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Plastic to Microplastic: An Emerging Challenge to Animal Health and Food Safety

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Introduction:

It can be stated that plastics have now become an indispensable part of modern livestock and poultry production systems. Plastics are used in packaging, feeding, drinking water supplies, silage films, machinery, agricultural film covers and many other agricultural products. Their low cost, durability and versatility make their use almost unavoidable. But the story does not end here when it comes to discarding any plastic material. Exposure to sunlight, temperature, humidity, mechanical degradation and environmental degradation of any plastic material results in the decomposition of larger material to smaller sizes. These small particles less than 5mm are called microplastics (MPs). Nanoplastics are plastic particles smaller than 100 nm.

What needs to be emphasized is the occurrence of these small particles not only in aquatic ecosystems but also in agricultural soils, animal feed, manure and livestock and poultry production. Microplastics have been recently considered an emerging hazard to animal health, livestock productivity and food safety.

Methods by Which Microplastics Enter Farm Animal Systems:

There are various methods through which farm animals ingest microplastics.

- **Feed:** Contamination can occur at various points including feed/ingredient production and processing. Equipment breakdown and the degradation of feed packaging also introduce plastic fragments.
- **Water:** Microplastics may enter farm water sources due to plastic pipes, water containers, and storage units degrading.
- **Farmland:** Plastic litter and films deposited on the farm can also contaminate the farm with microplastics. In addition, soil can also contain microplastics due to contamination.
- **Manure and Compost:** Livestock manure, containing microplastics, is frequently used as fertilizer. Microplastics then end up in soil, and then ultimately end up in farm feed, farm crops, and even back

in livestock.

- Essentially, a simplified view of the path of a microplastic would be:

Plastic waste → Soil/water → Feed → Animal → Animal product

- A number of recent studies have shown that there is microplastic contamination on farms, especially on farms for livestock and poultry.

What Happens After Animals Ingest Microplastics?

The gastrointestinal tract is amongst the first biological systems that come into contact with ingested microplastics.

Microplastic exposure has been shown to be associated with the following issues:

- Dysbiosis of gut microbiota,
- Oxidative stress,
- Inflammation,
- Alterations in intestinal permeability,
- Metabolic disorders,
- Mitochondrial and cellular damage, and
- Gene expression.

In poultry, recent literature has documented various potential effects that may occur due to ingestion of microplastics in terms of the above-mentioned organs and physiological functions.

Nevertheless, a very important scientific point needs to be made here. The fact that microplastics exposure could be equated with any clinically defined disease in livestock should not be presumed a priori.

Most of the evidence comes from laboratory-based studies, which may use different exposure concentrations that are not necessarily comparable with those seen in natural farm settings. In a 2025 review, it was reported that oxidative stress, inflammation and apoptosis were proven experimentally, yet the impact of real-life exposure doses remains unknown. This is especially relevant to communicating the risks of microplastics exposure to farmers and the general public.

Poultry: An Emerging Area of Concern

Poultry farming should also receive special consideration since poultry birds can be exposed via feed, water, and litter as well as the environment around them.

According to recent reviews, microplastics could accumulate or be found in different tissue organs and that experimental exposure could affect gut flora, oxidation status, metabolism, growth, and reproduction.

Effects on poultry farming may involve the following:

Growth → feed efficiency → gut flora → immunity → egg laying → meat quality

However, the field is yet in its infancy stage. Further standardized research is needed to find out real

exposure levels in commercial poultry farming.

What About Cattle, Sheep and Goats?

Information on ruminants is far less compared to that of poultry. Contamination of ruminants, including cows, sheep and goats, may occur via polluted feeds, water, soil and the surrounding environment on farms. Effects of contamination may be seen in the digestive system and in relation to rumen microorganism populations.

One of the areas worth investigating is whether microplastics can affect rumen fermentation and rumen microbiome activity. This is an important aspect to investigate since the rumen is an ecosystem composed of microorganisms whose main function is to breakdown plant material into nutrition for the animal. Nevertheless, there are no studies that show routine contamination of animals with environmental microplastics results in reduced production.

Microplastics And the Food Chain:

The issue goes beyond animal welfare. Livestock and poultry serve as a source of food for human beings. Thus, the potential for the transfer of plastic fragments from the environment to animals, which would ultimately enter food tissues, has become a matter of growing scientific interest.

The chain of events is:

Farm environment → feed / water → animal → tissue / animal products → consumer

Plastic particles have been found in livestock and poultry tissue samples through scientific publications.

However, measuring their actual concentrations is difficult due to contamination in laboratories and varying methodologies used.

Thus, the scientific question is not: “Are there microplastics?"

But rather: “How much are animals actually exposed to, where do the particles come from, how much is retained, and what is the biological significance?”

Microplastics and Antimicrobial Resistance (AMR):

Microplastics are increasingly recognised as potential hotspots for microbial colonisation and interactions among microorganisms, antibiotics, and antimicrobial resistance (AMR) genes. Their surfaces can support microbial biofilm formation and may facilitate the persistence and exchange of AMR genes under certain environmental conditions.

This emerging concern is particularly relevant to animal husbandry, where livestock manure, agricultural wastewater, and contaminated soils may contain microplastics, antibiotic residues, antibiotic-resistant bacteria, and AMR genes. These components may interact and potentially contribute to the persistence and dissemination of antimicrobial resistance in the environment.

Can Farmers Prevent Microplastic Contamination?

The complete removal of plastics from the practice of agriculture in today’s world may be

impractical. However, the idea must aim at reducing the risk and managing the plastic responsibly.

1. Reduce use of plastics where unnecessary: Use of sturdy and reusable material must be adopted, especially in the case of frequently handled farm implements.
2. Proper storage of feed: Feed must be kept in clean and dry places, free from contaminated and torn packaging.
3. Prevention of plastic mixing into feed: Plastic fragments of any form must not be mixed with feed under any circumstances.
4. Maintenance of water supply systems: Regular cleaning of water tanks, pipes and drinkers is essential. Plastic materials that have severely degraded due to age must be replaced.
5. Do not burn plastic waste in open air: Plastic burning in the open air may lead to emission of harmful materials. Thus, plastic waste must be segregated and taken through waste management processes.
6. Removal of plastic from manure and compost: It is imperative to remove plastic materials before spreading manure or compost in agricultural lands, thus preventing the recycling of plastic into soils.
7. Maintenance of cleanliness on the farm: Adoption of simple cleanliness methods can prevent the accumulation of plastic bags, ropes, feed sacks and agricultural films on the farm.

What Can Veterinary Professionals Do?

There is an important contribution that veterinarians can make in this emerging area.

Farmers can be guided by veterinarians to identify environmental sources of plastics and include plastic management measures in farm health programs.

Other areas of research that veterinary scientists can work on include:

- detection of microplastics in feed and water;
- detection in manure;
- gastrointestinal and ruminal effects;
- change in gut microbiota;
- oxidative stress and inflammation biomarkers;
- impact on poultry growth and egg production;
- measurable impact on meat quality;
- the link between antimicrobial resistance and microplastics;
- accumulation in animal-derived foods; and
- biological and physicochemical methods of removing microplastics.

Some recent studies have investigated the use of microorganisms for plastic degradation, which is still in the research and development phase.

From "Plastic Pollution" To "Farm-To-Food Safety":

Microplastics pose a rather new research question to veterinarians.

The problem must not be considered in terms of being purely environmental. Microplastics effect on animal health, nutrition, microbiology, environmental biotechnology, food safety and public health are to be taken into consideration. So, in the future research agenda it is necessary to move from mere detection of microplastics to understanding of their real biological significance.

There are three key questions here:

- Where do microplastics come from?
- What occurs after exposure to microplastics in animals?
- How can we prevent contamination of animals all the way from farm to food?

To answer these questions the cooperation of veterinarians, animal scientists, microbiologists, environmentalists, toxicologists and food safety experts would be required.

Conclusion:

Microplastics are small, persistent and increasingly detected pollutants of agricultural environments. Experimental studies show that exposure can alter biological parameters such as oxidative status, inflammation and microbiota. However, the effects of environmentally relevant concentrations of microplastics exposure in commercially reared livestock and poultry are poorly known.

So, the message must not be the alarmist one, but preventive.

Today's tiny plastic fragment may become tomorrow's huge environmental problem.

Clean farm → clean feed → clean water → healthy animals → safe food.

Veterinary professionals are supposed to help to realize this chain.

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