



IONOPHORES:

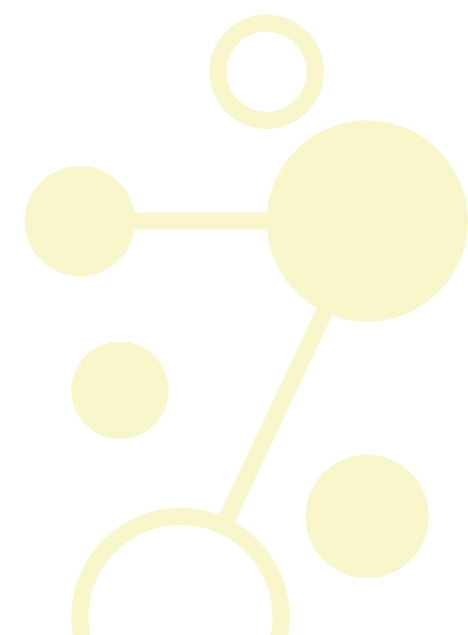
THE MOST WIDELY USED
AND LEAST REGULATED
FARM ANTIBIOTICS



NOVEMBER
2025

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SUMMARY

Government data, obtained by the Alliance to Save Our Antibiotics via a Freedom of Information request, shows that total sales of ionophore antibiotics, the most toxic antibiotics used in animal feed¹, increased by 21% in 2023 compared with 2022².

In 2023, 270 tonnes of ionophores were sold for use in poultry². This is 43% more than the total sales of all other antibiotics in all animal species in 2023 (189 tonnes)³.

Ionophore antibiotics are used in poultry farming to prevent a disease called coccidiosis. Coccidiosis spreads through the “faecal-oral route”. This means that it occurs when chickens ingest their own droppings or those of other chickens. Coccidiosis is the leading disease problem in modern, intensive chicken farming⁴, because of the unhygienic conditions in which the chickens are kept.

Ionophores are permitted to be added to poultry feed, without the need for a veterinary prescription, as a routine preventative treatment against coccidiosis.

Despite the enormous scale of ionophore use, the veterinary antibiotic-sales data published by the government’s Veterinary Medicines Directorate (VMD) do not include ionophores. This is because these drugs are too toxic to be used in human medicine, and so are not considered medically important, and are regulated less strictly than other antibiotics used in farming.

Advocates of continued routine ionophore use in intensive poultry farming often claim that ionophore use has no impact on human health and that because these feed additives are unrelated to antibiotics used in human medicine, their use is unlikely to lead to resistance to medically important antibiotics^{5,6}.

However, research from scientists in the Netherlands and Norway, and an international study carried out by US scientists, now provides strong evidence that the use of ionophores in poultry does in fact increase resistance to antibiotics used in human medicine in enterococci bacteria, which can cause serious infections in humans⁷. The near-total elimination of ionophore use in poultry in Norway led to a major reduction in enterococci resistant to certain medically important antibiotics in Norwegian poultry⁸.

Furthermore, Dutch scientists carried out DNA sequencing and found that a gene conferring resistance to certain ionophore antibiotics was genetically linked to other genes conferring resistance to medically important antibiotics in

enterococci from poultry. They said that this was an “alarming” finding as it implies that the use of ionophores could lead to greater resistance to medically important antibiotics⁹.

The Dutch scientists said that the evidence that ionophore use was selecting for resistance to medically important antibiotics meant that continued ionophore use in poultry requires “thorough review” and that “abandoning of prophylactic use of ionophores will be inevitable”.

A US study has also provided evidence that ionophores have “clear potential” to select for resistance to medically important antibiotics. The researchers investigated the global distribution of ionophore-resistance genes and found them in 51 countries. The ionophore-resistance genes were present in bacteria from farm animals and humans, and were linked with many genes conferring resistance to medically important antibiotics¹⁰.

Two genes conferring resistance to an ionophore antibiotic have been found in a small percentage (1.4% to 2.3%) of human invasive *Enterococcus faecium* infections in the UK, even though ionophores have never been used in human medicine, showing that ionophore-resistant bacteria can transfer from poultry to humans¹¹.

Residues of ionophores in food are also a significant concern because of these drugs’ high toxicity. Ionophores are much more toxic to animals and humans than other antibiotics used in farming. The lethal dose for rats of two of the most widely used ionophores in poultry (lasalocid and monensin) has been described by scientists as “quite close to that of the poison potassium cyanide”¹.

Most years, residues of ionophores above legal Maximum Residue Levels (MRLs)* are found in a small percentage of hen eggs. These residues can be up to nine times higher than the MRL¹².

Furthermore, ionophore residues above legal MRLs, particularly of lasalocid, are



* The Maximum Residue Level is the highest legally permitted concentration of a residue of a veterinary medicine or pesticide in a particular food.

often found in a high percentage of tested samples of pheasant muscle, partridge muscle, quail muscle and quail eggs. Only a very small number of samples (between 12 and 16) of these foodstuffs are tested each year. Between 2018 and 2024, residues of the ionophore lasalocid above MRLs/reporting levels** were found in 16 of 90 (18%) samples of these foods in statutory residue testing reported by the government's VMD.

There are also environmental concerns associated with the massive use of ionophores in poultry. Residues of ionophores and their metabolites in excreta produced by chicken can contaminate soil and surface waters when chicken manure is spread on land. No routine monitoring is carried out to determine the environmental impact of ionophore use in poultry, but the presence of ionophores in surface waters, soils, and sediments has been reported in studies carried out in the EU, the US and Asia¹.

In 2024, two scientific opinions were published by the European Food Safety Authority's Panel on Additives and Products or Substances used in Animal Feed (FEEDAP) on the safety and efficacy of the ionophores monensin and narasin, which are both used in EU and UK poultry production. In both cases, FEEDAP was unable to conclude that the drugs were not environmentally harmful.

FEEDAP concluded that, when used at the highest doses in chickens raised for meat, monensin posed an environmental risk to the "aquatic compartment" and narasin a risk to the "terrestrial compartment"^{13,14}.

The routine use in livestock of medically important antibiotics is no longer permitted, because of concerns about antibiotic resistance. Given the clear evidence of ionophore use contributing to resistance to medically important antibiotics, the routine use of ionophores in poultry should also be ended.

Industry estimates suggest that ending ionophore use in poultry, and introducing vaccination against coccidiosis, would increase the cost of production by between 5 and 20 pence per chicken, with the most likely cost increase being about 7 to 11 pence^{5,15}. UK consumers eat an average of 19.9 kg of poultry meat a year¹⁶, which equates to about 8.8 chickens per person a year. This means that if the production cost per bird were to increase by 11 pence, the production cost increase per consumer would be less than £1 a year.

Coccidiosis should be controlled through better husbandry. Organic poultry farmers and many poultry farmers in Norway have already shown that this is possible.

In particular, the maximum stocking density permitted should be reduced significantly. The poultry industry should also switch to slower-growing, more resilient breeds. Slower-growing breeds use 6–9 times fewer medically important antibiotics than standard fast-growing breeds¹⁷, and it is likely that their greater resilience will also help minimise coccidiosis.

1.

WHAT ARE IONOPHORES AND WHY ARE THEY USED IN FARMING?

Ionophores are the most toxic antibiotics used as a feed additive in livestock farming. They are particularly widely used in poultry farming.

Ionophores are not currently used in human medicine because they are believed to be too toxic. Ionophores are however effective against certain human pathogens and some scientists believe it may be possible to make alterations to ionophores so that they are less toxic to humans and therefore usable as human medicines¹⁸.

Ionophores are used in chicken farming as "coccidiostats". Coccidiostats are drugs added routinely to chicken feed to control a disease called coccidiosis which is caused by single-celled parasites called coccidia. Ionophores are also used in turkey farming and when game birds are raised indoors.

Coccidiosis occurs when chickens ingest their own droppings, often referred to as the "faecal-oral route"¹⁹. It is a major problem in intensive chicken farming, where each shed can contain tens of thousands of birds with a space allowance of less than an A4 sheet of paper per bird. These cramped conditions result in poor hygiene which is why coccidiosis is the most important disease problem in intensive chicken farming⁴.

The mode of action of ionophores makes them unsuitable as treatments for birds already showing signs of coccidial infection²⁰.

For this reason, ionophores are only licensed to prevent and control coccidiosis, and not to treat birds that are already sick with the disease. This is why the preventative use of ionophores tends to be routine on most British intensive chicken farms. No veterinary prescription is required when ionophores are used as coccidiostats. This is justified on the grounds that ionophores are not currently considered medically important, and therefore there are fewer concerns about selecting for antibiotic resistance.

In organic farming the preventative use of antibiotics or other non-homeopathic medicines is not permitted (unless the animal is undergoing surgery), and therefore the use of ionophores to prevent coccidiosis is not allowed. Soil Association organic standards require poultry farmers to rotate pasture to ensure that there is no buildup of parasites such as coccidia²¹.

** Sometimes a legal MRL has not been set for certain drug/food combinations. In which case, a reporting level is used for reporting high residues. Residues detected below the reporting level are not reported. Reporting levels sometimes change from year to year.

Ionophores also used to be licensed as growth promoters in pigs and cattle in the UK and the EU, but the use of any antibiotics as growth promoters, including the ionophores, was banned in the EU in 2006.

However, ionophores are still widely used as growth promoters outside of the EU, including in countries such as the US, Canada, Australia and New Zealand²².

The European Union and the UK also licensed monensin, an ionophore, as a veterinary medicine to control the disease ketosis in cattle. Ketosis is a metabolic

disorder which can occur in cattle when their energy intake does not match meet their requirements²³. However, in May 2024 the European Medicine Agency suspended the use of monensin in the EU and Northern Ireland for this purpose as a quality defect meant that the product could be regurgitated by the cattle, resulting in non-target species, in particular dogs, consuming the tablets. This resulted in some dogs dying, as monensin is highly toxic to dogs²⁴. However, in Great Britain the product can still be used²⁵.

2. ARE IONOPHORES REALLY ANTIBIOTICS?

An antibiotic is a compound that inhibits the growth or kills bacteria²⁶. Ionophores are antibiotics as they have activity against certain bacteria.

Numerous publications in the scientific literature refer to them as “ionophore antibiotics” or “polyether ionophore antibiotics”^{18,27,28}. The European Medicine Agency (EMA) refers to them as antibiotics²⁹, even though for regulatory purposes they are usually classified as coccidiostats and treated differently to other antibiotics. Also, the US Food and Drug Administration (FDA) does not allow poultry producers that avoid the use of medically important antibiotics, but still use ionophores, to refer to their production as “antibiotic free”³⁰.

However, the British Poultry Council (BPC), which represents poultry farmers producing 90% of British poultry meat, claims that “ionophores are not antibiotics, they are antiparasitics”³¹. The UK government’s Chief Veterinary Officer, Christine Middlemiss agrees and has said “Using and talking about evidence correctly is important. Ionophores are not antibiotics”³¹. In reality, ionophores are both antiparasitics and antibiotics since they have activity against both parasites and bacteria.

It is true that in poultry production ionophores are only licensed to treat coccidiosis, a disease caused by coccidia, which are not bacteria. However, ionophores are also known to control the bacterial infection necrotic enteritis in chickens³², and this is partly why ionophores are more widely used than non-antibiotic coccidiostats, like nicarbazin².

Ionophores are not included in government antibiotic-sales data or BPC antibiotic-use data because they are not currently used in human medicine and are therefore not considered medically important.





3.

EXTENT OF IONOPHORE USE IN POULTRY FARMING

Ionophores are extremely widely used in poultry farming. In 2023, the UK poultry industry used 270 tonnes of ionophore active ingredient².

This compares with just 15.6 tonnes of medically important sold for use by members of the BPC, and 189 tonnes of medically important antibiotics sold for use across all animal species³.

So, in 2023, the total sale of ionophores in poultry in was 43% more than the total sales of all other antibiotics in all animal species. It was also about 17 times

more than the BPC's use of medically important antibiotics.

Although the poultry industry continues to use coccidiostats routinely, it has made large reductions in its use of medically important antibiotics in recent years. Between 2014 and 2023, BPC members cut their use of medically important antibiotics by 76%³.

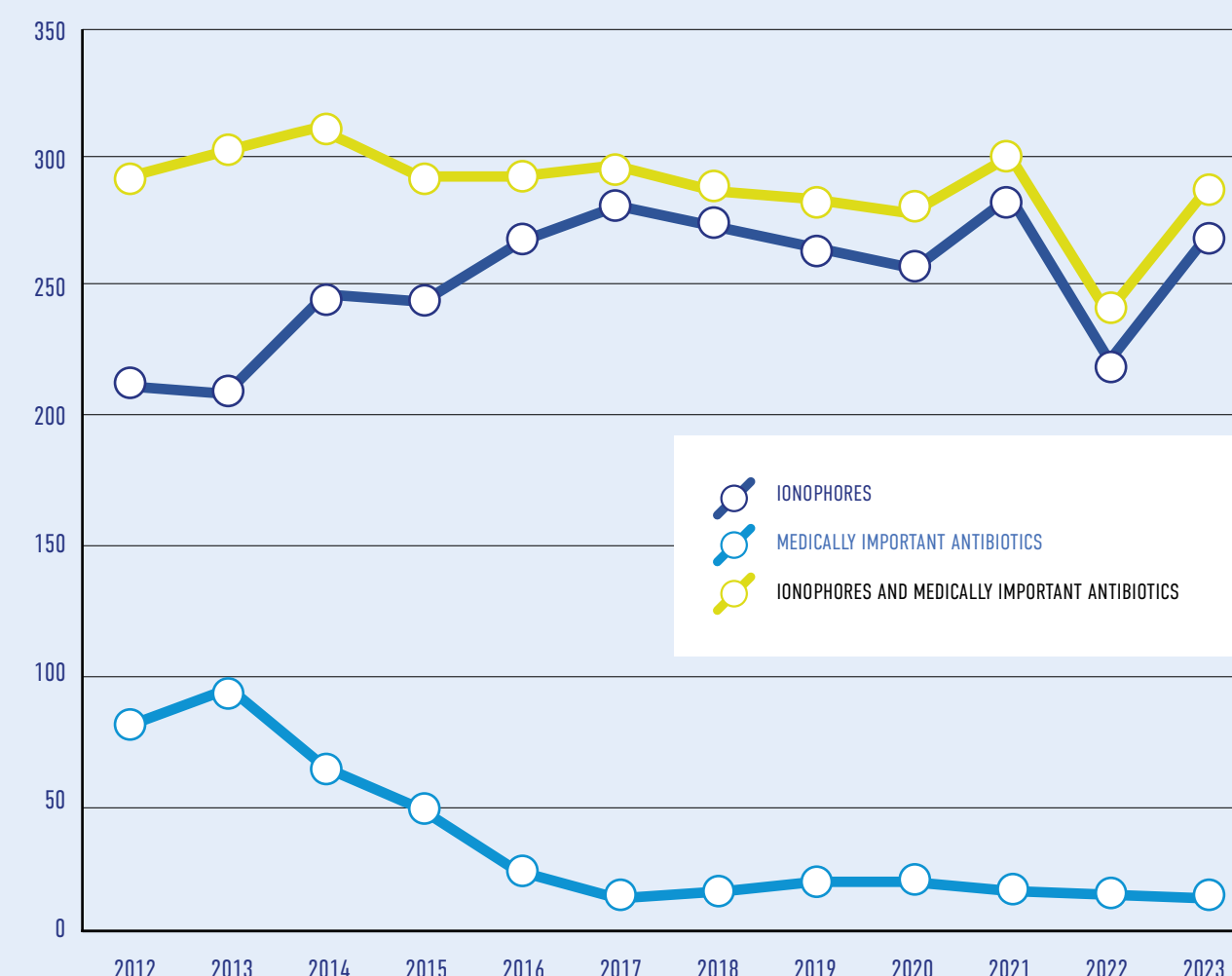
The BPC's decision to introduce antibiotic use data collection has been a key factor in these reductions. Alongside this, the BPC's commendable decision in 2016 to end purely preventative treatments has helped end most routine use of medically important antibiotics in poultry.

However, between 2013 and 2017, while the use of medically important antibiotics was falling rapidly, the use of ionophores increased from 209 tonnes to 281 tonnes, so that the overall use of antibiotics in poultry farming barely changed.

In 2012, total use of ionophores and medically important antibiotics was 294 tonnes, and by 2023 this had only reduced very slightly to 286 tonnes, see Graph 1.

GRAPH 1

Use of medically important antibiotics by the BPC and ionophore sales in poultry (tonnes).





**IT APPEARS THAT REDUCTIONS
IN USE OF THE MEDICALLY
IMPORTANT ANTIBIOTICS
HAVE BEEN, AT LEAST PARTLY,
COMPENSATED FOR BY AN
INCREASED USE OF IONOPHORES**

4.

ARE IONOPHORES BEING USED TO REPLACE THE USE OF MEDICALLY IMPORTANT ANTIBIOTICS?

2012 to 2023³³

In 2019, a BBC Countryfile programme highlighted the intensive poultry industry's widespread use of ionophores, and an Alliance to Save Our Antibiotics spokesperson featured during the programme.

The Alliance said that a possible explanation for the increasing use of ionophores was that they were possibly being used to compensate for the reduction in the use of medically important antibiotics that was occurring in the UK poultry industry³⁴.

In response, the BPC said that "Ionophores are animal-only antimicrobials that are not classified as veterinary medicinal products and their usage is not linked to reduction in antibiotics"³¹.

The BPC claimed that the increase in the use of ionophores was in line with the growth in poultry production. However, the size of the poultry industry, measured in a unit called the "population correction unit" (PCU), only increased by 12% between 2013 and 2017³⁵, and ionophore use grew by 34% during that period. In terms of mg of active ingredient per PCU, ionophore use increased from 197 mg/PCU in 2013 to 237 mg/PCU in 2017. In 2023, use was still 223 mg/PCU.

In reality, it appears that reductions in use of the medically important antibiotics, from 89 mg/PCU to 12 mg/PCU in 2017 and 13 mg/PCU in 2023, have been, at least partly, compensated for by an increased use of ionophores. This is not surprising since chickens are still being farmed in intensive, stressful and unhygienic conditions.

Two years later, with the poultry industry becoming concerned about the possibility of ionophore use being more strictly regulated in the future, and maybe even phased out, a paper co-authored by a leading BPC Veterinary Consultant said that if ionophores were removed from the poultry industry, use of medically important antibiotics "could increase by 40%"⁵ to compensate for disease problems that might emerge. This appears to be an admission from the poultry industry that the levels of ionophore use and of medically important antibiotics use are in fact linked.

Feeding chickens ionophores is known to control the disease “necrotic enteritis” caused by *Clostridium perfringens* bacteria^{5,32}. This disease can have a major economic impact on intensive chicken farming and is partly controlled by using certain medically important antibiotics. It is possible that large reductions in the use of these antibiotics may have required an increase in ionophore use to control the disease.

Another explanation may relate to the growth-promoting effect that some ionophores have. Even though using antibiotics for growth promotion is no longer legal, the use of antibiotics for legal purposes can still promote growth. The increase in ionophore use may be compensating for a reduction in the use of some medically important antibiotics, like tetracyclines and macrolides, which are also known to promote growth and were previously licensed as growth promoters in chickens.

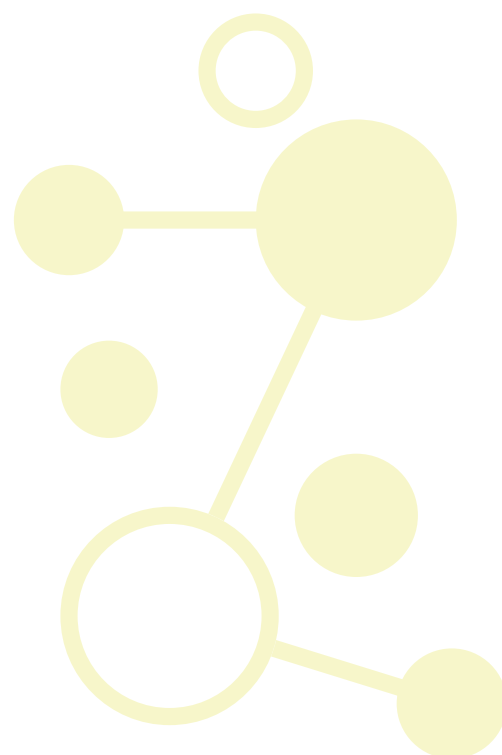
The ionophores monensin and salinomycin used to be licensed in the UK and the EU for growth promotion in cattle and pigs respectively³⁶, but were banned for this purpose in 2006³⁷. Ionophores were never licensed for growth promotion in poultry but when they are used as coccidiostats, they are used routinely and without the need for a veterinary prescription, which is similar to how growth promoters were used.

Furthermore, there is publicly available information showing that ionophores do have a growth-promoting effect in poultry: the study co-authored by the leading BPC Veterinary Consultant found that removing ionophores resulted in a worse “Feed Conversion Ratio”, i.e. the chickens put on

less weight for a given amount of feed consumed. This resulted in the birds needing a day longer to reach the target weight^{5,15}.

In the modern, intensive broiler-chicken production (i.e. chickens raised for meat), it is estimated that feed can represent over 60–70% of the cost of production. Reducing the amount of feed needed to produce saleable meat is considered key to remaining profitable, and the Feed Conversion Ratio is the most important economic indicator used by most chicken farmers³⁸.

It is therefore perhaps not surprising that a large increase in ionophores occurred when farmers were reducing their use of medically important antibiotics, since maintaining a good Feed Conversion Ratio was a key goal of intensive chicken farming.



5.

WHAT ARE THE CONCERNS ABOUT USING IONOPHORES IN FARMED ANIMALS?

Several concerns exist regarding the routine use of ionophores in poultry farming. These include the selection of resistance to medically important antibiotics, potentially toxic residues in food, environmental harm caused by residues contaminating soil and water, and the fact that ionophores may be used in human medicine in the future and so their overuse in livestock may undermine their effectiveness in humans.

5.1. IONOPHORE USE MAY SELECT FOR RESISTANCE TO MEDICALLY IMPORTANT ANTIBIOTICS

Poultry-industry advocates, who defend continued routine ionophore use in intensive poultry farming, often claim that ionophore use has no impact on human health and that because these feed additives are unrelated to antibiotics used in human medicine, their use is unlikely to lead to resistance to medically important antibiotics^{5,6}.

However, research from scientists in the Netherlands and Norway now provides strong evidence that the use of ionophores in poultry can increase resistance in enterococci bacteria to

vancomycin, a highest-priority critically important antibiotic used in human medicine. Enterococci can cause serious infections in humans⁷ and vancomycin can be used to treat these infections.

For a number of years, it was suspected that the use of narasin, an ionophore, in poultry farming could increase the number of enterococci bacteria in poultry that were resistant to vancomycin, through a process called co-selection³⁹. Co-selection occurs when the use of an antibiotic simultaneously selects for resistance to more than one type of antibiotic. This can happen if bacteria that are resistant to one antibiotic also tend to be more resistant to another antibiotic than bacteria that are sensitive to the first antibiotic.

Data on resistance in enterococci in chickens in Norway suggested that the use of narasin was co-selecting for vancomycin-resistant enterococci (VRE). Because of negative publicity in the Norwegian media about narasin use, the Norwegian broiler industry stopped using ionophores in 2016.

Subsequently, research failed to find any VRE in Norwegian broilers. Scientists also found that narasin resistance in the enterococci bacteria had reduced.

They said that the ending of narasin use in broilers in Norway appeared to have contributed to the reduction in VRE⁸.

Research in the Netherlands has found further compelling evidence that ionophore use could select for resistance to medically important antibiotics⁹. The scientists examined enterococci bacteria from poultry that were resistant to the ionophore salinomycin, which is also commonly used in poultry. They found that there was a significant correlation in enterococci bacteria between the presence of salinomycin resistance and the presence of resistance to erythromycin, a critically important antibiotic used in human medicine, as well as resistance to tetracycline and ampicillin, two other medically important antibiotics.

Furthermore, the Dutch scientists carried out DNA sequencing and found that genes conferring resistance to salinomycin and narasin were genetically linked to other genes conferring resistance to several medically important antibiotics in enterococci from poultry, including erythromycin and tetracycline. They said that “This is an alarming observation, since it implies that the use of ionophores may drive the transfer and dissemination of other clinically relevant types of antimicrobial resistance by co-selection.”

They also warned of the possibility that the use of ionophores could have a similar effect in other bacteria too, since ionophores have activity against other bacteria. They mentioned that ionophores might select for resistance to medically important antibiotics in *Staphylococcus aureus*, the cause of MRSA infections in humans. Further research into this possibility should be carried out.

The Dutch scientists said that the evidence that ionophore use was selecting for resistance to medically important antibiotics meant that continued ionophore use in poultry requires “thorough review” and that “Abandoning of prophylactic use of ionophores will be inevitable, therefore alternative options for the management of coccidiosis, such as vaccination, need to be explored”.

“
ABANDONING OF PROPHYLACTIC USE OF IONOPHORES WILL BE INEVITABLE
”
Pikkemaat et al., 2022

The findings of a recent study by US scientists have provided further evidence that the use of ionophores in agriculture may be selecting for resistance to medically important antibiotics¹⁰. The researchers investigated the global distribution of ionophore-resistance genes and found them in 51 countries, including the UK. The ionophore-resistance genes were present in bacteria from farm animals and humans, and were linked with many genes conferring resistance to medically important antibiotics, including tetracyclines, aminoglycosides, macrolides and vancomycin.

The scientists also estimated statistical associations between ionophore resistance genes in *Enterococci* bacteria and the presence of genes conferring resistance to medically important antibiotics in these same bacteria. In the pathogenic bacteria *Enterococcus faecalis* they found positive statistical associations between the ionophore resistance genes and 13 other types of resistance genes, and for the pathogenic *Enterococcus faecium* they found positive statistical associations for 11 resistance genes and 4 mutations conferring resistance.



“
THERE IS THUS CLEAR POTENTIAL FOR IONOPHORE USE TO IMPACT THE PRESENCE OF ANTIBIOTIC RESISTANCE GENES IN THE FOOD SUPPLY.
”
Ibrahim et al. 2025

The US scientists concluded that: “We found that ionophore resistance is widespread and that it is usually linked to resistance genes for medically relevant drugs. There is thus clear potential for ionophore use to impact the presence of antibiotic resistance genes in the food supply.” And that: “These observations indicate that we cannot assume that ionophore use is risk-free, with clear potential for co-selection for clinically relevant antimicrobial resistance.”

In the UK, two genes conferring resistance to an ionophore antibiotic have been found in a small percentage (1.4% to 2.3%) of human invasive *Enterococcus faecium* infections, even though ionophores have never been used in human medicine. This is evidence that ionophore-resistant bacteria can transfer from poultry to humans¹¹.

There is also evidence that the use of ionophores other than narasin and

salinomycin can select for resistance to medically important antibiotics. One study found that growing three different types of bacteria in the presence of monensin, an ionophore widely used in poultry, increased their resistance to the antibiotic avoparcin⁴⁰. Avoparcin is an antibiotic closely related to the highest-priority critically important antibiotic vancomycin. Another study found that residues of monensin in poultry litter, increased the horizontal transfer of plasmids containing antibiotic resistance genes between *E. coli* bacteria⁴¹.***

Furthermore, research published in 2024, by scientists from Sweden, Germany, Denmark and Hungary, found that exposure to monensin increased the virulence of the human and animal pathogen *Staphylococcus aureus*. Monensin-resistant *Staphylococcus aureus* had a higher growth rate in vitro but also in vivo in mice⁴².

*** Plasmids are small pieces of DNA, which often carry antibiotic-resistance genes, and that can be transferred between bacteria. The horizontal transfer of plasmids is a major cause of the spread of antibiotic resistance.

Commenting on these findings, and further findings about the potential impact on the environment, Italian scientists stated:

“The use of monensin and other ionophores in livestock requires careful management and oversight to mitigate the potential repercussions on animal health, welfare, and the environment, all while considering broader implications for antimicrobial resistance and gut microbiota ecology. It is paramount to acknowledge that antibiotics cannot substitute sound animal management practices or tailored diets aligned with livestock production cycles. The preservation of animal welfare, the environment, and human health should remain the primary and overriding objectives. Therefore, ionophores, including monensin, should be subject to rigorous analytical monitoring within agronomic and environmental systems as part of One Health initiatives. This is especially crucial in countries with intensive cattle and poultry production systems to prevent the exacerbation of bacterial cross-resistance, posing a deeper public health challenge”⁴³.

5.2. RESIDUES IN FOOD

When farm animals are treated with antibiotics, including ionophores, residues of these medicines, or their metabolites, may end up in meat, milk or eggs for human consumption. To ensure that these residues do not have harmful effects on consumers, including toxic effects or increasing levels of antibiotic-resistant bacteria in the human intestine, residues need to be kept below Maximum Residue Levels (MRLs). Different MRLs are set by regulators according to the antibiotic and food in question.

For each antibiotic, regulators set withdrawal periods, which are periods when the antibiotic cannot be used before animals go to slaughter or eggs or milk are collected for sale, as this helps ensure that residues are kept below MRLs.

Despite these safeguards, statutory testing of food samples does still find residues which are above MRLs, and therefore not proven safe for human consumption. This occurs, in particular, for ionophores, which are the most toxic antibiotics used in animal feed.

Extremely high residues of the ionophore lasalocid, some of which were over 20 times higher than the MRL, used to be found in a small number of egg samples each year. After this issue was widely publicised by a Soil Association report⁴⁴, the egg industry took some voluntary action: Lions Egg no longer permits the lasalocid to be used in pullets being raised to become egg layers (lasalocid is not permitted to be used in hens that are already laying)⁴⁵.

Unfortunately, successive governments and regulators have refused to take action against all lasalocid use in the egg

TABLE 1
Residues of ionophores in hen egg samples, 2018 to 2024

	2024	2023	2022	2021	2020	2019	2018
Positive residues	0 of 500	2 of 718	3 of 728	1 of 745	4 of 661	0 of 640	5 of 589
Lasalocid	0	0	1	1	1	0	4
Monensin	0	0	0	0	1	0	0
Narasin	0	2	0	0	1	0	0
Salinomycin	0	0	2	0	1	0	1

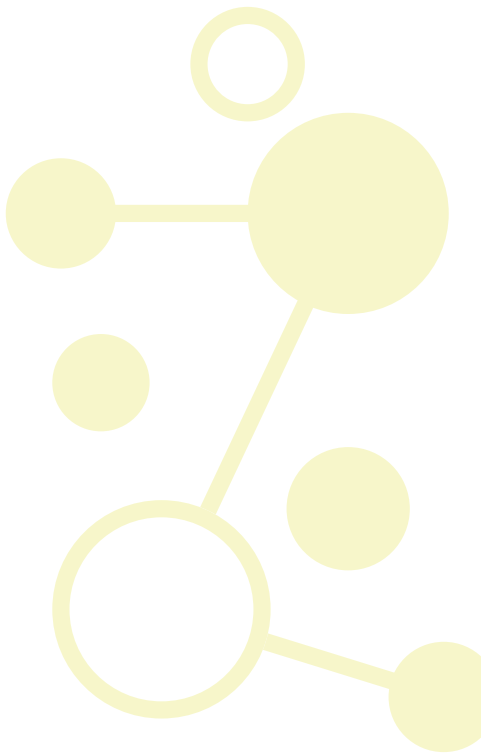
industry, and despite Lions Egg standards, residues of lasalocid and some other ionophores above MRLs are still found in egg samples most years⁴⁶. See Table 1.

In some cases, the residues of lasalocid are particularly high. In 2020, the positive residue of lasalocid was 1,400 µg/kg****, which is over 9 times the MRL of 150 µg/kg. In 2018, one residue of lasalocid was at 790 µg/kg, which is over 5 times the MRL.

It is also important to note that, for residue testing, up until 1997 an egg sample was just one egg. However, since 1998 a sample has been 12 eggs from the same batch mixed together⁴⁷, which inevitably dilutes the highest concentration residues. This means that some of the eggs included in the samples with high residues referred to above are likely to have had residues with even higher concentrations.

Residues of lasalocid are also frequently found in a high percentage of tested samples of pheasant muscle, partridge muscle, quail muscle and quail eggs. Only a very small number of samples (between

12 and 16) of these foodstuffs are tested each year. Between 2018 and 2024, residues of the ionophore lasalocid above MRLs or reporting levels were found in 16 of 90 (18%) samples of these foods in statutory residue testing reported by the VMD. See Table 2.



**** A µg is a microgramme, i.e. 1 millionth of a gramme.

TABLE 2
Residues of lasalocid above MRL/reporting level in pheasant muscle, partridge muscle, quail muscle and quail eggs, 2018 to 2024⁴⁸

	2024	2023	2022	2021	2020	2019	2018
Pheasant muscle	0 of 7	0 of 4	1 of 5	0 of 7	0 of 7	-	1 of 5
Partridge muscle	2 of 5	0 of 6	1 of 7	3 of 7	2 of 7	3 of 8	2 of 5
Quail muscle	-	-	-	-	-	-	0 of 2
Quail eggs	1 of 2	0 of 2	0 of 2	0 of 2	0 of 2	-	-

TABLE 3
Residues of monensin in chicken liver above the MRL, 2018 to 2024⁴⁸

2024	2023	2022	2021	2020	2019	2018
0 of 1,045	0 of 1553	1 of 1,454	0 of 1,432	0 of 1,463	1 of 1,380	1 of 1,336

Even though chicken meat is the most widely eaten meat in the UK¹⁶, and the coccidiostats are by far the most widely used antibiotics in chicken production, testing for ionophore residues in chicken meat is only carried out as part of a mult-residue screen which screens for residues of numerous other substances. No residues of ionophores in chicken meat above MRLs have been reported through this testing⁴⁸.

On the other hand, for residues in chicken liver there is more specific residue testing targeted at coccidiostats only. This testing does sometimes find residues of the ionophore monensin above the MRL. See Table 3.

5.3. ENVIRONMENTAL POLLUTION

There are environmental concerns associated with the massive use of ionophores in poultry. Residues of ionophores and their metabolites in excreta produced by chicken can contaminate soil and surface waters when chicken manure is spread on land. This may have an impact on soil organisms, crops and other plants, and field run-off can mean that ionophores can pollute watercourses and affect aquatic organisms.

Unfortunately, no routine monitoring is carried out to determine the environmental impact of ionophore use in poultry, but the presence of ionophores in surface waters, soils, and sediments has been reported in studies carried out in the EU, the US and Asia Scientific studies have highlighted the potential adverse

environmental impact of high levels of ionophore use^{1,49,50,51,52,53}.

In 2024, two scientific opinions were published by the European Food Safety Authority’s Panel on Additives and Products or Substances used in Animal Feed (FEEDAP) on the safety and efficacy of the ionophores monensin and narasin, which are both used in EU and UK poultry production. In both cases, FEEDAP was unable to conclude that the drugs were not environmentally harmful.

FEEDAP concluded that, when used at the highest doses in chickens raised for meat, monensin posed an environmental risk to the “aquatic compartment” and narasin a risk to the “terrestrial compartment”^{13,14}.

5.4. POTENTIAL FUTURE USE OF IONOPHORES IN HUMAN MEDICINE

Although ionophores are not currently used in human medicine, some scientists are exploring whether, despite their apparent toxicity, ionophores could be developed for use in human medicine in the future²⁷.

This is because ionophores don’t just have an impact on the parasites causing coccidiosis but can kill certain other bacteria too. Several studies have suggested that ionophores, or closely related antibiotics, may have the potential to be developed as human medicines for treating the serious, and sometimes lethal, infection *Clostridium difficile*^{54,55,56}. Very few antibiotics are currently available to treat this disease so advancements in this area would be welcome.

Ionophores can also kill MRSA and enterococcal bacteria, they have anti-fungal activity and are even being examined as possible future cancer treatments²⁷. So, there is a possibility that ionophores or their derivatives could become medically important.

Furthermore, a study in Nature published in 2021 reported on the development of an ionophore that retained good antibacterial effects without affecting mammalian cells⁵⁷. The scientists concluded in their paper that “our study suggests the exciting prospect of optimizing polyether ionophores for use as antibiotics”.

Some of the same scientists involved in the research published in Nature subsequently published in 2023 a further study showing that some ionophores, including lasalocid, have significant activity against *Staphylococcus aureus* bacteria involved in human bloodstream infections. They said that, despite concerns about ionophore toxicity to humans, “We hypothesise that the differences in membrane composition between mammalian and bacterial cells can be exploited to prepare ionophores with acceptable therapeutic indices for use in certain clinical scenarios to treat resistant bacterial infections in humans.”⁵⁸

So, ionophores may need to become prescription-only antibiotics in the future to protect them from misuse. This would mean that the current reliance on routine use in farming would no longer be possible.

6.

ENDING IONOPHORE USE AND IMPROVING HUSBANDRY AND ANIMAL HEALTH

In order to minimise the spread of antibiotic resistance, the routine, prophylactic use of ionophores in poultry feed should be phased out.

The Norwegian poultry industry voluntarily phased out the use of the ionophores between February 2015 and June 2016⁵⁹. Organic farmers in the UK and throughout the EU also raise their chickens without using ionophores.

This shows that it is perfectly possible to raise chickens without using these antibiotics. Furthermore, UK research shows that ending ionophore use would not lead to large cost increases for chicken production, see Box Section.

In Norway, control of coccidiosis is partly achieved through vaccination^{60,61}. Norwegian poultry producers also sometimes use a “probiotic” treatment to help control necrotic enteritis. A probiotic is a live micro-organism that is beneficial to animal health when consumed and prevents the growth of certain pathogenic organisms. According to the Norwegian Veterinary Institute, the probiotic *Bacillus subtilis* has shown promising potential for controlling necrotic enteritis⁵⁹.

In addition to introducing vaccination for coccidiosis, a key husbandry change that the ADAS researchers said would be needed to raise chickens without ionophores is a reduction in the stocking density, i.e. the total weight of birds kept per square meter inside the barns¹⁵. They said this would need to be reduced from 38 kg/m², the maximum stocking density permitted under Red Tractor standards, to 34 kg/m²⁶². It is worth noting that the fact that a higher stocking density can be achieved with ionophores shows that these drugs are currently being used to keep chickens in more intensive, stressful and disease-inducing conditions.



HOW MUCH WOULD IT COST TO END IONOPHORE USE IN POULTRY?

Two models of the UK poultry industry found that ending the use of ionophores in poultry would only increase the cost of production per bird by a few pence.

A UK study carried out by ADAS, a provider of agricultural and environmental advice and research, examined the economic consequences of ending ionophore use in poultry. Their best estimate was that this would increase the cost of production of a chicken by about 10.6 pence. Their more “optimistic scenario” found that the production cost would only increase by 6.2 pence, whereas for their more “pessimistic scenario” the cost increase was estimated to be about 20.1 pence¹⁵.

A second UK study found an even lower cost to ending ionophore use. It found that the production cost per chicken would increase by between 5.6 pence and 8.6 pence⁵. Taking the two studies together, the increased cost of production may be about 7 to 11 pence.

An end to the use of ionophores in poultry production would therefore be very affordable. UK consumers eat an average of 19.9 kg of poultry meat a year¹⁶, which equates to about 8.8 chickens per person a year. This means that if the production cost per bird were to increase by 11 pence, which is towards the higher end of the cost increase, the production cost increase per consumer would still be less than £1 a year.



A stocking density of 34 kg/m² remains high. Under organic standards, a much lower stocking density must be used when the animals are indoors in fixed housing: the maximum stocking density permitted is 21 kg of bird per square metre. Furthermore, organic birds must have access to an outdoor range, of at least 4m² per bird²¹. Higher stocking densities are permitted under organic rules when mobile housing is used. This is because the use of mobile housing enables the pasture to be rotated, and moving birds onto fresh pasture enables parasites like coccidia to be controlled.

Furthermore, organic standards require that slower-growing breeds of chickens be used, or that the slaughter age be at least 81 days. Standard, fast-growing, intensively farmed chickens, are slaughtered aged 28 to 42 days⁶³. Slower-growing chickens are known to have better health, and much less need for antibiotic treatment⁶⁴. In the Netherlands, slower-growing breeds now account for 55% of broiler chickens, and the latest data shows that these slower-growing birds consumed eight times less antibiotics per bird in 2024 compared with faster-growing birds⁶⁵. It is likely that the greater resilience, and better health of slower-growing chickens will also help minimise coccidiosis.

Norsk Kylling, the Norwegian poultry company, which produces 20% of Norwegian chicken meat, provides a good example of improvements to husbandry leading to better animal health and fewer problems with coccidiosis. In August 2022, Norsk Kylling became the world's first industrial-scale chicken producer to adopt the Better Chicken Commitment (BCC). The BCC requires producers to only use slower-growing breeds of chickens and to use a maximum stocking density of 30kg/m²⁶⁶.

According to Hilde Talseth, the company's Chief Executive Officer, the switch has led to much lower mortality and almost no use of coccidiostats or other medicines⁶⁷. Furthermore, Talseth has stated that the much lower mortality and significant reductions in general sickness and trauma have resulted in greater profitability for farmers and means that the company can sell the slower-growing chickens at the same price, or even a lower price, than the standard fast-growing Norwegian chicken⁶⁸.

Some British retailers have also made changes to their production practices, which should make it easier to avoid using ionophores. Waitrose already achieves the BCC for its fresh chicken, and will be implementing the standard for all its chicken, including ingredients, from September 2025⁶⁹. Similarly, Marks and Spencer has committed to implementing the BCC for its fresh and ingredient chicken from 2026⁷⁰.

No other UK supermarkets have yet committed to implementing the BCC, but the Co-op, Morrisons, Sainsbury's and Tesco have lowered their stocking density for their own-label fresh chicken to 30 kg/m², and Lidl has also committed to doing so⁷¹.

These improvements to the conditions in which chickens are kept in the UK, which are being voluntarily introduced by supermarket policies, are welcome, and should make it easier to phase out the use of ionophores. However, government regulation is also needed to improve the minimum husbandry standards for all UK chicken farming.



**GOVERNMENT REGULATION
IS NEEDED TO IMPROVE
THE MINIMUM HUSBANDRY
STANDARDS FOR ALL UK
CHICKEN FARMING**

7.

CONCLUSIONS AND RECOMMENDATIONS

There is now strong evidence that the widespread, routine use of ionophores in intensive chicken farming is selecting for resistance to medically important antibiotics in bacteria. This resistance can transfer to humans, resulting in some serious, invasive infections being more difficult to treat.

New Veterinary Medicines Regulations in the UK and the EU mean that medically important antibiotics can no longer be used routinely in the UK or the EU⁷², because of concerns relating to antibiotic resistance. Unfortunately, these regulations do not yet apply to ionophores, as these antibiotics are not considered medically important.

However, given the evidence that routine ionophore use is contributing to resistance to medically important antibiotics, the routine use of ionophores should also be ended.

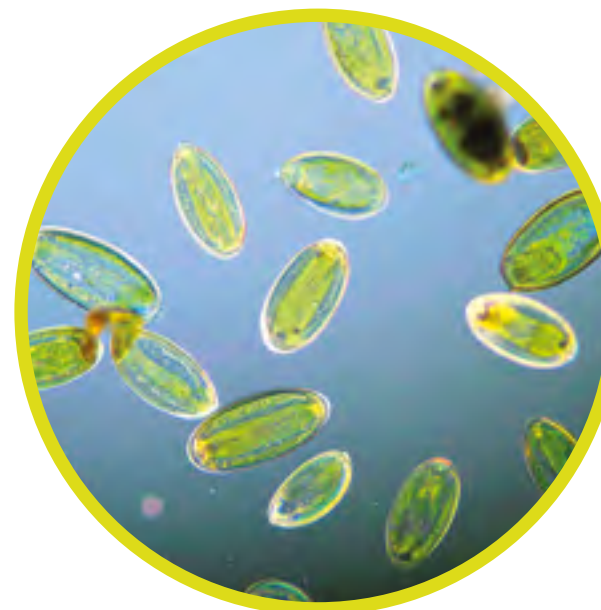
The use of ionophore antibiotics for the routine, preventative control of coccidiosis in poultry should therefore be phased out. The government should regulate to end this use.

Ending ionophore use in poultry will also help protect human health, by ending the ongoing problems with residues occurring in food. It will also end the potentially harmful impacts on terrestrial and aquatic species through the widespread dissemination of ionophores in the environment.

Industry estimates suggest that ending ionophore use in poultry would increase the cost of production by between 5 and 20 pence per chicken, with the most likely cost increase being about 6 to 11 pence. This is clearly a proportionate cost in light of the huge benefits this would bring.

Organic poultry farmers and poultry farmers in Norway have already shown that it is possible to raise poultry without resorting to ionophore use. While vaccination and the use of other products, such as probiotics, can help control coccidiosis, the priority should be improving husbandry to secure better poultry health, and improved control of coccidiosis.

It should no longer be permitted to keep chickens and other poultry in conditions that are so cramped and unhygienic that disease becomes unavoidable and the routine use of medication is required. The maximum stocking density permitted should be reduced significantly. Currently over 95% of UK chickens are housed at a stocking density of 38 kg/m², whereas the



maximum indoor stocking density for organic is 21 kg/m² for free range it is 27.5 kg/m² and the maximum permitted for the Better Chicken Commitment is 30 kg/m²⁷³. A new maximum stocking density of 25-30 kg/m² should be introduced.

The poultry industry should also be supported to switch to slower-growing, more resilient breeds, such as those used in free-range and organic production, and by producers meeting Better Chicken Commitment standards. There is clear evidence from the Netherlands that these birds are healthier and require fewer antibiotics, and it is likely that their greater resilience will also help minimise coccidiosis.



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The Alliance to Save Our Antibiotics is an alliance of health, medical, environmental and animal welfare groups working to stop the over-use of antibiotics in animal farming. It was founded by the Soil Association, Compassion in World Farming International and Sustain in 2009. The Alliance vision is for a world in which human and animal health and well-being are protected by food and farming systems that do not rely on routine antibiotic use.



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