Breakfast Case:
Continental breakfast
vs.
Full English breakfast

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Summary

This LCA study compares two breakfasts options: Continental breakfast & Full English breakfast. The production and use phase are considered. The Continental breakfast has the lowest impact in all EF categories except land use and water use. For Land use, mainly dairy causes a relatively high impact. Although meat is more intensive than dairy, the amount of dairy used in this Continental breakfast recipe is higher than the amount of meat used in the Full English breakfast. For Water use, the impact of the continental breakfast is caused by the apple and bagel. Fruit is, after meat, the highest scoring food group in this impact category. The impact of the bagel is mostly explained by the production of wheat. Overall, the Full English breakfast has the highest impact, mostly caused by meat ingredients like 'Black pudding' and 'Sausage'. In the sensitivity analysis, it became clear that switching kitchen appliances to 'green' electricity and using an induction stove instead of gas, could prevent up to 43% of the CO_2-eq. emissions. Using meat alternatives like tofu could be even more environmentally friendly, based on their Climate change impact.

1. Introduction

This LCA was carried out on behalf of Hedgehog Company and was drawn up by Zoë Tan and checked by Saro Campisano . This report was completed on February 22nd 2022. It meets the requirements of NEN-EN-ISO 14040 (NEN, 2006)and NEN-EN-ISO 14044 (NEN, 2006). The study provides a comparison LCA between two types of breakfast, based on desk research. No material or supplier specific conclusions can be drawn from this report.

2. Goal and Scope definition

2.1 Goal

The goal of this LCA is to compare two extensive breakfast options, including coffee and tea. The breakfasts are a typical Continental breakfast and a traditional English breakfast. The scope of this LCA is confined to the production and use phase. In this case, the use phase is the preparation of food in the kitchen. The production phase contains the raw material production, transport and processing into food products. The overall objective of this study is therefore:

Quantifying and comparing the environmental impact of the production and use phase of Continental and English breakfast.

The results can give insight into the environmental impact of dietary decisions. It can support environmentally conscious consumers in their dietary decisions, when picking breakfast or even in overall diet. The data used in this LCA is not supplier specific and is based on general databases and desk research. It gives an average view in the comparison between both breakfast options. Results can differ when comparing specific suppliers.

2.2 Scope

The following section describes the scope of this study. This contains, but is not limited to, identifying the different product systems, the product function and functional unit, the system boundaries, allocation procedures and cut-off criteria.

2.2.1 Functional unit

The amounts are based on recipes for one portion. The functional unit is a one person breakfast. The Full English breakfast was taken from an online recipe (Pratt, n.d.). The Continental breakfast was inspired by several recipes, but there is no set 'traditional' Continental breakfast. The term Continental breakfast refers to a breakfast served buffet style (often at hotels). However, we assumed that the one person Continental breakfast contained the most frequently mentioned components, as described in section 3.2. The traditional English breakfast has a caloric value of 807. To make a fair comparison, the breakfasts need to be equal in the energy they provide to the consumer. The Continental breakfast, with the selected ingredients, contains a comparable amount of roughly 800 calories.

This LCA compares two breakfast options with a caloric value of 800, taking into account the production and use phase.

2.2.2 System boundaries

This study focuses on the production and 'use' phase of the ingredients (see figure 1). The use phase considers the processes required from the consumer before eating the ingredients, e.g. gas for frying.

The disposal and waste treatment phase are not considered. Since we assume the breakfasts will be consumed completely, the disposal of either breakfast will be through organic waste in sewage water. The waste treatment will be equal, namely treatment in a wastewater treatment plant. Although there will be an environmental impact linked to this waste process, it is an inevitable process that is not specific to the consumption of these breakfasts.

The geographical region for this study is the Netherlands. When possible, local production was used. Otherwise transport was calculated to the Netherlands, or a global market reference was used.

2.2.3 Impact assessment method

This study uses the impact categories from the EF Impact Assessment Method. This impact assessment method is the result of the Product Environmental Footprint (PEF) Initiative and offers a standard for impact assessment, so it is easier and more meaningful to compare products.

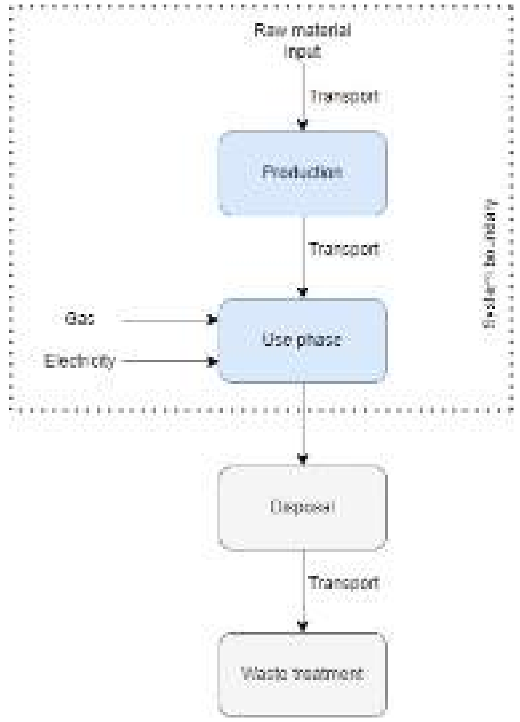

Figure 1. System boundaries of this LCA, for both breakfast recipes.

3. Life Cycle Inventory

3.1 Data collection

As this LCA is conducted as a comparative LCA without specific supplier data, the data is collected through desk research only. No specific data was requested from any producers or suppliers. This study will only compare the average difference in environmental impact between a Continental and full english breakfast. Based on the most popular online recipes for both, an overview of the required inputs was gathered. Based on this information, relevant processes of the Ecoinvent (v3.6) and Product Environmental Footprint (v2.0) are selected. The selected processes are described in detail in section 4.2.

Figure 1. System boundaries of this LCA, for both breakfast recipes.

Full English Breakfast

Item	Amount	Unit
Sausage	**1**	**unit**
Furnace	10	minutes
Pork	75	gram
Bacon	**2**	**unit**
Furnace	10	minutes
Pork	28	gram
Fresh tomatoes	**35**	**gram**
Baked beans	**100**	**gram**
Navy beans	51	gram
Tomato sauce	14	gram
Water	30	ml
Suiker	5	gram
Furnace	5	minutes
Black pudding	**50**	**gram**
Pig blood	3.125	gram
Water	21.875	ml
Pig fat	9.375	gram
Onion	1.5625	gram
Oats	11.875	gram
Pearl Barley	1.5625	gram
Coriander	0.1875	gram
Salt	0.3125	gram
Intestines for casing	0.01	gram
Furnace	120	minutes
Fried Egg	**1**	**unit**
Egg	53	gram
Furnace	5	minutes
Slice of bread	**1**	**unit**
Wheat flour	20.6	gram
Water	13.15	ml
Salt	0.2055	gram
Electricity for oven	0.8314	kWh
Cup of tea	**1**	**unit**
Water	200	ml
Dried tea leaves	2	gram
Electricity for cooker	0.02	kWh

3.2 Inventory and allocation

The recipes for both breakfasts are shown in tables 1 and 2. The recipes were slightly adjusted. Because of the lack of suitable database references the following ingredients were excluded from the analysis: Stabilizer (cream cheese), yeast (bread and bagel), black pepper (black pudding), mace (black pudding), mushrooms (Full English breakfast).

3.2.1 Production stage

All ingredients have been added with a market reference, when possible. Except for onions and fresh tomatoes, for which global markets were available. Both are produced in the Netherlands. However, there are no markets available for this region. Instead of using the global market, the local production references were used.

Table 2. The components and ingredients for the Continental breakfast are listed along with the amounts which were added.

Continental Breakfast

Item	Amount	Unit
Apple	**90**	**gram**
Yogurt	**150**	**gram**
Raisins	**15**	**gram**
Grapes	60	gram
Sunflower seeds	**15**	**gram**
Muesli	**40**	**gram**
Oats	40	gram
Drying in oven	0.55	kWh
Bagel	**1**	**unit**
Egg	53	gram
Honey	7.5	gram
Olive oil	1.05	gram
Sugar	1.875	gram
Wheat flour	65	gram
Water	45	ml
Salt	1.05	gram
Gas for furnace	5	minutes
Electricity for oven	0.55	kWh
Cream cheese	**30**	**gram**
Milk	20	ml
Cream	20	ml
Lemon juice	0.6	gram
Salt	0.2	gram
Gas for furnace	5	minutes
Cup of coffee	**1**	**unit**
Water	200	ml
Roasted coffee	7	gram
Electricity for cooker	0.02	kWh

No market reference was available for eggs. Therefore, a PEF2.0 reference for the production of eggs from non-cage, indoor hens was used instead.
No market reference was available for honey, therefore we used a production reference from PEF2.0.

3.2.2 Transport

When possible, a market reference was used. The transport (and losses related to this) from producer to consumer are included in these references. Often these transport distances are underestimated, therefore we added the transport for the total weight per breakfast as well. The distances were assumed to be 150 km.

3.2.3 Use

The use phase refers to the preparation of the ingredients in a household kitchen. It includes the electricity used for boiling water or heating an oven, and natural gas for a gas furnace.
It was assumed that ovens were preheated for 10 minutes at 2000 kW and kept at a stable temperature at 1000kW. We could assume that one uses 0.101 m3 gas per hour. This assumption is based on a daily use of one pit for one hour.

4.Data validation

4.1 Data quality:

4.1.1 Representativeness

When possible, the references were taken for Europe or the Netherlands. If these regions were not available, a global reference was used.

4.1.2 Consistency check

The quantitative data and process descriptions as described in this study are presented in such a way that they are reproducible and adaptable to more specific cases. Used references are selected based on the production location and adequate transport distances are estimated to match the defined system boundaries for this case study.

4.2 Qualitative and quantitative description of processes, scenarios and sources

This paragraph describes all background processes that are used to perform this LCA. Table 3 describes which references are selected for each emission source, from which database this reference is collected and why this reference is selected. All references are selected from Ecoinvent v3.6 or PEF v2.0.

Table 3. References, database and argumentation for all emission sources from both breakfasts.

Full English Breakfast

Emission source	Reference	Database	Argumentation
Gas	0111-pro&Aardgas, algemeen gebruik, per m3 (o.b.v. 31,7 MJ Heat, district or industrial, natural gas {RER}| market group for | Cut-off, U) [NL]	Ecoinvent v3.6	Most representative reference
Pork, pig blood, and pig fat	market for swine for slaughtering, live weight | swine for slaughtering, live weight | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Beans	market for fava bean, organic | fava bean, organic | Cutoff, U [GLO]	Ecoinvent v3.6	Proxy reference. Navy beans are not available.
Sugar	market for sugar, from sugar beet | sugar, from sugar beet | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Tomato (sauce)	market for tomato, processing grade | tomato, processing grade | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Tap water	market for tap water | tap water | Cutoff, U [EwS]	Ecoinvent v3.6	Most representative reference
Oats	market for oat grain | oat grain | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Coriander	market for coriander | coriander | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Pearl Barley	market for barley grain | barley grain | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Casing for black pudding	cattle for slaughtering, live weight to generic market for red meat, live weight | red meat, live weight | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Onion	onion production | onion | Cutoff, U [NL]	Ecoinvent v3.6	Most representative reference
Salt	market for salt | salt | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Electricity (oven)	market for electricity, low voltage | electricity, low voltage | Cutoff, U [NL]	Ecoinvent v3.6	Most representative reference
Wheat flour	market for wheat flour | wheat flour | Cutoff, U [RoW]	Ecoinvent v3.6	Most representative reference
Egg	Eggs, at farm, from laying hens, indoor system, non-cage, per kg [EU-28+3]	Product Environmental Footprint v2.0	Most representative reference
Tea	market for tea, dried | tea, dried | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Sausage	market for swine for slaughtering, live weight | swine for slaughtering, live weight | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Tomato (fresh)	tomato production, fresh grade, in heated greenhouse | tomato, fresh grade | Cutoff, U [NL]	Ecoinvent v3.6	Most representative reference
Transport (tomato, onion, honey, egg)	transport, freight, lorry with reefer, cooling | transport, freight, lorry with reefer, cooling | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference

Table 3: Selected database references for the emissions sources of ADL

Continental Breakfast

Emission source	Reference	Database	Argumentation
Apple	market for apple | apple | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Egg	Eggs, at farm, from laying hens, indoor system, non-cage, per kg [EU-28+3]	Product Environmental Footprint v2.0	Most representative reference
Gas	0111-pro&Aardgas, algemeen gebruik, per m3 (o.b.v. 31,7 MJ Heat, district or industrial, natural gas {RER}| market group for | Cut-off, U) [NL]	Ecoinvent v3.6	Most representative reference
Honey	Honey, at farm, conventional farming, per kg [EU-28+3]	Product Environmental Footprint v2.0	Most representative reference
Olive oil	market for olive | olive | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Electricity	market for electricity, low voltage | electricity, low voltage | Cutoff, U [NL]	Ecoinvent v3.6	Most representative reference
Sugar	market for sugar beet | sugar beet | Cutoff, U [RoW]	Ecoinvent v3.6	Most representative reference
Sugar from sugar beet	beet sugar production | sugar, from sugar beet | Cutoff, U [RoW]	Ecoinvent v3.6	Most representative reference
Wheat flour	market for wheat flour | wheat flour | Cutoff, U [RoW]	Ecoinvent v3.6	Most representative reference
Tap water	market for tap water | tap water | Cutoff, U [EwS]	Ecoinvent v3.6	Most representative reference
Salt	market for salt | salt | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Cream	market for cream, from cow milk | cream, from cow milk | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Lemon	market for lemon | lemon | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Milk	market for cow milk | cow milk | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Oats	market for oat grain | oat grain | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Coffee	market for coffee, green bean | coffee, green bean | Cutoff, U [GLO]	Ecoinvent v3.5	Most representative reference
Roasting of coffee	heat production, natural gas, at industrial furnace >100kW | heat, district or industrial, natural gas | Cutoff, U [EwS]	Ecoinvent v3.5	Most representative reference
Raisins	market for grape | grape | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Yogurt	market for yogurt, from cow milk | yogurt, from cow milk | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference
Sunflower seeds	market for sunflower seed | sunflower seed | Cutoff, U [GLO]	Ecoinvent v3.6	Most representative reference

5. Life Cycle Impact Assessment

5.1 Results

This section shows the results of the impact calculation. The EF impact method was used. It consists of several impact categories of which the results are presented in table 4. These results are a total from the production and use phase. No normalization or weighting method was used to obtain these results.

Table 4. The impact per category according to impact assessment method EF 3.0. No normalization or weighting was applied. The cumulative impact of all components of Full English Breakfast (FEB) and Continental Breakfast (CB) are displayed.

Impact category name	Reference unit	Total CB	Total FEB
Acidification	mol H+ eq	9.45E-03	1.83E-02
Climate change	kg CO2 eq	1.39E+00	2.29E+00
Climate change - Biogenic	kg CO2 eq	1.26E-01	3.44E-01
Climate change - Fossil	kg CO2 eq	1.18E+00	1.81E+00
Climate change - Land use and LU change	kg CO2 eq	8.53E-02	1.43E-01
Ecotoxicity, freshwater	CTUe	3.74E+01	1.38E+02
Ecotoxicity, freshwater - inorganics	CTUe	2.92E+00	9.86E+01
Ecotoxicity, freshwater - metals	CTUe	2.35E+01	3.13E+01
Ecotoxicity, freshwater - organics	CTUe	1.10E+01	8.24E+00
Eutrophication, freshwater	kg P eq	1.46E-04	1.73E-04
Eutrophication, marine	kg N eq	5.72E-03	7.17E-03
Eutrophication, terrestrial	mol N eq	3.58E-02	7.24E-02
Human toxicity, cancer	CTUh	1.01E-09	3.12E-09
Human toxicity, cancer - inorganics	CTUh	0.00E+00	0.00E+00
Human toxicity, cancer - metals	CTUh	5.07E-10	2.55E-09
Human toxicity, cancer - organics	CTUh	5.03E-10	5.70E-10
Human toxicity, non-cancer	CTUh	2.36E-08	2.57E-07
Human toxicity, non-cancer - inorganics	CTUh	3.29E-09	4.89E-09
Human toxicity, non-cancer - metals	CTUh	1.80E-08	2.50E-07
Human toxicity, non-cancer - organics	CTUh	2.47E-09	2.06E-09
Ionising radiation	kBq U-235 eq	3.43E-02	4.52E-02
Land use	Pt	1.78E+02	8.76E+01
Ozone depletion	kg CFC11 eq	9.00E-08	1.48E-07
Particulate matter	disease inc.	6.29E-08	1.37E-07
Photochemical ozone formation	kg NMVOC eq	3.18E-03	4.57E-03
Resource use, fossils	MJ	1.39E+01	2.16E+01
Resource use, minerals and metals	kg Sb eq	1.70E-05	4.14E-05
Water use	m3 depriv.	2.04E+00	1.55E+00

5.2 Relative impact

To ease the comparison between the two breakfasts, the impact per category was normalized and visualized in Figure 2. For most categories, the Full English breakfast has the biggest impact. When we look at Climate Change specifically, the impact of the Continental Breakfast is only 60% of the impact of Full English breakfast.

The exceptions are the categories 'Water use' and 'Land use'. 'Human toxicity, non-cancer - organics' and 'Ecotoxicity, freshwater - organics' also have a higher impact caused by Continental breakfast. However, when looking at their overarching categories 'Human toxicity, non-cancer' and 'Ecotoxicity, freshwater', the Full English breakfast is the main contributor. For 'Human toxicity, cancer - inorganics' both breakfasts had an impact of zero. Overall, we can say that it would be more sustainable to opt for an Continental breakfast over a Full English breakfast.

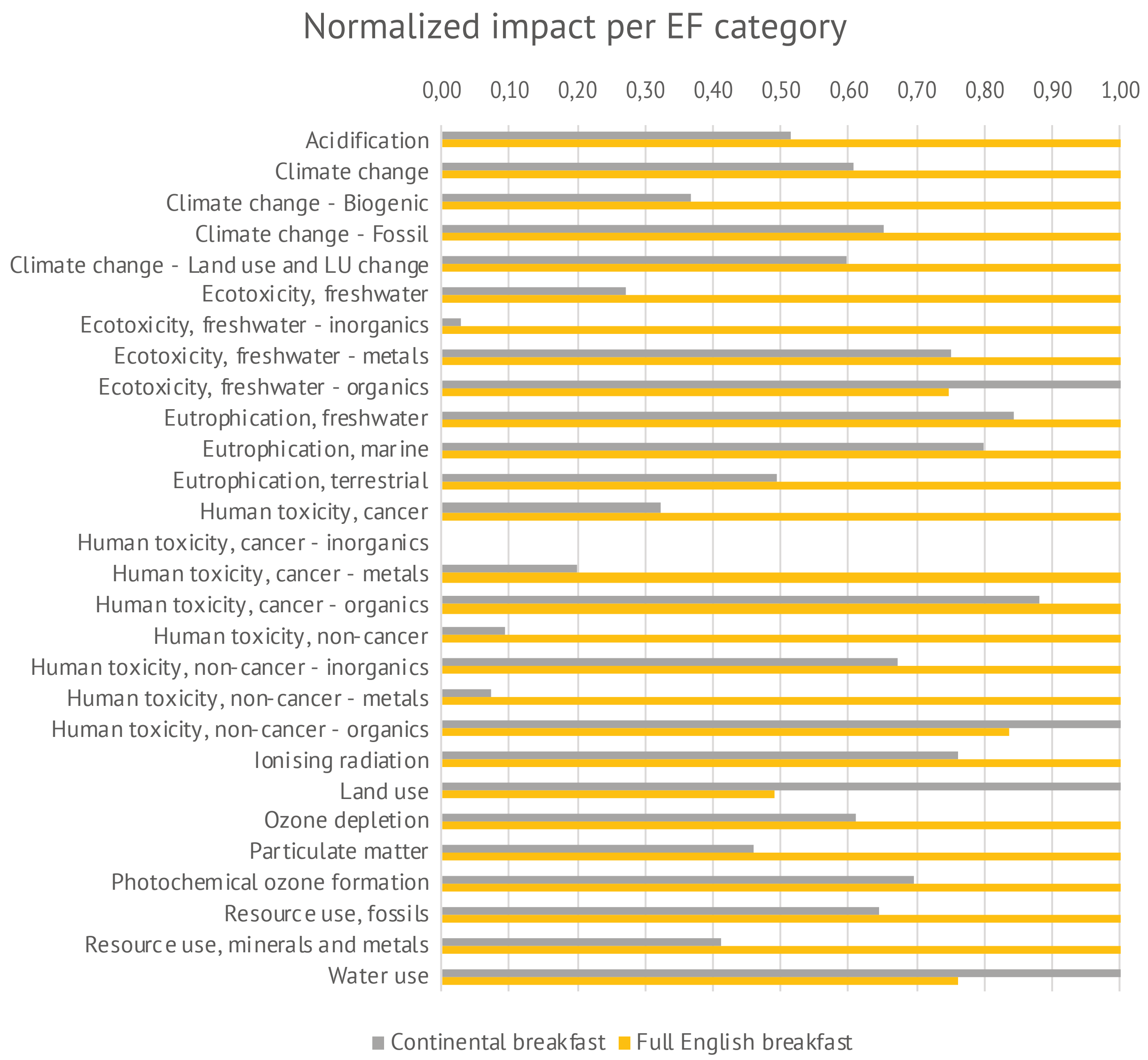

Figure 2. The normalized impact of both breakfasts for all EF categories.

5.3 Coffee vs. Tea

Additionally, the environmental impact of coffee and tea was isolated and studied closer. The relative environmental impact is shown in Figure 3. The impact of coffee is highest in all categories except Land use and Water use. In the ecoinvent references, irrigation of the tea plant takes 6.96 m3 of water whereas irrigation of the coffee plant takes 0.816 m3. The land use takes into account, soil quality index, biotic production, erosion resistance, mechanical filtration and groundwater replenishment. Tea production is apparently more harmful for those indicators. Producing and preparing a cup of coffee emits 0.071 kg CO2 eq. while the production and preparation of a cup of tea only emits 0.017 kg CO2 eq.

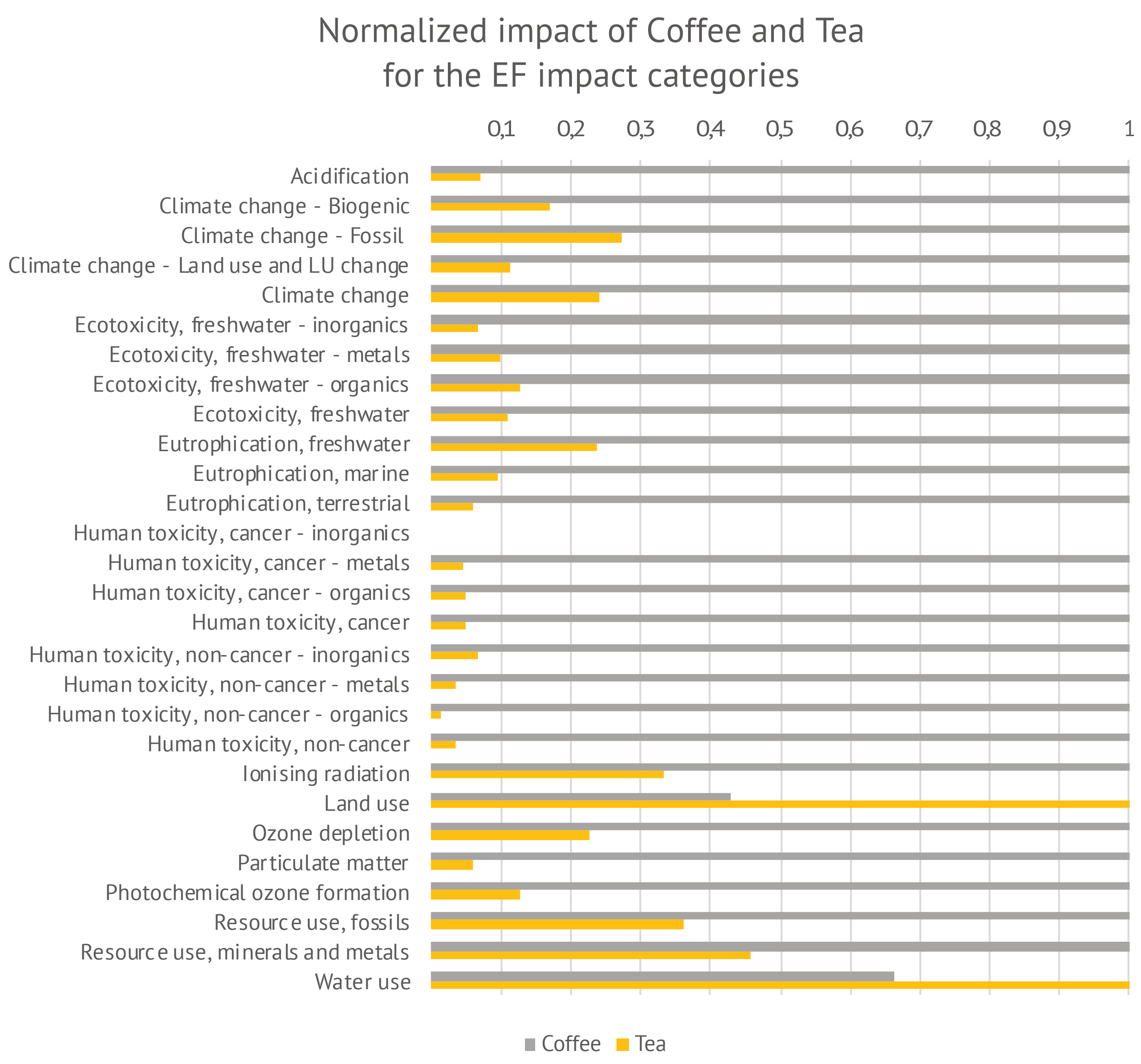

Figure 3. Normalized impact of coffee (from Continental breakfast) and tea (from Full English breakfast) for all EF categories.

6. Interpretation

6.1 Contribution analysis

In order to get a better understanding of which components cause the environmental impact for both breakfast recipes, a contribution analysis is made. By tracing the emissions back to the separate components of the breakfast, we can get a better understanding of the major contributing factors.

Figure 4 shows the contribution analysis of the Full English Breakfast. We see that 'sausage' and 'black pudding' are two components with a significant impact in most categories. Producing meat, in this case pork, is well known for being more intensive than producing fruit or vegetables. This is mostly caused by the large amount of feed an animal needs to produce a relatively small amount of meat.

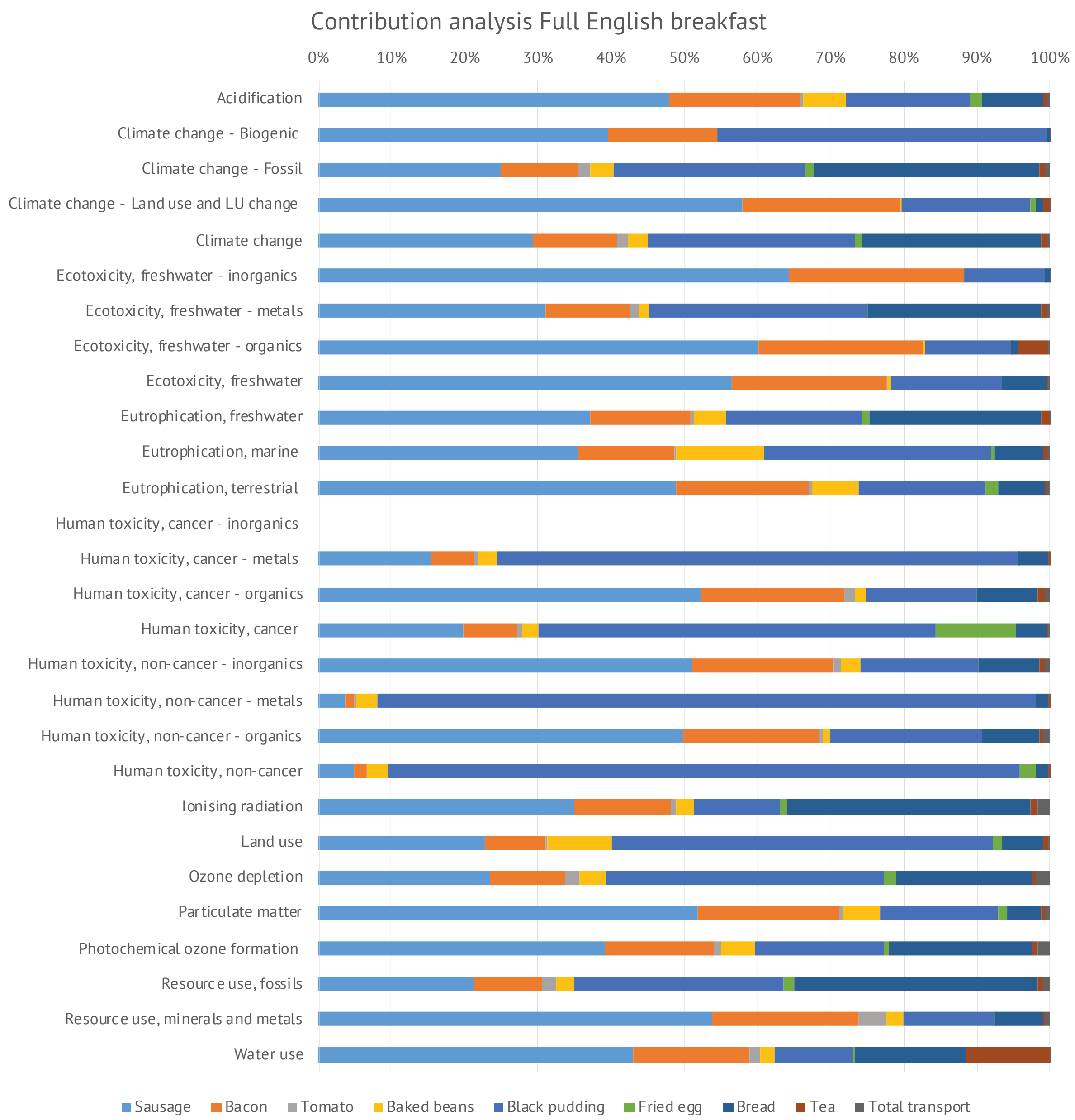

Figure 4. The impact per ingredient (%) per category for Full English Breakfast.

In figure 5 we see that the impact of coffee, bagel and yogurt are considerable for a number of categories. For coffee mostly in 'Human toxicity, cancer' and 'Human toxicity, non-cancer'. In the other categories, mostly yogurt, muesli and the bagel have big shares in the total impact. This can be explained by the naturally high impact of dairy products, especially in 'Land use' and 'Climate change - biogenic'. The preparation of the muesli (drying/roasting) and the bagel (boiling and baking) require some electricity and gas. The electricity mix in the Netherlands is largely based on fossil resources, which explains why these components score high in fossil fuel related categories.

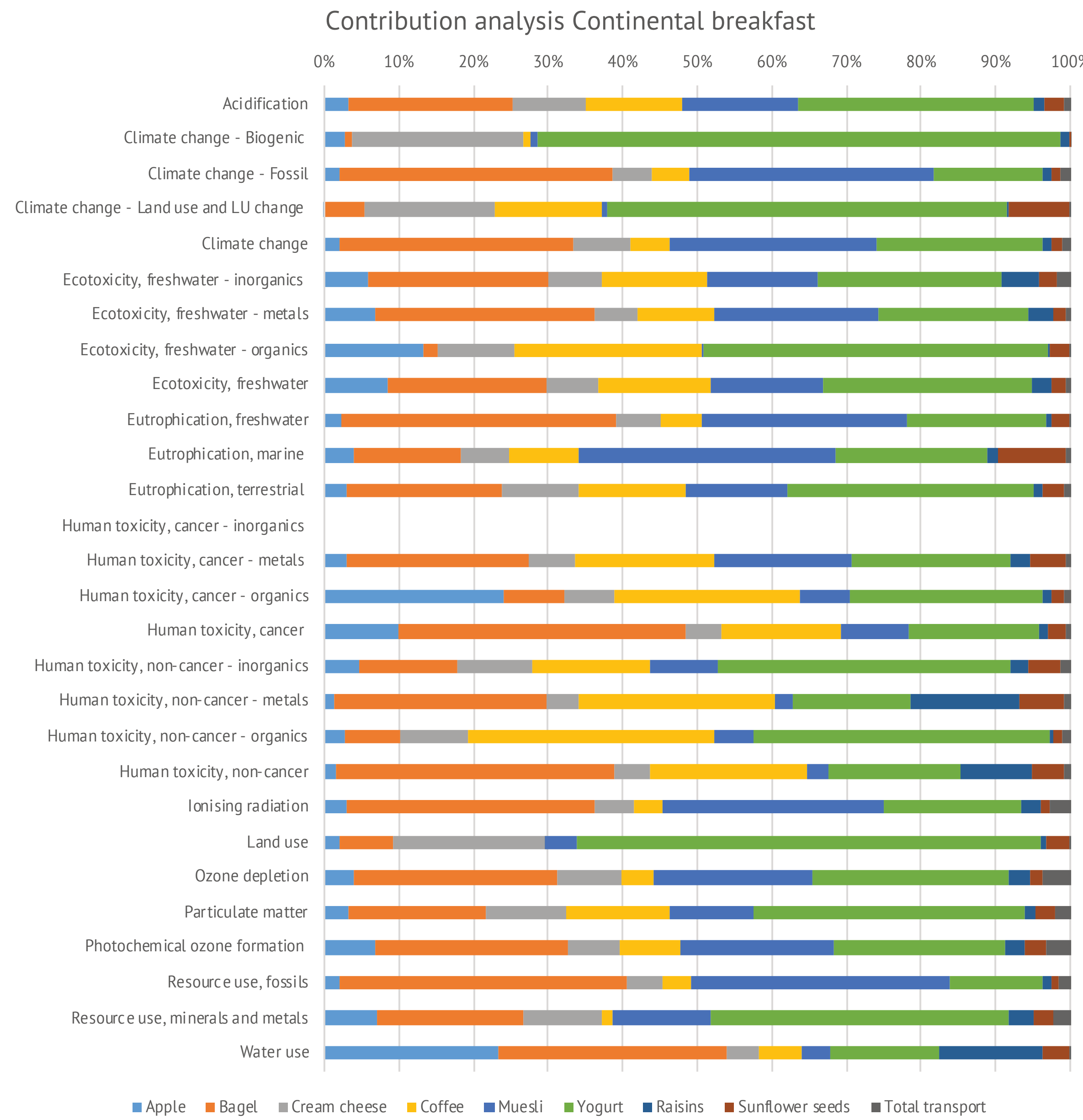

Figure 5. The impact per ingredient (%) per category for Continental Breakfast.

6.2 Sensitivity analysis

For the sensitivity analysis, the electricity for any kitchen processes was assumed to be 'green' electricity, which is produced by a mix of wood, biogas (from manure, biowaste, and sludge), wind energy, water energy and solar energy. The furnace with natural gas was replaced by an electric furnace (induction furnace) for all processes in the use phase. An induction furnace uses 0,479 kW per hour[7]. The reference used for the sensitivity analysis is shown in table 5.

Table 5. Reference, database and argumentation for the emission source used in the sensitivity analysis.

Emission source	Reference	Database	Argumentation
Electricity (green)	Electricity, low voltage, at grid/NL U (Groene stroom; 26,5% hout, 26,5% biogas uit mest, bio-afval en RWZI-slib, 45% wind, 1,4% hydro, 0,5% PV) [NL]	Nationale Milieudatabase v3.3	Most representative reference.

6.2.1 Sensitivity Full English breakfast

The replacement of natural gas and 'grey' electricity was followed by a large effect in the related categories. For the Full English breakfast, the biggest sensitivity was found to be in 'Human toxicity, non-cancer - inorganics' (+79%) 'Land use' (-52%), 'Ozone depletion' (-49%) and 'Resource use, fossils' (-58%). Also, in 'Climate change - fossil' a big decrease in environmental impact was seen (-44%), but this was partially compensated for in 'Climate change - biogenic' (+26%).

6.2.2 Sensitivity Continental breakfast

Also for the Continental breakfast, the categories Resource use - fossils (-66%) and 'Human toxicity, non-cancer - inorganics' (+63%) were notably affected by the replacement of fossil resources. Again, 'Climate change - fossil' decreased in impact (-55%) but 'Climate change - biogenic' increased (+41%).

The different sensitivities can be attributed to the different preparations for the ingredients. Sausages, bacon and a fried egg all need some preparation on a gas stove.

6.2.3 Overall sensitivity

Table 6 shows the overall results of both sensitivity analyses for all impact categories. Additionally, the percentual difference is calculated by comparing the baseline scenario with the sensitivity results.

The impact of 'green' electricity and the use of an induction stove is considerable, however the overall conclusion remains the same. Continental breakfast has the lowest impact in most categories, also in this scenario. To reach an even lower impact, the Continental breakfast could be prepared with 'green' electricity and an induction stove.

6.3 Discussion

The impact from the Continental breakfast was lower than that of Full English breakfast in all categories except 'Water use', 'Land use' 'Human toxicity, non-cancer - organics' and 'Ecotoxicity, freshwater - organics'. From the contribution analysis we could conclude that a large share of the impact was caused by the sausage and black pudding. The lack of these meat ingredients explains the notably lesser impact of the Continental breakfast. In table 7 the climate change impact of the studied meat products is compared to that of meat alternatives. One could replace meat products with these alternatives to save up to 65% in Climate change. However, since the impact on the other categories is not clear, it is not necessarily the most environmentally friendly option.

The Continental breakfast can be considered the most environmentally friendly option of the two breakfasts. However, it should be considered that for land and water use the Continental breakfast has a bigger impact. When one would want to eat a Full English breakfast but also mitigate the impact by using 'green' electricity and an induction furnace, the effect can decrease up to 66% in fossil fuel related emissions. Ultimately, the most sustainable option would be to use 'green' electricity and an induction furnace to prepare a Continental breakfast.

6.4 Conclusion

We can conclude that overall the most environmentally friendly option is the Continental breakfast, especially in combination with 'green' electricity and an induction furnace. However, to spare land and water use it would be advisable to opt for the Full English breakfast. The sensitivity analysis pointed out that it would make a significant difference to use 'green' electricity and an induction furnace for preparation of the ingredients, instead of fossil fuels.

Table 6. Sensitivity results of both breakfasts. With for each breakfast the baseline emissions, sensitivity results and percentual differences between those, for each impact category.

Impact category	Continental breakfast			Full English breakfast		
	Baseline emissions	Sensitivity results	Percentual difference	Baseline emissions	Sensitivity results	Percentual difference
Acidification	9.45E-03	1.10E-02	**16.685**	1.83E-02	2.23E-02	**21.633**
Climate change	1.39E+00	7.86E-01	**-43.372**	2.29E+00	1.59E+00	**-30.776**
Climate change - Biogenic	1.26E-01	1.78E-01	**41.040**	3.44E-01	4.35E-01	**26.237**
Climate change - Fossil	1.18E+00	5.22E-01	**-55.596**	1.81E+00	1.01E+00	**-44.093**
Climate change - Land use and LU change	8.53E-02	8.54E-02	**0.118**	1.43E-01	1.43E-01	**0.254**
Ecotoxicity, freshwater	3.74E+01	4.16E+01	**11.027**	1.38E+02	1.54E+02	**11.473**
Ecotoxicity, freshwater - inorganics	2.92E+00	2.97E+00	**1.870**	9.86E+01	9.92E+01	**0.614**
Ecotoxicity, freshwater - metals	2.35E+01	2.76E+01	**17.357**	3.13E+01	4.66E+01	**48.642**
Ecotoxicity, freshwater - organics	1.10E+01	1.10E+01	**0.052**	8.24E+00	8.27E+00	**0.403**
Eutrophication, freshwater	1.46E-04	1.13E-04	**-22.728**	1.73E-04	1.55E-04	**-10.230**
Eutrophication, marine	5.72E-03	5.69E-03	**-0.631**	7.17E-03	7.36E-03	**2.611**
Eutrophication, terrestrial	3.58E-02	4.31E-02	**20.587**	7.24E-02	8.81E-02	**21.775**
Human toxicity, cancer	1.01E-09	1.15E-09	**14.252**	3.12E-09	3.50E-09	**12.053**
Human toxicity, cancer - inorganics	0.00E+00	0.00E+00	**0.000**	0.00E+00	0.00E+00	**0.000**
Human toxicity, cancer - metals	5.07E-10	6.17E-10	**21.753**	2.55E-09	2.84E-09	**11.068**
Human toxicity, cancer - organics	5.03E-10	5.36E-10	**6.687**	5.70E-10	6.64E-10	**16.464**
Human toxicity, non-cancer	2.36E-08	2.98E-08	**25.952**	2.57E-07	2.72E-07	**5.932**
Human toxicity, non-cancer - inorganics	3.29E-09	5.36E-09	**63.062**	4.89E-09	8.75E-09	**78.794**
Human toxicity, non-cancer - metals	1.80E-08	2.17E-08	**20.612**	2.50E-07	2.61E-07	**4.267**
Human toxicity, non-cancer - organics	2.47E-09	2.77E-09	**12.097**	2.06E-09	2.70E-09	**30.966**
Ionising radiation	3.43E-02	1.68E-02	**-51.176**	4.52E-02	3.15E-02	**-30.230**
Land use	1.78E+02	2.04E+02	**14.487**	8.76E+01	1.33E+02	**52.395**
Ozone depletion	9.00E-08	5.99E-08	**-33.477**	1.48E-07	7.52E-08	**-49.061**
Particulate matter	6.29E-08	8.32E-08	**32.281**	1.37E-07	1.76E-07	**28.443**
Photochemical ozone formation	3.18E-03	3.01E-03	**-5.485**	4.57E-03	4.97E-03	**8.563**
Resource use, fossils	1.39E+01	4.72E+00	**-66.157**	2.16E+01	8.97E+00	**-58.499**
Resource use, minerals and metals	1.70E-05	2.17E-05	**27.678**	4.14E-05	5.21E-05	**25.856**
Water use	2.04E+00	1.98E+00	**-2.946**	1.55E+00	1.51E+00	**-2.713**

Table 7. Meat products and alternatives and their impact on Climate change per kg product. The scope per study differs and is summarized in this table.

Meat (alternative) (*1kg***)**	**Climate change** *(kg CO_2-eq.)*	**Scope**
Black pudding	*6.44*	*As described in section 2.2.2*
Sausage	*8.97*	*As described in section 2.2.2*
Bacon	*9.61*	*As described in section 2.2.2*
Beyond Burger	3.35	Production, packaging (disposal), production facility lighting, storage and distribution.
Quorn Vegetarische Stukjes	3.47	Production, packaging (disposal), storage, distribution and use.
Vegetarische hamburger[8]	3.77	Production, packaging (disposal), storage, distribution (also for supermarket), use and consumption loss, sewage and waste incineration.
Tofu[8]	4.34	Production, packaging (disposal), storage, distribution (also for supermarket), use and consumption loss, sewage and waste incineration.
Vegetarische schnitzel[8]	5.92	Production, packaging (disposal), storage, distribution (also for supermarket), use and consumption loss, sewage and waste incineration.

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