Plastic Particles in Livestock Feed, Blood, Milk, and Meat

A Pilot Study

Conducted by the Vrije Universiteit Amsterdam (VU)
Commissioned by Plastic Soup Foundation (PSF)

The Netherlands is home to millions of livestock animals for human consumption. There are currently around 3.7 million cows and 11.5 million pigs. About 1 million sheep are kept, as well as about 0.33 million goats for milking. These farm animals may be exposed to plastic particles via their feed and other exposure routes such as water or air. Dairy or meat products of these animals end up for human consumption.

This pilot study sought to screen a variety of samples from livestock (cows and pigs) farms in the Netherlands for the presence of plastic particles. Studies of exposure to plastic particles on farms were lacking prior to this study. The a small sample size (inherent of pilot studies) in each category, provides a **first indication** that plastic particles are present at detectable concentrations in modern-day livestock feed, in the animals that eat it, and in products from the farm (including processed, plastic-packaged products).

This small-scale study does not allow for making any broad sweeping generalizations about the concentration range, frequency of detection, differences between the sample types, or infer conclusions about which plastics are the most prevalent. It's a starting point, not a concluding point.

The concentrations encountered in this small set of samples do raise big questions on just how widespread this issue is.

Samples collected:

- **Feed**: feed pellets (n=9), fresh feed roughage (n=5), and shredded supermarket feed (n=2);
- **Blood**: from cows (n=12) and pigs (n=12);
- **Milk**: from cows including hand-milked milk (n=5), tank milk (n=5), and packaged milk from supermarkets (n=15);
- **Meat**: meat samples, all plastic-packaged, including filet and processed meat products (from both farms and supermarkets) (n=16).

Measurements of plastic particles:

- The methodology delivers mass concentrations of different plastic polymers
- The mass concentration is expressed as microgram polymer per gram sample
- Particles were not counted with this method.
- The sizes of particles targeted for extraction and analysis was700 nm and larger
- Quality controlled analytical procedure applied (e.g. monitoring background plastic contamination)
- The method had been previously validated for the analysis of human blood (Leslie et al., 2022)
- The present study also included the polymer polyvinyl chloride (PVC-P)

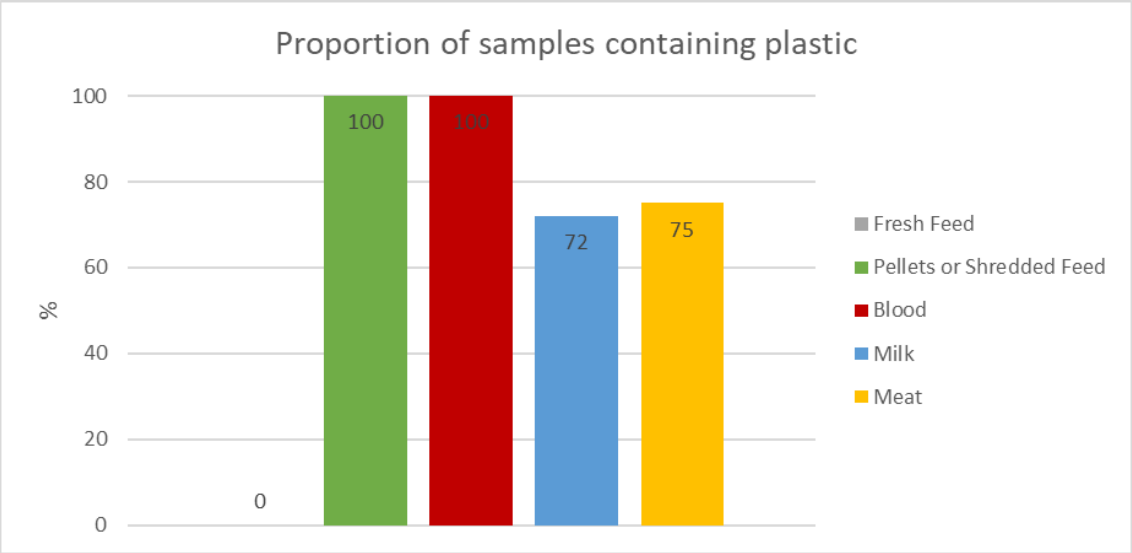
- The methodology applied did not measure the concentrations of additives (or any other small molecules) that may be present in the plastic.

High production volume polymers targeted:

- polymers of polyvinyl chloride (PVC-P)
- poly(methyl methacrylate) (PMMA)
- polypropylene (PP)
- polymers of styrene (Styr-P)
- polyethylene (PE)
- polyethylene terephthalate (PET)

Overall:

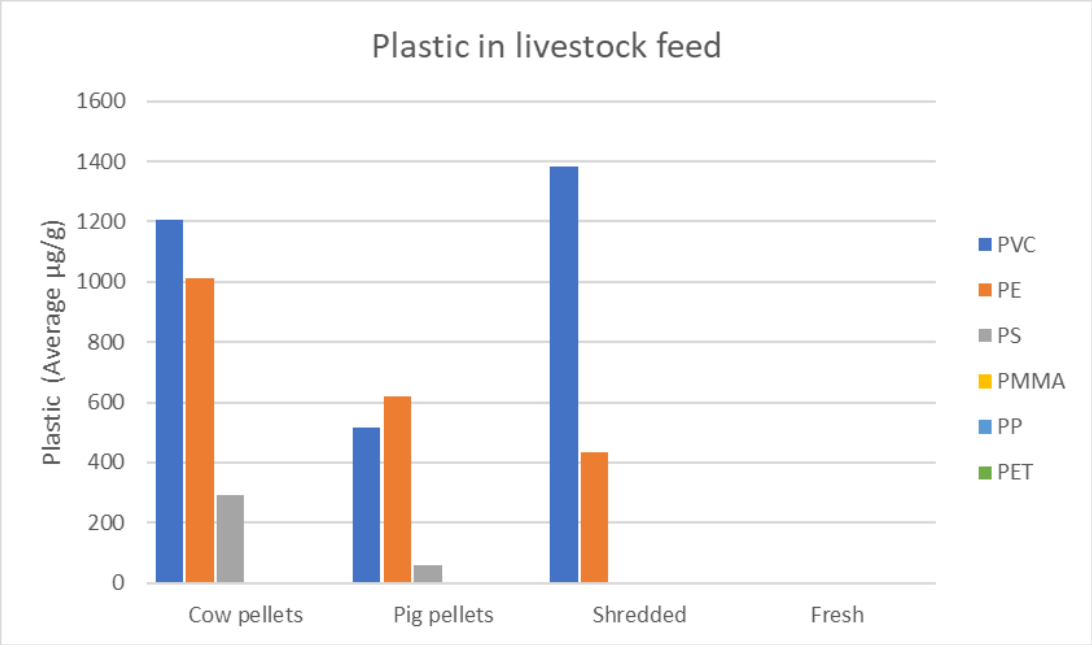
- 80% of all samples combined, contained detectable amounts of at least 1 type of plastic
- None of the fresh feed samples contained detectable amounts of plastic particles.
- 100% of the pellets and shredded feed samples contained detectable amounts of at least 1 type of plastic
- 100% of the cow and pig blood samples contained detectable amounts of at least 1 type of plastic
- 72% of the milk samples of any type contained detectable amounts of at least 1 type of plastic
- 75% of the meat samples of any type contained detectable amounts of at least 1 type of plastic



Feed:

Fresh feed => None of the samples (n=5) contained detectable amounts of plastic particles.

Pellets and shredded feed (n=12):
PVC-P and **PE** in all samples
Styr-P in 8 samples
PMMA, **PP** and **PET** were <u>not</u> detected.



Blood **=>** Plastic particles were detected all blood samples

All Cow blood samples (n=12) contained **PVC-P**, **PE** and **Styr-P.**
Cow blood had below detection limits of **PMMA** and **PET**

All Pig blood samples (n=12) contained **PE** and **Styr-**P
Some pig blood samples also contained **PET**, **PP**
Pig blood had below detection limits of **PMMA**

Milk **=>** Plastic particles were detected in 18 of 25 milk samples of all types.

PMMA was found in 68% of the milk samples,in concentrations only just above the limit of detection
PVC was found in 16% of the milk samples
PE was found in 2 milk samples
PET was found in 1 milk sample
PP and **Styr-P** were <u>not</u> detected in any of the milk samples.

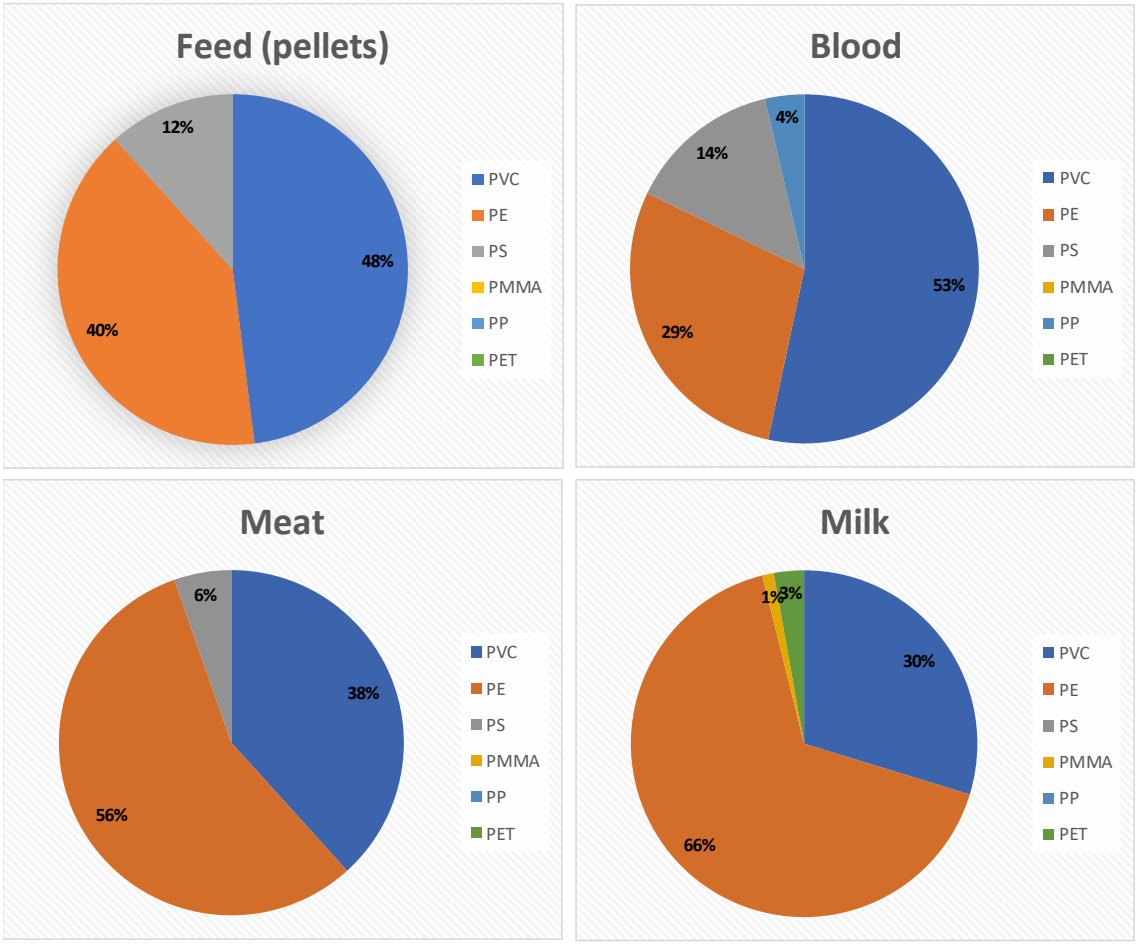
Although some of the milk samples did contain one or more plastics types, a general answer cannot be given on how much plastic is present in Dutch cow's milk.

Meat => Plastic particles were detected in most meat samples:

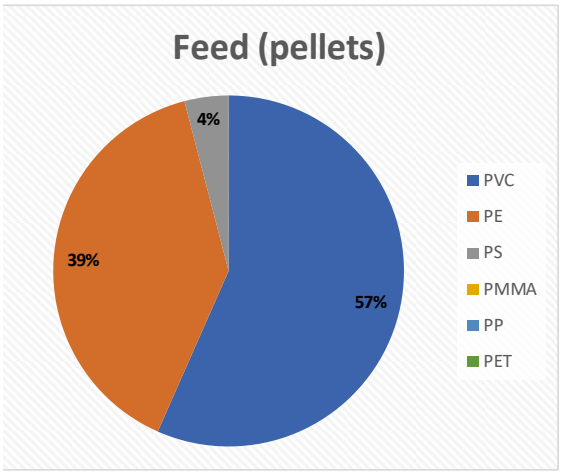
Beef 7 of 8 samples contained at least one plastic type;
PVC-P and **Styr-P** (77-200 µg/g) were found in 3 samples
PE was found in 7 samples
PMMA, **PP**, and **PET** were not detected.

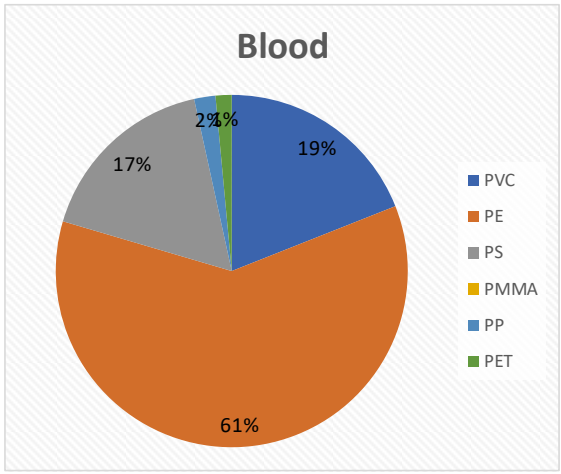
Pork 5 of 8 meat samples contained at least one plastic type.
PE in 5 samples (88-690 µg/g).
PVC-P and **PP** each only in 1 sample
PMMA, **STYR-P** and **PET** were not detected

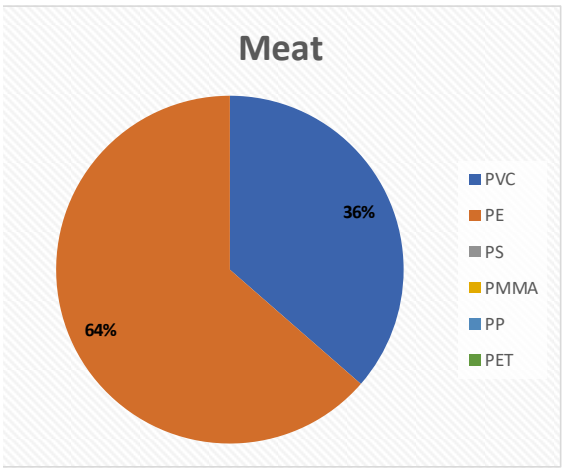
Cow samples: Proportion of different types of plastic



Pig samples: Proportion of different types of plastic







Plastic particles **in feed pellets** represents one of the possible exposure routes through which plastic particles reach the bodies of animals, alongside ingestion of water and respiration of air, (the latter two routes were outside the scope of this study and are currently included in other human exposure research initiatives).

The plastic particle concentrations measured **in blood and hand-milked milk** samples are indicative of the 'internal exposure' in the animals, i.e. the particles that had been absorbed in the animal's body.

Large particles are not absorbable across biological membranes. This means that any plastic particles detected in an animal's bloodstream itself are likely to be very tiny.

Blood and hand-milked milk samples did not come into contact with plastic parts of milking equipment or plastic packaging, or the polymeric lining inside glass bottle caps (unlike supermarket milk and all meats packaged in plastic), and therefore are more indicative of the concentrations in the bloodstream and milk in the animal's body at the time of sampling.

Outlook

A much larger number of samples should be measured in follow up studies to increase the understanding of the range of concentrations, frequency of detection in the animals and products, temporal and spatial variation in the concentrations, statistical differences between sample types etc.

For a formal exposure assessment, hundreds of samples are typically required for achieving representative sampling for full statistical analysis. This was beyond the scope of this pilot study.

Plastic sources, potential uptake routes and toxicological effects were outside the scope of this pilot study.

No conclusions can be drawn regarding where all the plastic particles came from, or exactly how they entered the feed or the animals' bodies (blood, milk and meat).

Until further research is completed it remains unknown if there are any potential toxicological risks of these findings. Exposure data are an essential element of risk assessment, as they give information on the real-world plastic particle concentrations that are present. These concentrations can then be compared to the threshold concentrations above which adverse effects on populations are expected, as determined in laboratory toxicity tests.

Conclusion

Animals are able to absorb at least some of the plastic particles they are exposed to in their living environment (i.e. via feed, air and/or water).

Some milk and meat products also contain plastic, though it has not yet been investigated if this is the result of plastic absorption into the animal body from feed, water and/or air, or the result of processing and/or packaging of the milk and meat, or all of the above.

Ingestion is an uptake route that is suspected to play a major role in determining plastic doses and internal exposure.

No conclusion can be made whether the concentrations observed in this study are safe or not safe until toxicological data is collected.

This pilot study should act as an impetus to further explore the full scope of exposure and any risks that may be associated with it.

The production of plastic-free feed for animals may be one of the ways to improve the plastic particle exposure scenario for livestock.