



Uncovering the different environmental impacts of protein choices

Perceived sustainability

Consumption of meat is associated with a high environmental impact. Therefore, eating (more) plant-based proteins is recommended. There are many meat alternatives available on the market, with different ingredients. This factsheet shows an environmental impact comparison of reference burgers based on meat (beef and chicken), a plant-based burger based on pea protein isolate (PPI), and canned beans.

Take home message

The more sustainable choice can be made by quantifying sustainability indicators as greenhouse gas emissions (GHG emissions in kg CO_2 equivalents). Here the AgroChain greenhouse gas Emissions (ACE) calculator was used to visualise, determine, and prioritise hotspots. Chicken and plant-based burgers are more sustainable in terms of GHG emissions than beef, with canned beans having the lowest emissions. When expressed per kg of protein, canned beans' impact becomes comparable to the pea isolate burger due to their lower protein content. Furthermore, it was found that more refined protein ingredients tend to have higher GHG emissions due to intensive processing.



Figure 1: Simplified steps to produce 1kg of meat/plant-based burgers or canned beans.

The ACE calculator

The ACE calculator provides **insights** in the effects of **interventions** on **sustainability** within **boundaries** of the food production and distribution chain.

The calculator aids in quantification of the environmental sustainability impacts of food processing systems and is able to include a wide range of interventions. Possible interventions include alternative ingredient and sourcing, energy sources, packaging, processing and end-of-life options.

Sustainability indicators: CO2-eq, energy, water

Case study

To evaluate different protein choices, a comparison between degree of processing and protein origin was made, see the scenarios in Fig. 1.

Main assumptions

The beef and chicken burger are used as reference products with data obtained from literature. For the plant-based options a commercial burger made with PPI and canned brown beans were used. Ingredients are primarily sourced from Europe. PPI is extruded to create a meat-like structure, with 5% loss during the process not being valorized (Heller & Keoleian, 2018). All burgers are packed in a plastic tray. The PPI burger also has a cardboard sleeve. The brown beans are sterilized and packed in a steel can, (the most common packaging for canned beans). Transportation and distribution are excluded, as the case study focuses on ingredients and processing. Furthermore, transportation and distribution are similar across scenarios.

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Results

- The GHG emissions impact of beef is about 3 times larger than the chicken burger and 10 times higher than the plant-based burger based on PPI. The GHG emissions of the canned beans are about 3 times lower than of the plant-based burger (Fig. 2a).
- Ingredients have the largest GHG emissions contribution to the burgers (Fig. 2a). For the canned beans, packaging and ingredients have the largest contributions (0.31 and 0.25 kg CO₂eq/kg product respectively). Note that the GHG emissions related to production of PPI and minced meat are considered part of ingredients and not of processing.
- The contribution of processing to the beef and chicken burgers is relatively small as mixing and patty forming is not energy intensive. The extrusion process of the PPI is energy demanding, but only 16% of the final burger consists of extruded PPI, which reduces the impact on total basis.
- When the GHG emissions are expressed per kg protein, the GHG emissions of the plant-based burger and canned beans are more similar (Fig. 2b). This is because the protein content of brown beans (6%) is much lower than that of the plant-based burger (16%). The beef burger contains 20% protein and the chicken burger 17%. Despite higher protein content, meat burgers have higher GHG emissions than PPI burgers, though the difference is smaller.

Intermezzo - degree of protein refining

Plant protein ingredients come in various forms and refining levels, each with a different environmental impact.



Figure 3: GHG emissions of different plant-based protein ingredients (Broekema 2009; 2011).

Beans, pea protein concentrate (PPC), and PPI vary in GHG emissions (Fig. 3). To make PPCs and PPIs, the peas must go through a process called fractionation to increase the protein levels. In PPC, the protein content reaches 50-75%, while in PPI this is >80% protein (Boukid 2021). This fractionation process involves several steps, and each step adds to the overall GHG emissions from the processing. In addition, more raw material is needed to produce the protein-enriched ingredients, therefore both the ingredients and transport GHG emissions are larger.

Information

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Advise to facilitate sustainable protein choices?

To reduce environmental impact and improve sustainability in meat alternatives, ingredient sourcing should consider several factors:

- Choosing more whole foods, such as beans, chickpeas, and peas, when possible. Products with less processed ingredients typically have lower protein content, but also have a lower environmental impact. As most people in the Netherlands meet their daily protein intake (Voedingscentrum), choosing whole foods still provides sufficient proteins.
- Avoiding plant protein ingredients with higher footprints, for example try finding alternatives for refined ingredients such as protein isolate, which requires extensive processing. Choosing a product made with protein concentrate instead, could lower the footprint significantly.

Please keep in mind that the outcomes of this factsheet are product specific, comparing other meat/plant-based burgers or beans may lead to a different outcome. Please find complete information in the report or contact us for more details. Learn more about our <u>sustainability assessment tools</u>.

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