out of ethylene and paraxylene. Their derivatives (ethylene glycol and terephthalic acid) are made to react at high temperature and high pressure to obtain amorphous PET. The resin is then crystallized and polymerized to increase its molecular weight and its viscosity. PET is generally used in packaging (e.g. bottles) and often contains additives such as UV stabilisers and flame retardants.

PET major impact has high energy demand, much higher that other plastics such as PP or PE. On the other hand, PET mechanical recycling rates are high compared to other plastics[103].

Polyolefins (PE and PP)

Polyolefins such as Polyethylene (PE) and Polypropylene (PP) are simpler polymer structures that do not need plasticizers, although they do use additives such as UV and heat stabilizers, antioxidants and in some applications flame retardants. The polyolefins pose fewer risks and have the highest potential for mechanical recycling. Both PE and PP are versatile and cheap, and can be designed to

[101] Life Cycle Assessment of PVC and of principal competing materials. PE Europe GmbH, Institut für Kunststoffkunde und Kunststoffprüfung (IKP), Instituttet for Produktudvikling (IPU), DTU, RANDA GROUP. Commissioned by the European Commission, July 2004.

[102] Mechanical recyclening of PVC wastes. Study for DG XI of the European Commission (B4-3040/98/000821/MAR/E3) in co-operation with: Plastic Consult (Italy), COWI (Denmark).Eckhard Plinke (Prognos), Niklaus Wenk (Prognos), Gunther Wolff (Prognos), Diana Castiglione (Plastic Consult), Mogens Palmark (COWI), Basel/Milan/Lyngby, January 2000

[103] LCA of one way PET bottles and recycled products. IFEU- Heidelberg. 2004

replace almost all PVC applications. PE can be made either hard, or very flexible, without the use of plasticizers. PP is easy to mould and can also be used in a wide range of applications.

In comparison with PVC, PE and PP use fewer problematic additives, have reduced leaching potential in landfills, reduced potential for dioxin formation during burning (provided that brominated/chlorinated flame retardants are not used), and reduced technical problems and costs during recycling.

Bio-based Polymers

There are two possible categories of plastics that can be derived from renewable resources. One option is the production of new monomers (such as polylactic acid) to make new, possibly biodegradable, polymers (e.g. PLA). Here the commercial challenge is to compete with existing large volume plastics in terms of production economics and adapting processing equipment. The other route is to make high volume monomers such as ethylene (or other ethylene derivatives) from ethanol derived from renewable sources. This can then be used in existing polymerisation plants making the well known polyethylene grade ranges. In both cases the chemistry is proven, but a key consideration will be the amount of non-renewable energy used in the overall manufacturing chain.

Bio-based plastics can be made out of products obtained from raw materials produced by a natural living or growing systems, such as starch and cellulose. The advantage of bio-polymers is that they readily degrade and can be composted. Natural polymers include cellulose (from wood, cotton), horn (hardened protein) and raw rubber. Converted natural polymers include vulcanized rubber, vulcanized fibre, celluloid and casein protein.

Biodegradable plastics from renewable sources (bio-based) are seen as a promising alternative for plastic products which have a short life cycle or are impractical to recycle, such as food packaging, agricultural plastics and other disposables.

Based on CEEI a comparative environmental impact for PET, PE and PLA is presented in Table 75 below. CEEI show the composite's impact on the environment, taking into account the resources used and the pollution generated during production, use, and disposal of the item. It can be seen that PLA has the biggest environmental impact, followed by PET whereas PE is the polymer with lower impact.

Table 74. Comparative environmental impact for PET, PE and PLA

Impact of 1kg of plastic	Overall impact (CEII):	Depletion (DI)	Pollution (PI)	Entropy (EI))
PET (polyethylene terephthalate)	2051.28	109105.37	1080.13	0.00
Polyethylene	924.29	8962.51	852.15	0.20
Corn plastic (bioplastic, polylactic acid, PLA)	3375.20	83295.63	2652.03	2.18

Source: CEII: Composite Environmental Impact Index[104]

[104] http://envimpact.org/

Eco-Profiles information for PET and PE

Environmental Product Declaration (EPD) from Eco-Profiles of Plastics Europe for PET and PE[105] has been consulted, in order to compare the two most commonly used polymers. A summary of the data is listed in table 76 below. It can be seen that PET has a higher impact in the majority of indicators related to energy and water use and also in category impact indicators than HDPE.

Table 75. Comparative inputs and outputs of PET and HDPE (EPD form Plastics Europe)

Input Parameters			
Indicator	**Unit**	**Value (PET)**	**Value (HDPE)**
Non-renewable energy resources[1]			
Fuel energy	MJ	30–34	21.7
Feedstock energy	MJ	35–39	54.3
Renewable energy resources (biomass)[1]			
Fuel energy	MJ	0.8	0.8
Feedstock energy	MJ		0
Abiotic Depletion Potential			
Elements	kg Sb eq	0.030	
Fossil fuels	MJ	69.0	
Minerals	g		2.6
Fossil fuels	g		1,595.7
Uranium	g		0.006
Renewable materials (biomass)	kg	0.001	8.704
Water use	kg		
For process	kg	7.00	3.378
For cooling	kg	53.00	-
Output Parameters			
Indicator	**Unit**	**Value (PET)**	**Value (HDPE)**
GWP	kg CO2 eq	2.15	1.96
ODP	g CFC-11 eq	0.01	n/a[3)]
AP	g SO2 eq	7.90	6.39
POCP (CML 2009)	g Ethene eq	0.59	1.23
EP (CML 2009)	g PO4 eq	0.81	0.43
Dust/particulate matter[2)]	g PM10	6.92	0.64
Total particulate matter[3)]	g	7.1	0.64
Waste (before treatment)			
Non-hazardous	kg	0.57	0.032
Hazardous	kg	0.0045	0.006

1) Calculated as upper heating value (UHV)
2) Including secondary PM10
3) Relevant LCI entries are below quantification limit.

Source: Plastic Europe PET Ecoprofile (2011-05)[106], Plastic Europe HDPE Ecoprofile (2008)[107]

[105] http://www.plasticseurope.org/plastics-sustainability/eco-profiles.aspx
[106] Environmental Product Declarations of the European Plastics Manufacturers. Polyethylene Terephthalate (PET) (Bottle Grade) Plastics Europe. May 2011

LCIA: Comparison of different packaging plastic materials

A comparative impact assessment has been done by LEITAT for different plastic packaging used for soaps category group. Analyses have been done in the framework of general LCA study and the same assumptions and method (2002+ impact assessment method) has been used. Materials have been taken from Ecoinvent Database. Results showed in figure 23 corroborate the results gathered from literature. In general, from the analysis done it could be said that PET is the material with major environmental impacts, as it consumes a high amount of energy and water to be produced. Also in categories related to human toxicity PET presents higher values, as well as in terrestrial ecotoxiciy and mineral resources extraction.

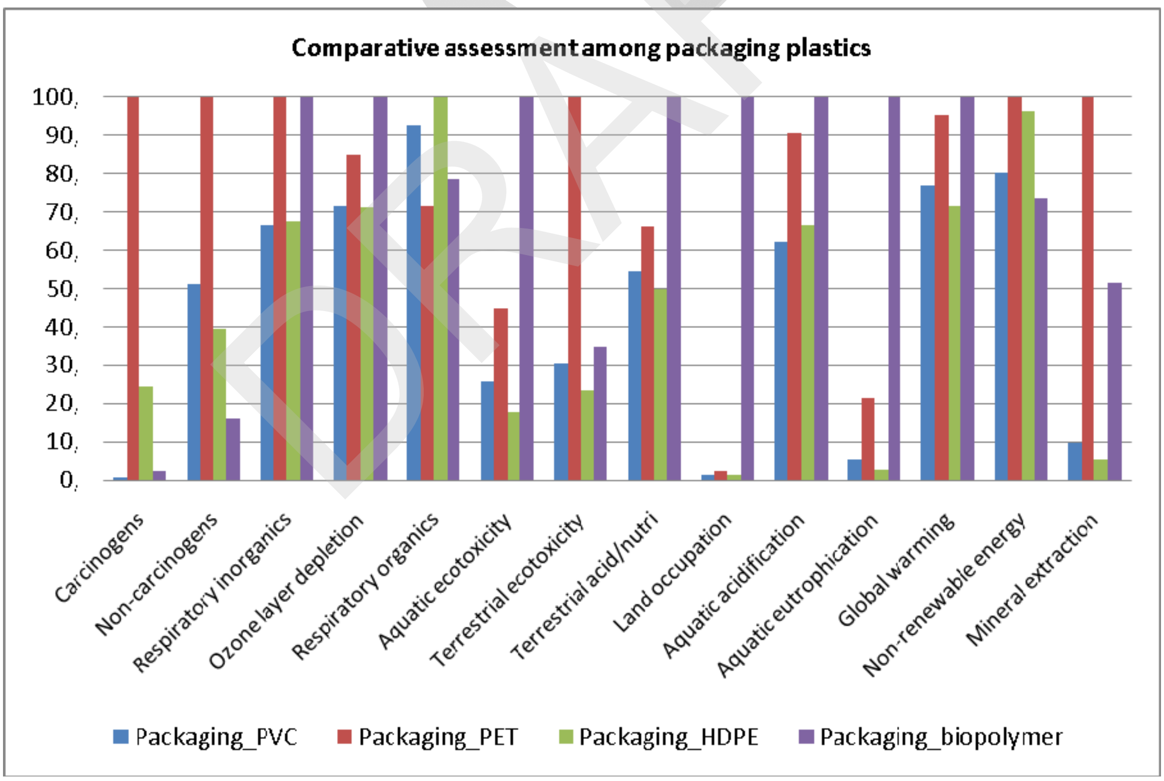
Biopolymers presents high environmental impacts in categories in aquatic toxicity and acidification, land occupation, global warming.

PVC seems to have lower impacts than PET and HDPE, but problematic additives in PVC and toxicity effect of chloride compounds may not be included and they should be taken into account.

In general terms, PVC bottles tend to have comparable impacts to those of PET bottles.

HDPE have lower impacts than its competitors, although it has high values in categories of respiratory organics and use of non-renewable energy.

Figure 23. Comparative analysis of PVC, PET, HDPE and biopolymer

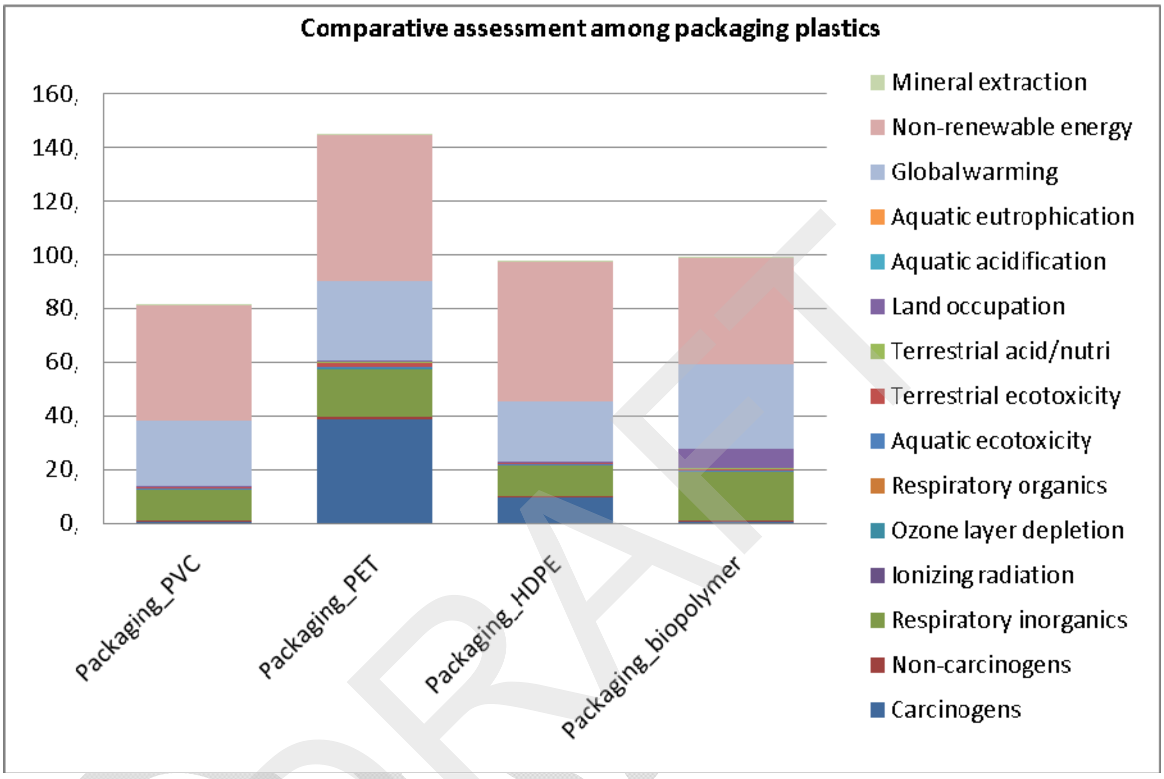


The same information represented in a unique punctuation aggregating all impact categories (weighting) can be seen in Figure 24. PET has the highest environmental impact, mainly due to the use of non-renewable energy, global warming and carcinogens. The second polymer with higher impact is Byopolymer, and environmental impacts come from the use of non-renewable energy,

[107] Environmental Product Declarations of the European Plastics Manufacturers. High density polyethylene (HDPE). 2008

global warming and terrestrial acidification. HDPE has minor impacts, which are due to non-renewable energy use, global warming, terrestrial acidification and carcinogens. PVC is the polymer with a lower environmental impact value, coming from non-renewable energy, global warming and respiratory inorganics. A clear recommendadation for a selection of only one particular material for packaging among the commonly used - PET, PE, PLA, PP and to lower extent PVC cannot be derived based on the technical analysis conducted so far.

Figure 24. Comparative assessment of PVC, PET, HDPE and biopolymer (unique punctuation)



Paper packaging

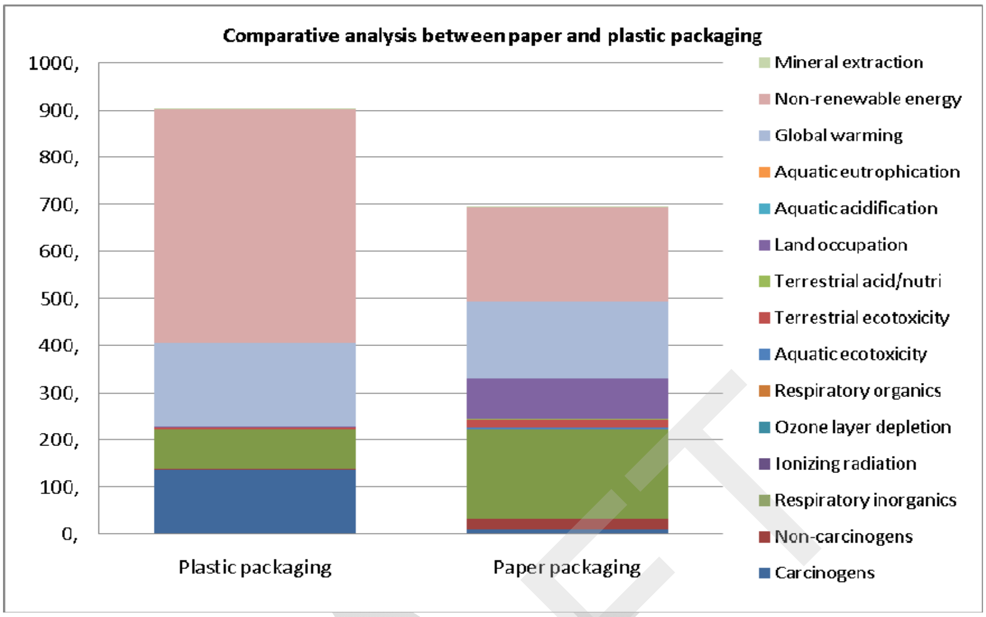
Different kinds of paper and cardboard are used for solid soaps: cardboard with white coating, plain paper, laminated paper, solid white cardboard, unlined cardboard, laminated cardboard, etc. Also plastic are used sometimes.

In general, it can be said that paper is preferable to plastic packaging, as it comes from a renewable resource and it is easily recycled (recycling rating for paper packaging is 81% whereas for plastic packaging is 30%[108])

If a comparative impact assessment is done between paper and plastic (PP), with 2002+ impact method and taken materials from Ecoinvent Database, it can be seen that plastic's environmental impact is higher, especially in non-renewable energy and carcinogens categories, as shown in Figure 25.

[108] Results of packaging recycling and recovery in the Member States and in the EU in 2008. European Commission Environment.

Figure 25. Comparative impact assessment between paper and plastic packaging.



Recycling and waste treatments of packaging materials

According to European statistics[109] (see inventory section) **paper and cardboard packaging** is recycled in 80% (much more than plastic packaging waste), although some kind of coated or laminated paper, or if it is contaminated with the content, can be difficult to be recycled properly and the share of real recycling can be lower.

Plastic packaging waste is partially sorted and recycled. Different kinds of plastic have different recycling processes and recycling ratios.

- **PET** is widely recycled as a material, making a large contribution to the recycling targets for packaging plastics. PET can be recovered, and the material reused, by simple washing processes or by chemical treatment to break down the PET into raw materials or intermediates. A final option for PET that is unsuitable for material recycling is to use it as energy source. When recycling is not undertaken, in landfills PET is stable and inert with no leaching or groundwater risk (Ref.).

- **HDPE** is also widely accepted at recycling centres, HDPE scrap is commonly recycled into new products such as plastic lumber, tables, benches, stationary and other durable plastic products. To return the highest value to recyclers, waste HDPE must be of one grade, one colour, and be almost entirely free of contamination. The expense of sorting material into different grades and colours can make its recovery uneconomic. Coloured HDPE, multi-

[109] Results of packaging recycling and recovery in the Member States and in the EU in 2008. European Commission Environment.

layered package types, and packages with barrier coatings or containing barrier resins may not be readily marketable. Package components such as the cap, the label, and the colouring can reduce the value of the recovered material if not removed or designed with recycling in mind.

- **PVC** used for packaging pose the greatest problems to be recycled, but currently post-use PVC used for packaging and present in mixed packaging waste can be recycled although to limited applications of the recycled material, as usually the amount of PVC in a typical waste site is less than 1 per cent and the metal content will generally not be more than 2 per cent of this amount[110].

- **Biodegradable polymers** can present advantages compared with long lasting polymers for packaging uses. For conventional plastics waste, material valorisation implies some limitations linked to the difficulties to find accurate and economically viable output for recycled material, and energetic valorisation yields some toxic emissions (e.g., dioxin). Biodegradation is an advantageous way of waste treatment, although some environmental impacts can be produced due to eco-toxicity for those by-products generated during biodegradation processes. The accumulation of contaminations with toxic residues and chemical reactions of biodegradation can cause plant growth inhibition in these products, which must serve as fertilizers".[111]

In conclusion, it can be said that sorting and recycling of any type of plastic packaging waste is well stidies and technical solutions are in general available but economic constraints are identified. Since collecting and recycling systems have to be established, aiming for sorted plastics of a certain (constant) mass stream and quality and are associated with costs. As materials extraction and manufacturing have a huge environmental impact, recycling process is of high importance, in order to use recycled material and avoid impacts coming from manufacturing new packaging material[112].

Labelling and printing processes in packaging

Impact assessment of labels and different printing and gravure processes has been assessed and compared. For liquid products, there are some bottles with labels, whereas in other products information is directly printed on the plastic packaging materials. For bar soap packaging, package is directly printed with different methods: lithography (46%), rotogravure (23%) and flexographic printing (20%)[113]

From the assessment done, it has been obtained that only a 8-5 % (depending on the label or printing system used) of the whole environmental impact related to packaging comes from labelling or printing process, whereas the rest of the environmental impact comes from packaging material and, whith a minor percentage, the packaging manufacturing process.

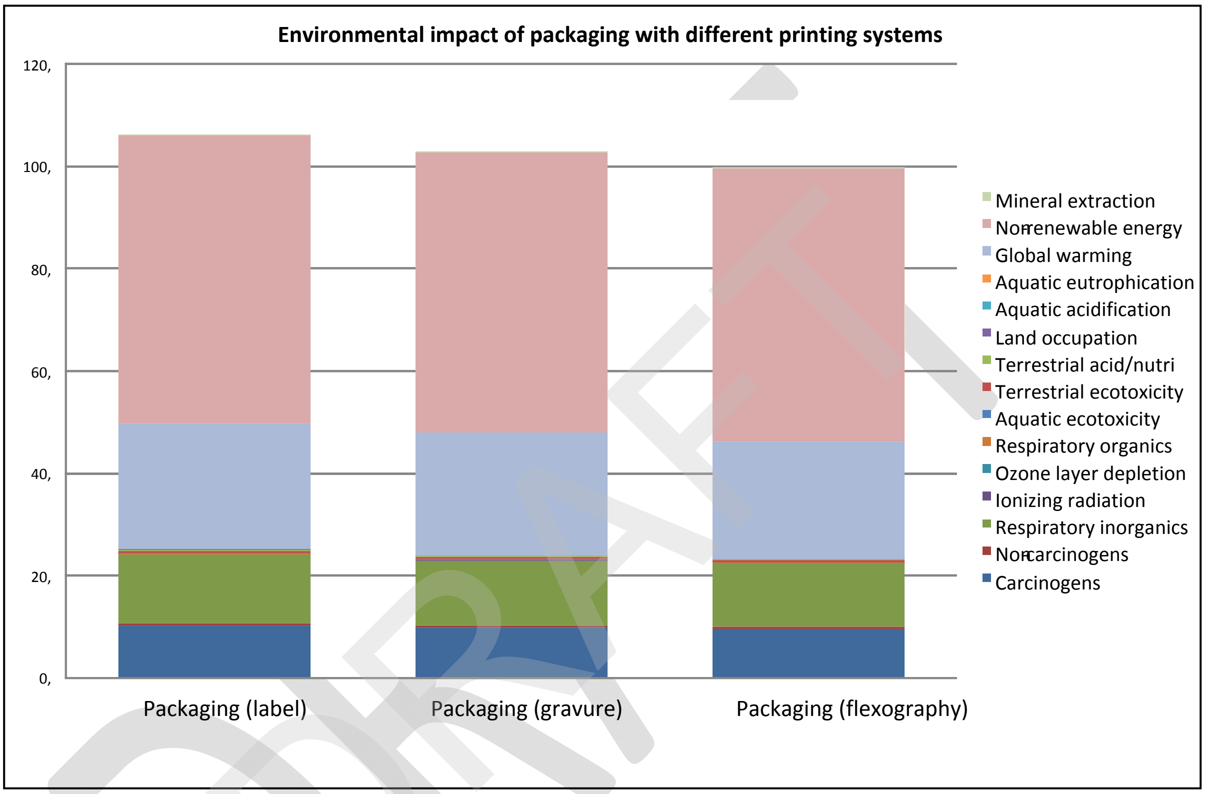
In Figure 26 it is compared different kinds of decoration: labelling, gravure printing and flexography printing. It can be seen that bottles with labels have bigger environmental impact than those which

[110] http://www.pvc.org/en/
[111] "Biodegradable polymers (Biopolymers)" available at http://www.biodeg.net/biopolymer.html
[112] The impact of plastics on life-cycle energy consumpion and GHG emissions in Europe; Denkstatt GmbH, 2010
[113] Mintel GNPD Database

are directly printed, due to the material used for the label. Moreover, some kind of labelling can complicate the recycling processes of packages. Metallised labels, for instance, do not separate well from the flaked plastic, potentially making recovery of packages with these labels uneconomic. PVC shrink labels are very difficult to remove and most do not have tolerance of PVC contamination.

Kinds of inks and substances present in these inks have been not analysed due to lack of data.

Figure 26. Comparative environmental impact for label packaging, packaging gravure and packaging flexography



Refilling – reusable packaging

Some soap products have the option of refilling or reusable package, where the refill package is usually lighter that the conventional package. It is quite usual in hand-soaps where refilling package have a dispenser and refill package is a more simple bottle. Also other soap products with refill packaging such as body liquid soap exist. Among all liquid soaps products of European market, 10% have refilling systems[114]. For shampoos it seems that only 26 products exist with refilling system (0.02%), and 2 conditioners products (0.04%).

Refilling system can provide a packaging saving of the 79% of weight, which can be converted to a 79% of saving of environmental impact of packaging stage[115], as it is mainly produced for the raw material and in material manufacturing, as the assessment done shows, environmental impact is directly proportional to weight. For instance in the case of liquid soaps, by using a refilling system, the packaging impact contribution can decrease from 34% to 12%, and the global environmental

[114] Mintel GNPD Data Base. Category: liquid soaps. 2012.
[115] Data obtained from direct calculation for a refilling product of liquid soap

impact of the product decrease by 27% with respect the original soap with non-refill packaging. Therefore withing the Ecolabel scheme special focus should be given to this issue.

10.10. Conclusions on life cycle impact assessment

Introduction of good environmental practices and requirements in the Ecolabel criteria have been analysed in order to estimate and measure the improvement potential and the resulting environmental impact minimization. In the following table 77 a general overview regarding the significant impacts found per life cycle phase and the corresponding action proposed for the Ecolabel is outlined. The following four information elements and their interrelation are presented:

1. Outcomes of the environmental performance of the product group
2. Appropriateness and potential to regulate this area through the policy tool of Ecolabel
3. Ecolabel criterion that is taken or is now proposed per area of action.
4. The environmental savings and improvement that is expected from the Ecolabel criterion

Table 76. Outcomes of life cycle assessment and actions in Ecolabel – a general overview

STAGE	Environmental impact	Potential regulation by EU Ecolabel	Good environmental practices /restrictions	Improvement potential
Chemicals	24% of the total environmental impact for solid soaps, 19% for hair conditioners, 7% for shampoo , 5% for liquid soaps	High	Select for each functional group of those substances less pollutant (Ecotoxicity factors, CLP, biodegradability)	- Improvement of the environmental performance of ingredients used, including during stages of manufacturing, use and release to water. - Minimize potential ecotoxicity effects if products are released to different environmetnal compartments.
			Select substances with less energy and non-renewable consumption	- An important part of environmental impact of substances comes from energy and resources used during its manufacturing.
Manufacturing	8% on average of the total environmental impact	Moderate / Medium	Improvement in manufacturing processes efficiency, mainly in energy use	- Reduction of impacts from manufacturing process, which come mainly from the use of non-renewable energy for heating and electricity. - Minimization of environmental impacts in categories of global warming, use of non-renewable energy.
Packaging	25% of the total environmental impact for liquid soaps, 36% for hair conditioners, 32% for shampoo , 6% for solid soaps	High	Minimize packaging weight	- 70% environmental impact of packaging is due to the material used (the rest is generated by manufacturing of packaging) - Decreases in weight (amount of material) have direct decreases in environmental impacts.
			Increase recycled material sources	- 70% environmental impact of packaging is due to the material used - Decrease of virgin material has environmental impact savings.
			Materials selection: - Use materials with a minor environmental impact	- 70% environmental impact of packaging is due to the material used (the rest is generated by manufacturing of packaging) - Select plastic with low environmental impact along its life cycle (including production phase and recycling phase. Consider potential for reusability and recyclability
			Labelling / information system	- Packaging without label has a 3% of less impact. - Packaging without label is more easily recycled.
			Refilling systems	- Refilling system can provide a packaging saving of the 79% of weight
			Guarantee recyclability: - Use recyclable materials	- Recycling of waste is in general environmentally preferable than other treatments (energy recovery or landfill),

			- All parts separable or compatible	nevertheless it can differ for various materials. Recycling allows producing material which can enter again to the system enabling environmental impacts saving in first stages of life product.
Distribution	Average of 5% of total product environmental impact	Low	Improve efficiency in logistic and transport processes. Decrease weight of packaging (lower weight of transported product)	- Environmental improvement due to saving of fossil fuel use.
Use	34-17% of total product environmental impact depending on each product	Low	Improvements in products performance: dosage, more easily rinse-off.	- Reducing dose/washing action - Reducing water consumed /washing action
			Communication and awareness messages to users	- Reducing product and water consumed /washing action
Release to water	27-13% of total product environmental impact depending on each product	*Impacts from this stage depend on raw materials and use stage*	Use substances which are not toxic for the environment or the humans.	- Environmental impact minimization coming from wastewater treatment..
Treatment of packaging waste	0.5 % – 0.18 % of the total environmental impact of products (depending on each product)	*Impacts from this stage depend on packaging stage*	Increase recycling rates in packaging waste. Reduce amount of waste generated by packaging (refilling systems, lower packaging weight)	- In general, recycling of waste is environmentally preferable than other treatments (energy recovery or landfill), nevertheless, differences among materials exist in this respect.

11. Bibliography and references

Note: to be completed with documents referenced in the report.

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12. Annex I

Hazard statements according to CLP 1272/2008 for hazardous substances

Hazard statement according to CLP 1272/2008/EEC	*Associated risk phrases according to Directive 67/548/EEC*
H300 Fatal if swallowed	R28
H301 Toxic if swallowed	R25
H304 May be fatal if swallowed and enters airways	R65
H310 Fatal in contact with skin	R65
H311 Toxic in contact with skin	R65
H330 Fatal if inhaled	R23; R26
H331 Toxic if inhaled	R23
H340 May cause genetic defects	R23
H341 Suspected of causing genetic defects	R68
H350 May cause cancer	R45
H350i May cause cancer by inhalation	R49
H351 Suspected of causing cancer	R40
H360F May damage fertility	R60
H360D May damage the unborn child	R61
H360FD May damage fertility. May damage the unborn child	R60-61
H360Fd May damage fertility. Suspected of damaging the unborn child	R60-63
H360Df May damage the unborn child. Suspected of damaging fertility	R61-62
H361f Suspected of damaging fertility	R62
H361d Suspected of damaging the unborn child	R63
H361fd Suspected of damaging fertility. Suspected of damaging the unborn child	R62-63
H362 May cause harm to breast-fed children	R64
H370 Causes damage to organs	R39/23; R39/24; R39/25; R39/26; R39/27; R39/28
H371 May cause damage to organs	R68/20; R68/21; R68/22
H372 Causes damage to organs through prolonged or repeated exposure	R48/25; R48/24; R48/23
H373 May cause damage to organs through prolonged or repeated exposure	R48/20; R48/21; R48/22
H400 Very toxic to aquatic life	R50
H410 Very toxic to aquatic life with long-lasting effects	R50-53
H411 Toxic to aquatic life with long-lasting effects	R51-53
H412 Harmful to aquatic life with long-lasting effects	R52-53

Hazard statement according to CLP 1272/2008/EEC	*Associated risk phrases according to Directive 67/548/EEC*
H413 May cause long-lasting harmful effects to aquatic life	R53
EUH059 Hazardous to the ozone layer	R59
EUH029 Contact with water liberates toxic gas	R29
EUH031 Contact with acids liberates toxic gas	R31
EUH032 Contact with acids liberates very toxic gas	R32
EUH070 Toxic by eye contact	R39-41
H334 May cause allergy or asthma symptons or breathing difficulties if inhaled	R42
H317 May cause allergic skin reaction	R43

13. Annex II

Hazard statements according to the CLP Regulation

H200- SERIES: PHYSICAL HAZARDS	
H200	Unstable explosive
H201	Explosive; mass explosion hazard
H202	Explosive; severe projection hazard
H203	Explosive; fire, blast or projection hazard
H204	Fire or projection hazard
H205	May mass explode in fire
H220	Extremely flammable gas
H221	Flammable gas
H222	Extremely flammable material
H223	Flammable material
H224	Extremely flammable liquid and vapour
H225	Highly flammable liquid and vapour
H226	Flammable liquid and vapour
H228	Flammable solid
H240	Heating may cause an explosion
H241	Heating may cause a fire or explosion
H242	Heating may cause a fire
H250	Catches fire spontaneously if exposed to air

H251	Self-heating; may catch fire
H252	Self-heating in large quantities; may catch fire
H260	In contact with water releases flammable gases which may ignite spontaneously
H261	In contact with water releases flammable gas
H270	May cause or intensify fire; oxidizer
H271	May cause fire or explosion; strong oxidizer
H272	May intensify fire; oxidizer
H280	Contains gas under pressure; may explode if heated
H281	Contains refrigerated gas; may cause cryogenic burns or injury
H290	May be corrosive to metals

H300- SERIES: HEALTH HAZARDS	
H300	Fatal if swallowed
H301	Toxic if swallowed
H302	Harmful if swallowed
H304	May be fatal if swallowed and enters airways
H310	Fatal in contact with skin
H311	Toxic in contact with skin
H312	Harmful in contact with skin
H314	Causes severe skin burns and eye damage
H315	Causes skin irritation
H317	May cause an allergic skin reaction
H318	Causes serious eye damage
H319	Causes serious eye irritation

H330	Fatal if inhaled
H331	Toxic if inhaled
H332	Harmful if inhaled
H334	May cause allergy or asthma symptoms of breathing difficulties if inhaled
H335	May cause respiratory irritation
H336	May cause drowsiness or dizziness
H340	May cause genetic defects, (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)
H341	Suspected of causing genetic defects (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)
H350	May cause cancer May cause cancer (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)
H350i	May cause cancer by inhalation
H351	Suspected of causing cancer (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)
H360	May damage fertility or the unborn child (state specific effect if known)(state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)
H360F	May damage fertility
H360D	May damage the unborn child
H360FD	May damage fertility. May damage the unborn child
H360Fd	May damage fertility. Suspected of damaging the unborn child
H360Df	May damage the unborn child. Suspected of damaging fertility
H361	Suspected of damaging fertility or the unborn child (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)
H361f	Suspected of damaging fertility.
H361d	Suspected of damaging the unborn child.
H361fd	Suspected of damaging fertility. Suspected of damaging the unborn child
H362	May cause harm to breast-fed children
H370	Causes damage to organs (or state all organs affected, if known) (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)
H371	May cause damage to organs (or state all organs affected, if known) (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)
H372	Causes damage to organs through prolonged or repeated exposure (state all organs affected, if known) through prolonged or repeated exposure (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)

H373	May cause damage to organs through prolonged or repeated exposure (state all organs affected, if known) through prolonged or repeated exposure (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)

H400- SERIES: ENVIRONMENTAL HAZARDS	
H400	Very toxic to aquatic life
H410	Very toxic to aquatic life with long lasting effects
H411	Toxic to aquatic life with long lasting effects
H412	Harmful to aquatic life with long lasting effects
H413	May cause long lasting harmful effects to aquatic life

EUH- STATEMENTS	
EUH001	Explosive when dry.
EUH006	Explosive with or without contact with air.
EUH014	Reacts violently with water.
EUH018	In use may form flammable/explosive vapour-air mixture.
EUH019	May form explosive peroxides.
EUH044	Risk of explosion if heated under confinement.
EUH029	Contact with water liberates toxic gas.
EUH031	Contact with acids liberates toxic gas.
EUH032	Contact with acids liberates very toxic gas.
EUH066	Repeated exposure may cause skin dryness or cracking.
EUH070	Toxic by eye contact.
EUH071	Corrosive to the respiratory tract.
EUH059	Hazardous to the ozone layer.
EUH201	Contains lead. Should not be used on surfaces liable to be chewed or sucked
EU H201A	Warning! Contains lead.
EUH202	Cyanoacrylate. Danger. Bonds skin and eyes in seconds. Keep out of the reach of children.
EUH203	Contains chromium (VI). May produce an allergic reaction.

EUH204	Contains isocyanates. May produce an allergic reaction.
EUH205	Contains epoxy constituents. May produce an allergic reaction.
EUH206	Warning! Do not use together with other products. May release dangerous gases (chlorine).
EUH207	Warning! Contains cadmium. Dangerous fumes are formed during use. See information supplied by the manufacturer. Comply with the safety instructions
EUH208	Contains <name of sensitising substance>. May produce an allergic reaction
EUH209	Can become highly flammable in use.
EUH209A	Can become flammable in use.
EUH210	Safety data sheet available on request.
EUH401	To avoid risks to human health and the environment, comply with the instructions for use

14. Annex III

Risk phrases according to Directive 67/548/EEC

SINGLE RISK PHRASES	
R1	Explosive when dry.
R2	Risk of explosion by shock, friction, fire or other sources of ignition.
R3	Extreme risk of explosion by shock, friction, fire or other sources of ignition.
R4	Forms very sensitive explosive metallic compounds.
R5	Heating may cause an explosion.
R6	Explosive with or without contact with air.
R7	May cause fire.
R8	Contact with combustible material may cause fire.
R9	Explosive when mixed with combustible material.
R10	Flammable.
R11	Highly flammable.
R12	Extremely flammable.
R13	Extremely flammable liquified gas. This code is no longer in use.
R14	Reacts violently with water.
R15	Contact with water liberates highly flammable gases.
R16	Explosive when mixed with oxidizing substances.
R17	Spontaneously flammable in air.
R18	In use, may form flammable/explosive vapour-air mixture.
R19	May form explosive peroxides.
R20	Harmful by inhalation.
R21	Harmful in contact with skin.
R22	Harmful if swallowed.
R23	Toxic by inhalation.
R24	Toxic in contact with skin.

R25	Toxic if swallowed.
R26	Very toxic by inhalation.
R27	Very toxic in contact with skin.
R28	Very toxic if swallowed.
R29	Contact with water liberates toxic gases.
R30	Can become highly flammable in use.
R31	Contact with acids liberates toxic gas.
R32	Contact with acids liberates Very toxic gas.
R33	Danger of cumulative effects.
R34	Causes burns.
R35	Causes severe burns.
R36	Irritating to eyes.
R37	Irritating to respiratory system.
R38	Irritating to skin.
R39	Danger of very serious irreversible effects.
R40	Possible risks of irreversible effects.
R41	Risk of serious damage to eyes.
R42	May cause sensitization by inhalation.
R43	May cause sensitization by skin contact.
R44	Risk of explosion if heated under confinement.
R45	May cause cancer.
R46	May cause heritable genetic damage.
R47	May cause birth defects.
R48	Danger of serious damage to health by prolonged exposure.
R49	May cause cancer by inhalation.
R50	Very toxic to aquatic organisms.
R51	Toxic to aquatic organisms.

R52	Harmful to aquatic organisms.
R53	May cause long-term adverse effects in the aquatic environment.
R54	Toxic to flora.
R55	Toxic to fauna.
R56	Toxic to soil organisms.
R57	Toxic to bees.
R58	May cause long-term adverse effects in the environment.
R59	Dangerous for the ozone layer.
R60	May impair fertility.
R61	May cause harm to the unborn child.
R62	Possible risk of impaired fertility.
R63	Possible risk of harm to the unborn child.
R64	May cause harm to breastfed babies.

MULTIPLE RISK PHRASES	
R14/15	Reacts violently with water liberating highly flammable gases.
R15/29	Contact with water liberates toxic, highly flammable gas.
R20/21	Harmful by inhalation and in contact with skin.
R20/22	Harmful by inhalation and if swallowed.
R20/21/22	Harmful by inhalation, in contact with skin and if swallowed.
R21/22	Harmful in contact with skin and if swallowed.
R23/24	Toxic by inhalation and in contact with skin.
R23/25	Toxic by inhalation and if swallowed.
R23/24/25	Toxic by inhalation, in contact with skin and if swallowed.
R24/25	Toxic in contact with skin and if swallowed.

R26/27	Very toxic by inhalation and in contact with skin.
R26/28	Very toxic by inhalation and if swallowed.
R26/27/28	Very toxic by inhalation, in contact with skin and if swallowed.
R27/28	Very toxic in contact with skin and if swallowed.
R36/37	Irritating to eyes and respiratory system.
R36/38	Irritating to eyes and skin.
R36/37/38	Irritating to eyes, respiratory system and skin.
R37/38	Irritating to respiratory system and skin.
R39/23	Toxic: danger of very serious irreversible effects through inhalation.
R39/24	Toxic: danger of very serious irreversible effects in contact with skin.
R39/25	Toxic: danger of very serious irreversible effects if swallowed.
R39/23/24	Toxic: danger of very serious irreversible effects through inhalation and in contact with skin.
R39/23/25	Toxic: danger of very serious irreversible effects through inhalation and if swallowed.
R39/24/25	Toxic: danger of very serious irreversible effects in contact with skin and if swallowed.
R39/23/24/25	Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.
R39/26	Very toxic: danger of very serious irreversible effects through inhalation.
R39/27	Very toxic: danger of very serious irreversible effects in contact with skin.
R39/28	Very toxic: danger of very serious irreversible effects if swallowed.
R39/26/27	Very toxic: danger of very serious irreversible effects through inhalation and in contact with skin.
R39/26/28	Very toxic: danger of very serious irreversible effects through inhalation and if swallowed.
R39/27/28	Very toxic: danger of very serious irreversible effects in contact with skin and if swallowed.
R39/26/27/28	Very toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.

R40/20	Harmful: possible risk of irreversible effects through inhalation.
R40/21	Harmful: possible risk of irreversible effects in contact with skin.
R40/22	Harmful: possible risk of irreversible effects if swallowed.
R40/20/21	Harmful: possible risk of irreversible effects through inhalation and in contact with skin.
R40/20/22	Harmful: possible risk of irreversible effects through inhalation and if swallowed.
R40/21/22	Harmful: possible risk of irreversible effects in contact with skin and if swallowed.
R40/20/21/22	Harmful: possible risk of irreversible effects through inhalation, in contact with skin and if swallowed.
R42/43	May cause sensitization by inhalation and skin contact.
R48/20	Harmful: danger of serious damage to health by prolonged exposure through inhalation.
R48/21	Harmful: danger of serious damage to health by prolonged exposure in contact with skin.
R48/22	Harmful: danger of serious damage to health by prolonged exposure if swallowed.
R48/20/21	Harmful: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.
R48/20/22	Harmful: danger of serious damage to health by prolonged exposure through inhalation and if swallowed.
R48/21/22	Harmful: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed.
R48/20/21/22	Harmful: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed.
R48/23	Toxic: danger of serious damage to health by prolonged exposure through inhalation.
R48/24	Toxic: danger of serious damage to health by prolonged exposure in contact with skin.
R48/25	Toxic: danger of serious damage to health by prolonged exposure if swallowed.
R48/23/24	Toxic: danger of serious damage to health by prolonged exposure through inhalation and in contact with skin.
R48/23/25	Toxic: danger of serious damage to health by prolonged exposure through inhalation and if swallowed.
R48/24/25	Toxic: danger of serious damage to health by prolonged exposure in contact with skin and if swallowed.

R48/23/24/25	Toxic: danger of serious damage to health by prolonged exposure through inhalation, in contact with skin and if swallowed.
R50/53	Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R51/53	Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.
R52/53	Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.