It’s the small things in life: Chicken or chickpeas?

Student activity sheet

The issue

There are billions of people alive on Earth, and we all need feeding. Our diet must include protein-rich food for health and well-being. Meat and other animal products are important sources of protein for many people, but the animals we eat as meat need to feed on plants or other animal products themselves in order to grow big enough for us to eat. Since animals do not convert 100% of the protein in the plants they eat into meat that we can eat, this process is not efficient – protein is being wasted.

Should we all eat chickpeas – and other plant products high in protein – in place of chicken or other meat? Are some types of meat produced more efficiently than others? Would eating insects be a more efficient way of providing the protein-rich food that people enjoy?

Introduction

In this investigation, you are provided with four different sets of data about the efficiency with which animals convert food into meat and about the sustainability of meat production. When you have completed the activities you can use the information to think about the resources needed for your own diet, and whether you think it is sustainable.

Activities

Plant or animal protein?

Plants respire oxygen to carbon dioxide, but they take more carbon dioxide out of the atmosphere by photosynthesis in order to live and grow. Animals produce two greenhouse gases, carbon dioxide and methane, which add to global warming. When we eat animals instead of plants, we add another trophic level into the food chain, which makes it less efficient.

Here is a comparison of a protein-rich plant food – chickpeas – with animal protein – chicken.

Maksim Shebeko / Fotolia.com

Chicken

Per 100 g:

- Calories: 165 (690 kJ)
- Protein: 31.0 g
- Carbohydrate: 0.0 g
- Fat: 3.6 g

Figure 1 Cooked skinless, boneless chicken breast.

aalexandro900 / Fotolia.com

Chickpeas

Per 100 g:

- Calories: 164 (686 kJ)
- Protein: 8.9 g
- Carbohydrate: 27.4 g
- Fat: 2.6 g

Figure 2 Cooked chickpeas.

Questions

1. Produce a bar chart to compare the nutritional value of 100 g of cooked skinless, boneless chicken breast with 100 g of cooked chickpeas.
2. Draw up a table to show the advantages and disadvantages of eating chicken or chickpeas as your main protein source. Include as many factors as you can think of, not only their nutritional value.

How much plant makes meat?

Food conversion rates (FCRs) measure how efficiently animals turn their food into new animal. They express the ratio of kilograms of food required per kilogram of new animal created.

The FCRs used here are largely taken from a study commissioned by DEFRA (the Department for Environment, Food and Rural Affairs) and are based on farmers' records from many thousands of animals. They are still only approximate – many factors will affect them.

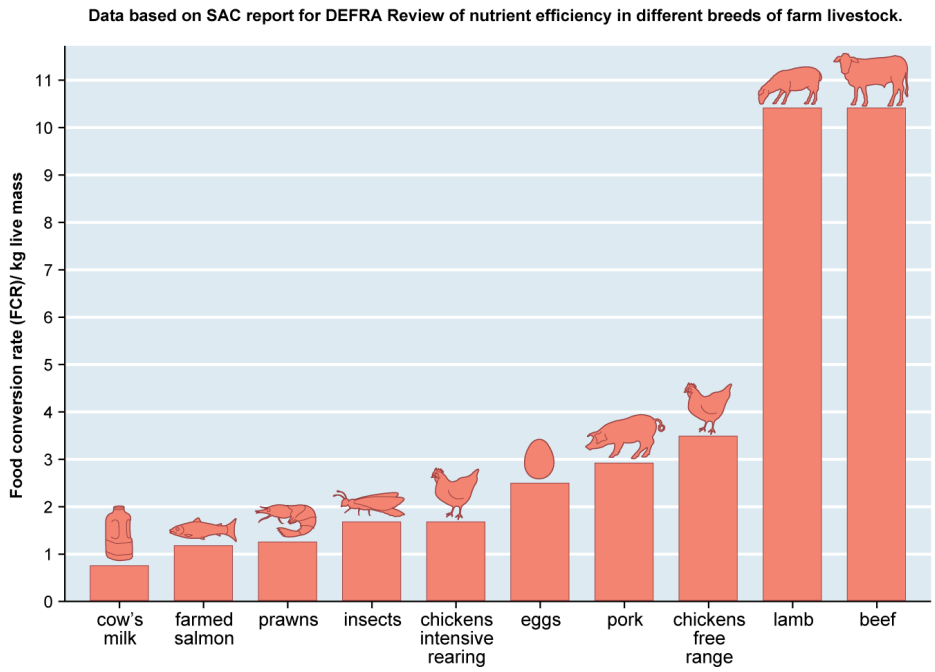

Figure 3 Food conversion rates for different breeds of farm livestock.

Questions

3. Which breed of animal has the most efficient FCR?
4. The FCRs for all these animals are only approximate. Suggest two reasons for this.
5. Suggest reasons why the FCR of broiler chickens intensively raised in barns for meat is so much more efficient than the FCR of free-range hens.
6. Explain why sheep and cows are so much less efficient than many other animals at converting food into new animal. (***Hint:*** Investigate the ways in which fish, chickens, pigs, sheep and cows are farmed.)
7. Choose one meat that can be produced very efficiently and produce a poster encouraging people to eat more of it and less of others, explaining why.
8. How can the milk ratio be less than 1 FCR/kg?

Grass, cows, carbon footprints and protein

World population is growing. As countries become more affluent, more people want to eat high-protein foods such as beef, chicken, pork and lamb. The Rothamsted Research team are looking at farming systems that can deliver red meat in sustainable ways, in work that challenges current negative attitudes to meat production. Their North Wyke Farm Platform in Devon is a research farm with the technology to monitor everything from the type of food eaten by the cattle in the fields to greenhouse gas fluxes in the atmosphere and water runoff. Different areas of the farm grow different grasses and clover, which are kept completely separate from each other.

Rothamsted Research

Figure 4 North Wyke Farm, Devon, UK.

Here are some of the findings from the farm:

- Cattle and sheep convert food that people cannot eat (grass and crop waste) into high-quality protein – meat!
- Grazing cattle and sheep means land that cannot be used to grow crops can still be used to produce protein food for people.
- Grassland acts as a store of carbon.
- Grazing maintains high biodiversity in habitats.
- Different diets produce different fatty acids and mineral contents in the meat, and can make it healthier as part of a balanced diet.
- Developing different grasses through selective breeding or biotechnology can produce pasture that improves efficiency and reduces greenhouse gas emissions.

Visit the Rothamsted Research website to find out more (**http://www.rothamsted.ac.uk/farmplatform**) and watch their video *The Real Beef About Meat* on **https://www.youtube.com/watch?v=VghbSbb8K1U**. Then answer the questions below.

Questions

9. Explain the main concerns about eating beef and lamb in terms of:

a) inefficiency of protein production and land use

b) the environmental effect

c) health.

10. Discuss how the work at Rothamsted Research on cattle and sheep shows that they can be farmed sustainably to produce beef and lamb relatively efficiently, with minimal environmental effect and with health benefits compared with existing types of meat.

Crickets are not a free lunch

This is an abstract from a research article by scientists Mark Lundy and Michael Parrella.

Vladimir Wrangel / Fotolia.com

Figure 5 House crickets (*Acheta domesticus*).

It has been suggested that the ecological impact of crickets as a source of dietary protein is less than conventional forms of livestock due to their comparatively efficient feed conversion and ability to consume organic side-streams [waste]. This study measured the biomass output and feed conversion ratios of house crickets (*Acheta domesticus*) reared on diets that varied in quality, ranging from grain-based to highly cellulosic diets [material high in cellulose, such as straw]. The measurements were made at a much greater population scale and density than any previously reported in the scientific literature. The biomass accumulation was strongly influenced by the quality of the diet […] In addition, for populations of crickets that were able to survive to a harvestable size, the feed conversion ratios measured were higher (less efficient) than those reported from studies conducted at smaller scales and lower population densities.

Compared to the industrial-scale production of chickens, crickets fed a poultry feed diet showed little improvement in protein conversion efficiency, a key metric in determining the ecological footprint of grain-based livestock protein. Crickets fed the solid filtrate from food waste processed at an industrial scale via enzymatic digestion were able to reach a harvestable size and achieve feed and protein efficiencies similar to that of chickens. However, crickets fed minimally processed, municipal-scale food waste and diets composed largely of straw experienced >99% mortality without reaching a harvestable size. Therefore, the potential for *A. domesticus* to sustainably supplement the global protein supply, beyond what is currently produced via grain-fed chickens, will depend on capturing regionally scalable organic side-streams of relatively high quality that are not currently being used for livestock production.

(Source: Lundy ME, Parrella MP. Crickets Are Not a Free Lunch: Protein Capture from Scalable Organic Side-Streams via High-Density Populations of *Acheta domesticus*. *PLoS ONE* 10(4) 2015; e0118785. DOI: 10.1371/journal.pone.0118785.

http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0118785

Questions

11. Identify and describe the clues in the abstract that tell you the research article was aimed at scientists, not GCSE students.

12. Use the information in this abstract to produce an article presenting arguments either for or against farming crickets as an alternative form of protein.

Summary activity

Produce a poster, podcast or presentation on the sustainability of eating meat as a source of protein.

Consider your own diet: are there any changes you would like to make to make it more sustainable?