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LCA of Packed Food Products

– the function of flexible packaging –
– Case Study: Spinach –

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Executive Summary - Case Study: Spinach

"LCA of Packed Food Products: the function of flexible packaging"

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The evaluation of the environmental performance of packaging usually concentrates on a comparison of packaging materials. Other aspects including sustainable consumption and production of packed goods are often neglected. The same applies to the functional role of flexible packaging, which is the distribution of goods to society to satisfy human needs.

Broader approaches, which focus on the life cycle of packed goods, including the entire supply system and the consumption of goods, are necessary to get an environmental footprint of the food supply system with respect to sustainable production and consumption.

And as the only reason to produce packaging is to enable the consumer to consume products the relevant question from a sustainability point of view can be only to optimize the sustainability along the total supply chain of consumer goods rather than focussing on parts of it.

The three main targets of this study are:

- the investigation of the environmental performance of flexible packaging with respect to its function within the life cycle of goods, i.e. within the supply chain and consumption of goods,
- the investigation of the role of flexible packaging in view of resource efficiency and prevention of spoilage of packed goods, and
- the investigation of the environmental relevance of stages and interdependencies within the life cycle of goods while taking consumers' patterns and portion sizes into consideration.

The study illustrates the environmental relevance of flexible packaging within the supply chain. While the results of this study are not immediately transferable to other packaging systems or types of products this study shows that the environmental impact from the packaging of the investigated sample products is minor in comparison to the impact from the production of the product, its processing and the consumer behaviour in the use of the product. Additionally, depending on the product, packaging can contribute to minimise the environmental impact of production, processing and use by reducing spoilage and overconsumption.

The results of this study are calculated for eight environmental indicators based on the CML 2001 method. The main impact assessment and discussion is based on five indicators which are:

- Cumulative energy demand (CED), non-renewable (MJ eq.)
- Global warming (kg CO_2 eq.)
- Ozone layer depletion (ODP) (kg CFC-11 eq.)
- Acidification (kg SO_2 eq.)
- Eutrophication (kg PO_4^{3-} eq.)

Case Study: Deep Frozen Spinach

The life cycle of spinach encompasses the whole food supply system from the cultivation of spinach to the preparation of frozen spinach in the kitchen ready to eat. The process steps for deep frozen spinach pro-

duction are: cultivation, harvesting, transport by lorry, sorting, dry purification, washing, blanching, and quick-freezing. Spinach is frozen within two or three hours after harvest and has, then, to be stored and transported at a temperature of at least minus 18°C. The cold chain consists of three different cold stores (at the processing plant, in a storage warehouse, at the regional distribution centres), the supermarket and refrigerated transports. At home spinach can be stored in freezers up to almost two years.

Packaging of frozen spinach is quite simple compared to the packaging of high processed products. The analysed packaging consists of a typically used linear low density polyethylene (LLDPE) bag.

The functional unit concerning deep frozen spinach in this study is 'the preparation of one kilogram of spinach ready to eat at home'.

The impact assessment of deep frozen spinach consumption includes a standard case with the following assumptions: an average production of deep frozen spinach, LLDPE packaging, refrigerated storage and transportation at minus 18°C, domestic storage for 180 days in a B-class freezer, cooking spinach for ten minutes with an electric stove and the European electricity mix.

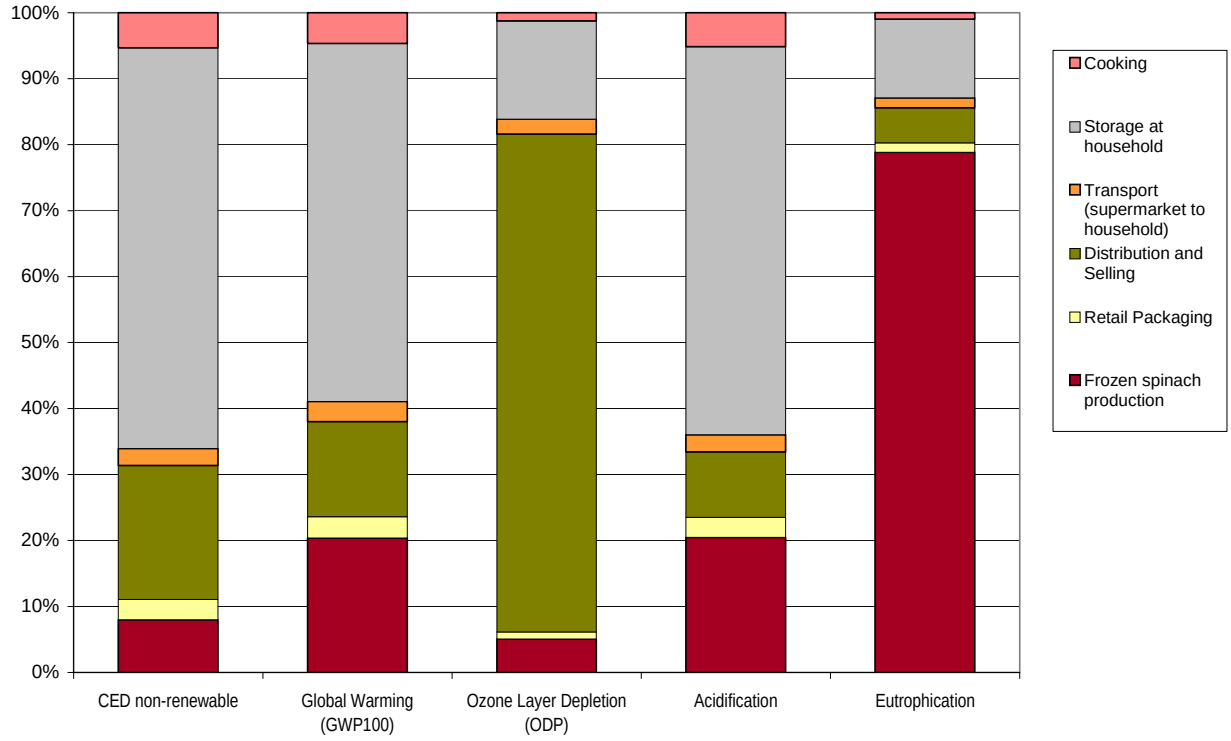

Figure 1: Results of the standard case for a pot of spinach with regard to the selected five indicators. The results are scaled to 100 %.

The study shows: the most relevant aspect regarding the life cycle of deep frozen spinach is both the cooling (storage at home and during distribution and selling) and the spinach production – compared to retail packaging, transport (from the supermarket to the household) and cooking which are of minor importance. Keeping spinach deep-frozen is, due to the long storage time, the most energy consuming process and responsible for most environmental impacts in all indicators except for eutrophication.

The sensitivity analysis compares modified parameters – e.g. chilled spinach with/without a 30 percent spoilage, A++ and C class freezer, gas cooking, packaging disposal in a landfill side instead of incineration – to the standard scenario.

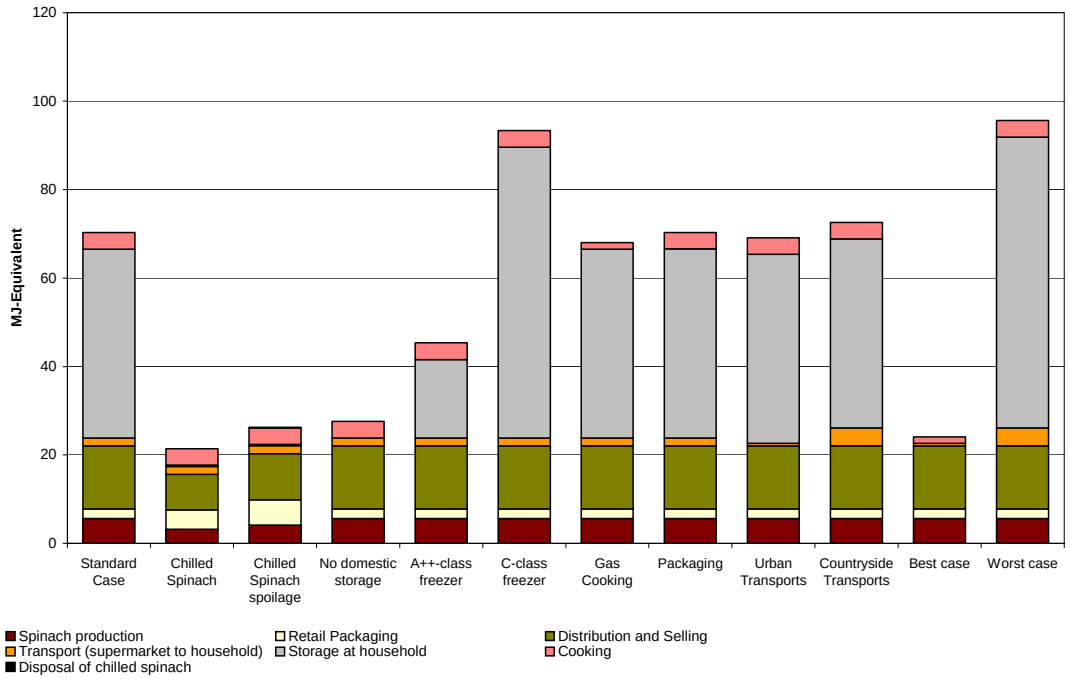

Figure 2: Sensitivity analysis with regard to non-renewable cumulative energy demand.

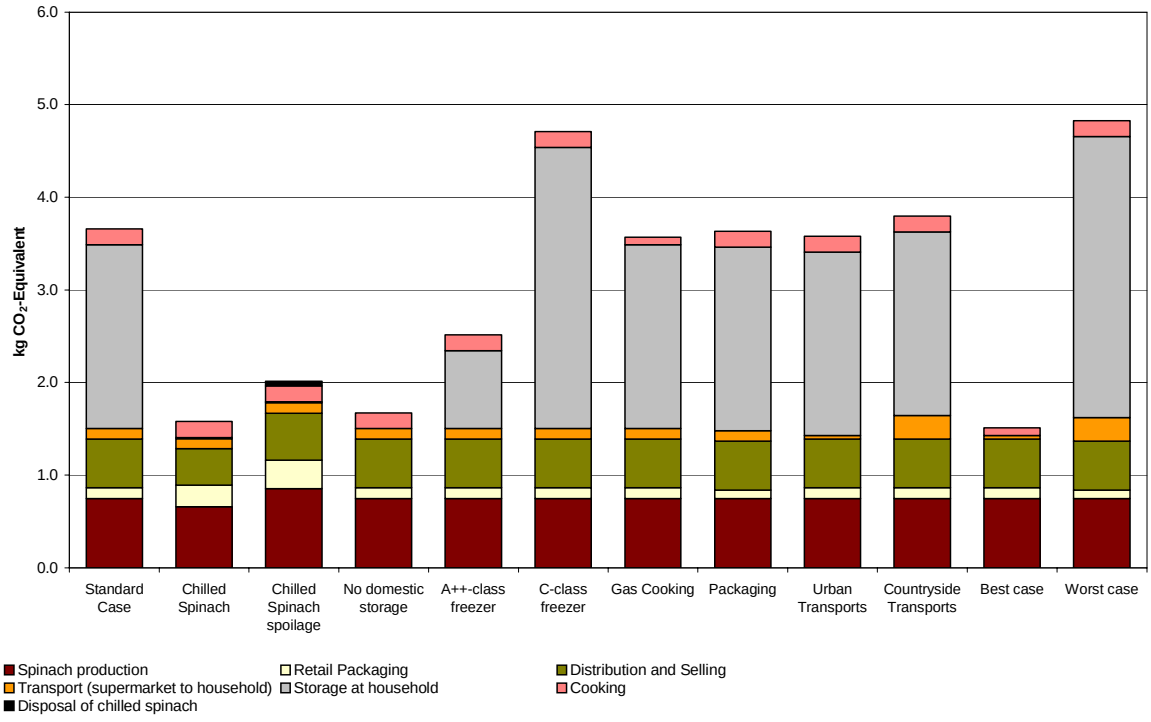

Figure 3: Sensitivity analysis with regard to global warming potential.

The sensitivity analysis has shown the following results: Chilled spinach (if no spoilage assumed) has lower impacts in all indicators considered mainly on account of the shorter storage time. The influence of packaging in the results for chilled spinach is between 3.2 percent for ODP and 54.2 percent for fresh water aquatic toxicity mainly due to the disposal of polypropylene. The domestic storage time is the most sensitive parameter in all indicators. When frozen spinach is consumed directly after buying the impact in

cumulative energy demand decreases about 61 percent compared to the case where spinach is kept for 180 days. The use of an A++ class freezer leads to savings in energy demand and global warming potential of about 30 percent. The use of a gas stove instead of an electric one has positive effects except for ozone layer depletion due to emissions at gas gathering. The disposal of packaging has practically no influence on the results because of the low share of packaging in the total environmental impacts. Means of transport and shopping distances are of limited importance.

The best case consists of no domestic storage, usage of a gas stove, packaging is disposed in incineration and for grocery shopping the urban scenario is taken. The worst case applies to 180 days of storage in a C-class freezer, usage of an electric stove, landfilled packaging and countryside grocery shopping.

Conclusions for the consumption of spinach: The most relevant factors concerning the environmental impact from the whole supply chain are, for most indicators, storage of deep frozen spinach at home, refrigerated storage and transportation in the cold chain, and spinach production. As a consequence the most relevant measures reducing environmental impacts is to minimise the storing time of deep frozen spinach at the household and the use of efficient electrical household appliances.

With the application of hydrocarbons and CO_2 as refrigerant in distribution and selling points, the environmental impacts concerning ozone layer depletion can be decreased in future. Even if the cold chain improves, deep frozen spinach always needs to be kept frozen. Therefore the storage of deep frozen spinach remains the issue with the highest impacts in some indicators.

With regard to the impacts of packaging in the life cycle of deep frozen spinach it is to say that they are small and not of primary importance. In case of chilled spinach the share of packaging to the environmental burdens are more significant in some indicators. The chilled spinach has a much lower density. Thus, a higher specific amount of packaging compared to the product packed is necessary. Furthermore there is a lower impact from other processes (shorter storage time, no blanching, no freezing) which also leads to a higher share of packaging in the life cycle of chilled spinach.

Summary

It should be the aim of every type of industry to minimize the environmental impacts directly related to their products. This study shows that in case of packaging industry this goal can only be reached if also aspects indirectly influenced by the product are taken into account. Thus, the packaging industry does not only aim to improve the production process of their packages, but also to provide packages whose functionality helps to reduce other more relevant environmental impacts in the life cycle. Depending on the product tailor-made packaging may also help to increase overall resource efficiency.