Federal Office of Consumer Protection and Food Safety

BfR

Zoonoses Monitoring 2020

Summary of Findings and Conclusions

1 Summary of findings and conclusions

Salmonella spp.

In the 2020 Zoonosis Monitoring, pig carcasses were found contaminated with *Salmonella* spp. at a rate of 4%, which is roughly in a range with findings in previous years (2019: 3.4%, 2018: 5.1%, 2017: 2.9%, 2015: 4.5%). This does not allow recognising a trend in *Salmonella* detection rates on pig carcasses over the past few years, but just stating that detection rates are fluctuating between about 3% and 5% of positive samples. Minced pork was contaminated with Salmonella at 0.7%. This detection rate was somewhat lower than in the 2019 Zoonosis Monitoring (1.9% positive samples), but roughly similar to the years preceding (2018: 1.3%, 2017: 0.7%). The findings have confirmed that raw minced pork (*e.g.*, *Mett*) is not a suitable food for vulnerable consumer groups, such as small children, elderly and immune-deficient people, or pregnant women.

Test results in the food chain related to broilers and fattening turkeys show that *Salmonella* detection rates have not further decreased after an initial decline in the years from 2009 to 2014/2016. Broiler neck skin samples were contaminated with *Salmonella* at a rate of 6.7%, and broiler fresh meat samples at 4.6%, which is a bit less than corresponding samples in the 2018 Zoonosis Monitoring (7.6% positive neck skin samples and 5.6% positive broiler meat samples). In caecal content of broilers, in contrast, *Salmonella* was detected slightly more often than in 2018, with a portion of 2.6% positive samples in 2019, compared to 1.9% positive samples in 2018. The same holds for fattening turkeys, where 0.8% of caecal samples were *Salmonella* positive, while this were only 0.2% in the 2018 Zoonosis Monitoring. In neck skin samples of fattening turkeys, Salmonella were detected at a rate of 15.4%, and thus less than in the 2018 Monitoring (22.7%).

The frequency of *Salmonella* contamination of carcasses again varied clearly among individual slaughter establishments, both in broilers and turkeys. The obvious variance in rates of positive samples should be reason to demand that slaughter establishments strictly observe the process hygiene criteria for *Salmonella* on poultry carcasses fixed by Regulation (EC) No. 2073/2005 *on microbiological criteria for foodstuffs*. Appropriate action should be taken if the criteria are violated.

Frequent findings of S. Senftenberg – a serovar which is not typical in turkeys – in neck skin samples of fattening turkeys in one slaughter establishment indicates that carcasses may have been cross-contaminated with slaughterhouse-specific *Salmonella* strains.

Another conspicuous fact was that the serovar *S.* Infantis again accounted for a large portion of findings in the broiler-related food chain. However, *S.* Infantis is not in particular

subject to control programmes designed for production sites, although it counts among the serovars frequently detected in diseased humans.

Salmonella was not found in eggshell pool samples, neither of eggs sampled at egg packing plants nor at retail level. In the Zoonosis Monitoring of the year 2010, 0.7% of pooled eggshell samples drawn at retail level at the end of the best-before date were contaminated with *Salmonella*, while the egg content was without findings. Although eggs are now hardly any more contaminated with *Salmonella* because of successful control regiments in laying hen farms, vulnerable consumer groups such as small children, elderly or immune-deficient people, and pregnant women, should refrain from consuming food containing raw eggs, and eat only cooked eggs, because raw eggs are still proven to be a major cause of food-born *Salmonella* disease outbreaks.

Samples of wheat flour drawn at mills were not found with *Salmonella*. So, wheat flour does not seem to be an important source of human infection with *Salmonella*.

Faecal samples of wild boar were detected with *Salmonella* at a rate of 4.6%, which is a bit higher than in the 2016 Zoonosis Monitoring, when 2.4% of the wild boar faecal samples were found *Salmonella* positive. The detection rate of *Salmonella* in faecal samples of fattening pigs in the Zoonosis Monitoring of 2019 was 5.7%, and thus in a roughly similar order of magnitude. So, the findings confirm that wild boar are a reservoir of *Salmonella*. Examinations carried out in the framework of the Zoonosis Monitoring in 2011 already showed that fresh wild boar meat, too, is a potential source of human infection with *Salmonella*, as 3.4% of the samples were positive then. Fresh wild boar meat should therefore only be consumed after thorough cooking.

Salmonella was detected in 0.4% of samples of dried leaf and grass products. The findings show that dried leaf and grass products pose a risk of infection of humans with *Salmonella*, all the more as these products are usually consumed without prior cooking, so that present germs are not destroyed. Also, further growth of *Salmonella* germs present in dishes with dried leaf and grass products cannot always be safely precluded.

Fresh lamb meat was found contaminated with *Salmonella* at a rate of 1.1%, which is roughly in the range of the *Salmonella* detection rate in samples of fresh veal and bovine meat (0.5% to 0.6% positive samples). This shows that fresh lamb meat means a fairly low risk of infection of humans with *Salmonella*. Still, vulnerable consumer groups should only consume sufficiently cooked lamb meat.

As in the years before, the situation of *Salmonella* resistance towards antimicrobial substances was very heterogenic, depending on the origin of the isolates. The percentage of resistant isolates was highest in the turkey-related food chain, with 84.3%. In the broilers food chain, a total of 73.1% of the isolates displayed resistance towards at least one of the substances tested, and in the fattening pigs-related food chain, 58.8% of the *Salmonella* isolates were found resistant.
Isolates obtained from lamb meat and from dried leaf and grass products were sensitive to all test substances. A third of the nine isolates originating from wild boar was resistant towards at least one substance tested.
Salmonella isolates stemming from the turkey and broiler food chains had a clearly higher resistance rate to the fluoroquinolone substance ciprofloxacin (>60% resistant isolates) than isolates from the fattening pigs food chain (5.9%). Ciprofloxacin is rated very important for antibiotic treatment of humans. A very positive finding was that again, none of the *Salmonella* isolates tested was resistant to the 3rd generation cephalosporins tested, nor to carbapenemen.

***Campylobacter* spp**.

With 49.8% samples of caecal content detected positive with *Campylobacter* in the 2020 Zoonosis Monitoring, broilers sampled at slaughter carried *Campylobacter* spp. clearly more frequently than in 2018 (41.6% positive samples, then). The *Campylobacter* spp. detection rate in fresh broiler meat was 54.7%, which was also higher than in earlier testing (46.4% positive samples in 2019). The rate of *Campylobacter* spp. findings in neck skin samples of broiler carcasses (54.4% positive samples) was noticeably lower than in the Zoonosis Monitoring programmes of previous years (2017: 78,8 %, 2016: 76,9 %), but in the 2016 and 2017 programmes, the number of neck skin samples actually tested was lower than in other years. In contrast to that, the representative testing of broiler carcasses in the Zoonosis Monitoring of 2013 then produced 52.3% positive neck skin samples, which again is in a range with the findings of the present programme.
In 47.6% of the broiler neck skin samples, the counts of *Campylobacter* spp. measured were higher than the analytical performance limit of the quantitative method. The percentage of neck skin samples detected with high *Campylobacter* counts of more than 1000 cfu/g was 21.9% in 2020, and thus about as high as in the years before (2013: 19.4%; 2016: 24.1%; 2017: 22.7%; 2018: 22.6%; 2019: 23.4%). This means that again, no noteworthy progress is showing as regards the reduction of high *Campylobacter* counts on broiler carcasses in 2020. At the same time there were again big differences

among individual slaughter houses as regards the frequency of occurrence of *Campylobacter* counts higher than the microbiological limit of 1,000 cfu/g neck skin samples, which means that slaughterhouses succeed to very different degrees in controlling cross-contamination with *Campylobacter*. Minimisation strategies should therefore in future focus on comparing slaughterhouses, in order to identify measures suitable to reduce germ counts on carcasses.
Same as in the years before, germ counts measured in fresh broiler meat were notably lower than in the neck skin samples. *Campylobacter* could actually be quantified in 2.3% of the fresh broiler meat samples. None of the samples had counts higher than 1,000 cfu/g. This is probably in part attributable to the fact that skin – which carries most of the contamination – does not form part of the fresh meat samples examined in the Zoonosis Monitoring. Besides, it is not clear to what extent bacteria are transiting into a state where they can no longer be cultivated, but are still alive. This question requires further examination. As the pathogen's infectious dose in humans is rather low, even low counts of *Campylobacter* spp. in foodstuffs pose a risk of infection.

The detection rate of *Campylobacter* spp. in caecal content of fattening turkeys sampled at slaughter was 63.0%, which is roughly the same level as in the 2018 Zoonosis Monitoring (64.3%). Neck skin samples of turkey carcasses contained *Campylobacter* spp. at a rate of 6.8%, which was much less than detected in monitoring programmes of earlier years (2010: 68.0 %, 2012: 53.5 %). It is not clear whether this difference is partly attributable to methodical difficulties in detecting, in particular, *Campylobacter coli* on the carcasses. This question requires clarification and further examinations.

Campylobacter spp. was detected in 3.2% of the pooled samples of eggshells stemming from conventionally produced, unsorted eggs sampled at the raw product entrance point of egg-packing factories. Pooled samples of eggshells drawn at the exit point of egg-packing plants from conventionally produced, sorted eggs destined for final consumers were found contaminated with *Campylobacter* spp. a little less, namely at a rate of 1.3%. With 0.5%, the *Campylobacter* spp. detection rate was lowest in pooled eggshell samples drawn at retail level from conventionally produced eggs destined for final consumers. This level corresponds to the detection rate in eggshells sampled from eggs destined for final consumers in the Zoonosis Monitoring of 2014, which was then 0.4%.
C*ampylobacter* spp. is transferred to the eggshell with laying hens' faeces – in the Zoonosis Monitoring of 2009, 41.8% of laying hens' faecal samples were positive with *Campylobacter* spp. – and the lower rate of detection of *Campylobacter* on eggs sampled at the exit point of egg-packing plants or at retail is probably connected with the fact that

eggs dirtied with faeces are sorted out in the egg-packing plant, so that eggs on retail are mostly clean. *Campylobacter* species' sensitivity to drying should also contribute to the reduction in the detection rate. Eggs are a potential source of infection of consumers with *Campylobacter* spp., because the bacteria may be transferred from the shell to the egg dish when eggs are cracked when preparing the dish. Therefore, only clean eggs should be used when preparing dishes with raw egg, and the eggshell should not come in contact with the food eggs are cracked. Consumers should thoroughly wash hands after toughng eggs.

The *Campylobacter* spp. detection rate in samples of minced pork was 0.2%, and thus in the same range as findings in previous years (0.4% positive samples). The Zoonosis Monitoring programmes of previous years showed that pigs are frequent carriers of *Campylobacter* spp. (>70% positive samples of caecal content). But the pig slaughtering process seems to provide efficient barriers to transmission of the bacteria to the meat, because fresh porcine meat is actually very seldom contaminated with *Campylobacter* spp. (between 0.2% and 0.5% of the samples are positive). So, pork seems to be of minor importance in transmitting this zoonotic pathogen to humans. Still, raw minced pork (such as, *Mett*) must be generally taken into account as a possible source of human infection with *Campylobacter* spp.

As in the years before, isolates of *Campylobacter coli* displayed higher rates of resistance to antimicrobial substances than isolates of *Campylobacter jejuni*. The difference was particularly obvious in the turkeys food chain, where 95.5% of the *Campylobacter coli* and 76.1% of the *Campylobacter jejuni* isolates were resistant towards at least one of the antimicrobial substances tested. The highest rates of anti-microbial resistance in both C*ampylobacter* species were found in the food chains related with broilers and fattening turkeys towards the (fluoro)quinolones ciprofloxacin and nalidixic acid, followed by tetracycline. Here it was also noticeable that the rate of resistance of *Campylobacter* jejuni isolated from the broiler food chain towards ciprofloxacin increased markedly over the past few years, namely from 65.8% in the year 2014 to 83.4% in 2020. The high rates of resistance to (fluoro)quinolones give reason to concern, because these are antibiotics which are particularly important for treatment of humans. As regards erythromycin, resistance was found only in *Campylobacter* coli, with 11.5% of isolates from the broiler food chain and 23.9% of isolates from the turkeys showing resistance towards this substance. This was problematic in so far as erythromycin is an antibiotic which is important in treating campylobacteriosis in humans. The few campylobacter isolates

obtained from egg shells were, in tendency, less often resistant to antimicrobials than isolates stemming from the poultry meat chains.

Listeria monocytogenes

Listeria monocytogenes was found at rates of 20.0% in broiler neck skin sampled at slaughter and 19.3% of fresh broiler meat samples. In the 2018 Zoonosis Monitoring, the detection rate of *Listeria monocytogenes* in fresh broiler meat was 15.4%, which is roughly a similar range. In quantitative measurements, 0.7% of fresh broiler meat samples had countable germ loads. One sample (0.3%) had a *Listeria monocytogenes* count of 500 cfu/g, which means a potential risk to human health (germ count >100 cfu/g). Here one has to give consideration to the fact that fresh broiler meat is not a ready-to-eat food, but is usually heat-treated before consumption. Still, frequent contamination of broiler carcasses with *Listeria monocytogenes* harbours the risk that the pathogen may invade meat processing plants through the raw material.

Samples of soft cheese from cow raw milk were positive with *Listeria monocytogenes* at a rate of 0.3 per cent. Though none of the samples was found with a germ count higher than the quantitative method's detection limit, present *Listeria* might grow over a longer storage period. Sensitive consumer groups such as small children, elderly and immune-suppressed people, and pregnant women, are therefore advised not to consume raw milk cheese. This recommendation is supported by findings from earlier Zoonosis Monitoring programmes, which found single raw milk soft cheese samples, both from cow raw milk and from sheep and goat raw milk, with high *Listeria monocytogenes* counts (namely, $6.2x10^3$ cfu/g and 570 cfu/g), which pose a potential threat to human health (germ count > 100 cfu/g).

Samples of dried leaves or grass products were not found with *Listeria monocytogenes,* neither in qualitative nor in quantitative measurements. So, based on these findings, dried leaves and grass products do not seem to play a role as a potential source of human infection with *Listeria monocytogenes.*

Shiga-toxin forming *Escherichia coli* (STEC)

STEC was frequently detected in wheat flour sampled at milling plants, with 9.1% of the samples found positive. So we can say that wheat flour - as a part of raw cookie dough, for instance – harbours a risk of human infection with STEC. The importance of wheat flour as a potential source of STEC infection of humans is underlined by the fact that the

isolates obtained partly carry the *eae* gene, which is a major factor of STEC virulence, and also belong to sero groups which frequently cause EHEC disease in humans. Potential sources of the microbial contamination of the flour are faeces of ruminant game in the field, contaminated sprinkling water, and organic fertilizers in the field. This question should be further investigated. It requires good hygiene practice in milling plants to prevent germs from spreading within and across production lots. Consumers should eat dough and bakery ware only fully baked, in order to protect themselves from infection with STEC by contaminated flour. Strict kitchen hygiene should be followed when flour is used, in order to prevent STEC present in the flour from spreading to other food which is intended to be consumed raw. The public should be made more aware of the presence of potential pathogens in flour.

STEC was detected in 7.0% of faecal samples of wild boar, which corresponds with the findings of the 2016 Zoonosis Monitoring, when 6.9% of wild boar faecal samples were positive with STEC. So the findings confirm that wild boar are an STEC reservoir.

Soft cheese from raw milk was STEC positive at a rate of 1.9%. The detection rate was somewhat higher than that found in raw-milk soft cheese, semi-soft cheese, and hard cheese in previous years' monitoring programmes, which was 0.6% in each. The findings confirm that raw-milk cheeses harbour a risk of human infection with STEC. Yet none of the STEC isolates carried the *eae* gene or was of a sero group which is found particularly often in diseased humans.

STEC was detected in 0.4% of samples of dried leaf and grass products. This means such vegetal foods or dietary supplements are a possible source of human infection with STEC, in particular, as they are not cooked prior to consumption. This is supported by the fact that the STEC isolate obtained from dried leaf/grass product carried the *eae* gene.

Samples of fresh lamb meat were contaminated with STEC at a rate of 13.2%, which is clearly more than rates found in earlier monitoring programmes in meat of calves and young bovines (about 6.0 %) or meat of adult bovines (1 to 2%).
Among the STEC isolates were sero groups that are frequently found in diseased humans. Yet none of the isolates carried the *eae* gene, which is attributed with serious diseases such as HUS. The findings show that lamb meat is associated with a risk of STEC infection of humans. Susceptible consumer groups, such as small children, elderly and immunosuppressed people, or pregnant women, should therefore eat lamb meat only after thorough cooking.

The majority of STEC isolates obtained from lamb meat and wild boar were sensitive towards the substances tested. Of the STEC isolates obtained from wheat flour and dried leaf and grass products, none displayed any resistance towards the antibiotics tested.

Methicillin-resistant *Staphylococcus aureus* (MRSA)

Carp-like fish from commercial fishery businesses without aquaculture carried MRSA fairly seldom, with 1.0% positive gill swab tests. Samples of imported, aquacultured fish tested in the Zoonosis Monitoring of 2019 were much more frequently contaminated with MRSA, with a rate of 29.1% positive samples. The resistance patterns and *spa* types (many non-CC398) analysed at that time differed from those types associated with food-delivering farm animals, and we do not know how the bacteria entered the food chain, and whether they may already be detectable in the aquaculture. From the carp-like fish, no STEC isolates were sent in for further type identification.

The detection rate of MRSA in nose swab tests of wild boar was 0.8%, while the 2016 Zoonosis Monitoring did not find any MRSA in wild boar. The two isolates that were analysed belonged to clonal complex CC398, which suggests an origin sourced in farm animals. Future Zoonosis Monitoring programmes should continue to look for MRSA in wild boar, in order to watch whether these resistant bacteria continue to spread there.

No MRSA was found in samples of raw-milk soft cheese. The samples of raw-milk soft cheese and raw-milk semi-hard sliced cheese analysed in the Zoonosis Monitoring of 2011 were then contaminated with MRSA at a rate of 1.6%. Bulk milk sampled from tanks at dairy farms under monitoring programmes of the past few years were found contaminated with MRSA at rates between 4% up to 10%.

Samples of fresh lamb meat were detected with MRSA at a rate of 2.8%. So, fresh lamb meat had a clearly lower rate of contamination with MRSA than fresh meat of calves and young bovines, which was found contaminated with MRSA at about 11% in zoonosis monitoring programmes in the years before. Fresh bovine meat analysed in earlier programmes had also, in tendency, higher MRSA contamination rates than fresh lamb meat, with rates of about 5% to 8% positive samples. The MRSA isolates obtained included such which were not of the farm animal-associated clonal complex CC398, which suggests that the meat was contaminated with the MRSA during production and processing by man.

The isolates sent in for resistance testing were all resistant to beta-lactam antibiotics, as it was expected. The isolates stemming from wild boar displayed resistance to tetracycline, which is actually typical of farm animal-associated MRSA strains. In contrast, only 54.5% of isolates obtained from lamb meat were resistant to tetracycline, which is explained by the higher portion of isolates which are not of the farm animal-associated MRSA type.

Clostridioides difficile

C. difficile was detected in 1.6% of neck skin samples of broiler carcasses and 0.2% of neck skin samples of turkey carcasses. Findings in a similar range were made in earlier programmes in minced pork, which was found contaminated with *C. difficile* at rates between 0.0% and 1.4% then. The findings show that, apart from pigs, broilers and fattening turkeys must also basically be considered as potential transmitters of *C. difficile* to humans. All isolates of *Clostridioides difficile* obtained were toxinogenic, but they were not of ribotypes frequently described in human medicine.

Presumptive *Bacillus cereus*

Presumptive *B. cereus* was detected by quantitative method in 31.7% of samples of dried leaf and grass products, the majority of findings counting below 1,000 cfu/g. Two samples (0.8%) had bacterial counts higher than 10^4 cfu/g. The highest count of *B. cereus* (s. l.) found in the framework of the Zoonosis Monitoring was 3,7 × 10^4 cfu/g in one sample of dried leaf and grass product. In the context of the majority of disease outbreaks caused by *B. cereus* (s. l.), however, literature reports bacterial counts higher than 10^5 cfu/g in the foodstuffs involved. Still, lower germ counts may also pose a risk under certain conditions. We can also not preclude that spores present in a food may germinate and spread if the food is kept warm or not sufficiently cooled. Most of the *B. cereus* isolates characterised more closely carried the genes responsible for formation of enterotoxins. On the other hand, the laboratory did not find the *cytK-1* gene (characteristic of *B. cytotoxicus*), nor the *ces* gene cluster (responsible for cereulide formation).

Commensal *Escherichia coli*

The results of antimicrobial resistance testing of *E. coli* isolates showed obvious differences in the resistance rates observed, depending on the origin of isolates. Isolates stemming from layer hens (26.0% resistant isolates) and eggs (17.5% to 46.3% resistant

isolates) or breeding layer hens (34.6% resistant isolates) again displayed clearly lower resistance to antimicrobials than isolates stemming from broilers (meat: 82.3%, caecal content: 84.6% resistant isolates) and fattening turkeys (72.3% resistant isolates). *E. coli* isolates from breeding hens, layer hens and eggs were mostly resistant to tetracycline and ampicillin, which corresponds to the widespread use of these antibiotics in chicken farming. Resistance rates noted in *E. coli* isolates stemming from the broiler and fattening turkey food chains were, in total, somewhat lower than in the 2018 Zoonosis Monitoring, but higher with regard to some single antimicrobial substances in the broiler food chain. This is problematic in particular as these are the substances ciprofloxacin, colistin, and cephalosporins of the third generation, which are of particular importance in antibiotic treatment of humans.
E. coli isolates of aquacultured freshwater fish and the isolate of dried grass and leaf product were not found resistant. Isolates obtained from lamb met and wild boar were nearly 90% sensitive to the antimicrobial substances tested. A relatively high rate of resistance to colistin of 5.3% in isolates obtained from wild boar was conspicuous. Colistin resistance in isolates stemming from wild boar was already noted in the Zoonosis Monitoring of 2016.

ESBL/AmpC-forming *Escherichia coli*

ESBL/AmpC-forming *E. coli* were detected using selective methods at a rate of 23.6% in faecal samples obtained from breeding layer hens, and at a rate of 19.9% in faecal samples obtained from layer hens. So, detection rates have nearly halved compared to findings in the 2014 Zoonosis Monitoring, when 39.3% of the faecal samples of breeding layer hens and 45.7% of the faecal samples of layer hens were found positive with ESBL/AmpC-forming *E. coli*.

Gill swabs of freshwater fish from commercial fishing businesses without aquaculture did not produce any ESBL/AmpC-forming *E. coli* findings. This shows that these resistance properties have not yet spread in commercial fishery businesses.

In caecal content samples from broilers at slaughter, ESBL/AmpC-forming *E. coli* was detected at a rate of 36.5%, and thus much less than in 2018 (46.8%). This continues a trend which could be observed over the past few years and which showed a declining presence of ESBL/AmpC-forming *E. coli* in broilers. Samples of fresh broiler meat were found positive with ESBL/AmpC-forming *E. coli* at a rate of 33.6%, which is roughly as often as in the Zoonosis Monitoring of 2018, with 35.4% positive broiler meat samples. This underlines the demand for improvements in poultry slaughter hygiene.

Contamination of broiler meat with ESBL/AmpC-forming *E. coli* continues to be very high, which is why broiler meat must be thoroughly heated before consumption, and cross-contamination in the kitchen should be avoided, in order to protect one's own health.

43.9% of samples of caecal content drawn from fattening turkeys at slaughter were detected with ESBL/AmpC-forming *E. coli*. Compared to the Zoonosis Monitoring of 2018, when 48.6% of caecal content samples were positive with ESBL/AmpC-forming *E. coli*, the detection rate in fattening turkeys has slightly declined.

Faecal samples of wild boar were detected with ESBL/AmpC-forming *E. coli* at a rate of 5.0%. The findings are so of a similar order as in the Zoonosis Monitoring of 2016, when 6.4% of wild boar faecal samples were positive with ESBL/AmpC-forming *E. coli.* Compared to findings in fattening pigs in earlier monitoring programmes, which found that about 45% of the pigs carried the ESBL/AmpC-forming *E. coli*, the detection rate in wild boar is low. But the findings show that these particular resistance properties occur also in the general environment, outside animal farming. Typification of isolates in the framework of the 2016 Zoonosis Monitoring showed that wild boar were carrying both those types predominating in animal farms and such primarily found in humans.

With 13.6% positive samples, minced pork was notably more often contaminated with ESBL/AmpC-forming *E. coli* than fresh porcine meat, which had positive rates of 5.5% and 5.7% in earlier Zoonosis Monitoring programmes. The findings give reason to concern with a view to the possible spreading of this resistance property by consumption of raw minced meat.

Fresh lamb meat had a contamination rate with ESBL/AmpC-forming *E. coli* of 2.1%, which is somewhat lower than measured in fresh beef in earlier Zoonosis Monitoring programmes (about 4%).

By the current state of scientific knowledge, we have to assume that these resistant, ESBL/AmpC-forming *E. coli* can be transmitted to humans also via foodstuffs, while the actual risk of infection is currently not accurately estimable. Bacteria present in the meat are safely killed by thorough heating when preparing the food. But lack of kitchen hygiene is a particular risk and can result in cross-contamination, with bacteria present in the raw meat being carried to other foods intended for raw consumption (such as, by using the same chop board for cutting meat and afterwards chopping salad vegetables). Strict kitchen hygiene can, however, minimise the risk of infection or colonisation by bacteria.

Carbapenemase-forming *Escherichia coli*

Two bacterial isolates obtained from fresh broiler meat samples and sent to the laboratory for suspected carbapenem resistance were not confirmed as carbapenem-resistant *E. coli*. In the years before, carbapenemase-forming *E. coli* were exclusively found in single cases in the food chain related with fattening pigs. This shows that these bacteria have so far been scarcely spread in farm animal holdings.

Enterococcus faecalis* and *Enterococcus faecium

Overall, resistance rates in isolates of *E. faecalis* in the food chains related to broilers and fattening turkeys were higher than in isolates of *E. faecium*. This was also noted in monitoring programmes in the years before. The differences in resistance rates between the two species were particularly wide in the isolates stemming from the broilers food chain. In both species, resistance rates were again highest towards tetracycline (57.8%) and erythromycin (58.6%). Both species displayed no resistance towards vancomycin and teicoplanine, while vancomycin-resistant *E. faecium* isolates are increasingly detected with humans. The generally different resistance patterns displayed by *Enterococcus* isolates obtained from animals and from humans indicate that broilers and fattening turkeys are not an important source of human disease with this bacterial species.

Roundup

The Zoonoses Monitoring programme raises representative and comparable data on the prevalence of zoonotic pathogens in major food-delivering animal species and major food products, allowing an evaluation of consumers' risk of infection through consumption of foodstuffs. Investigations into resistance improve the data situation in this field and contribute to being able to better analyse relations between the use of antimicrobials in animal farming and the development of antimicrobial resistance. Continual testing under this programme allows assessing trends and developments in the spread of zoonotic agents and antimicrobial resistance. In addition, the testing at various stages of production allows tracking recognising the paths of contamination with zoonotic pathogens along the food chain.

In many fields, the results of examinations in the food chains related to broilers and fattening turkeys in 2020 ranged in the same orders of magnitude as in the Zoonosis Monitoring in the years before.

The high detection rate of ESBL/AmpC-forming *E. coli* in minced pork was conspicuous. This is critical with regard to possible spreading of this resistance property by consumption of raw minced meat.

The high rate of contamination of broiler carcasses and fresh broiler meat with *Listeria monocytogenes* brings a risk of carrying these germs into food processing establishments, where they may re-contaminate products which have been finally heat-treated. Future investigations should examine the question in how far ready-to-eat chicken meat products might be contaminated with *Listeria monocytogenes*.

The contamination rate of turkey carcasses with Salmonella has declined compared to the year before, but remains at a high level. Again it were some few slaughterhouses that were responsible for high contamination rates, which suggests that there are considerable hygiene shortcomings in these particular establishments.

The results of the 2020 Zoonosis Monitoring also show that there has again been no progress in reducing *Campylobacter* in the food chain related to broiler chickens. The portion of neck skin samples with high *Campylobacter* counts of more than 1000 cfu/g has remained about as large as in the years before, despite introduction of the process hygiene criterion for *Campylobacter* in 2018.

Examination of fresh lamb meat, which was performed for the first time in the framework of the Zoonosis Monitoring in 2020, produced findings indicating in particular a risk of human infection with STEC through consumption of that meat.

Wheat flour, too, is a potential source of human infection with STEC, which is why food business operators should sell ready-to-bake doughs only after a heat treatment, or should manufacture such doughs only from heat-treated flour. The BfR is advising consumers on how to handle flours and ready-to-bake doughs in an opinion on the risks of STEC in flours (https://www.bfr.bund.de/cm/343/escherichia-coli-in-mehl-quellen-risiken-und-vorbeugung.pdf).

Eggshells seem to be very seldom contaminated with *Salmonella*, which can be attributed to EU-wide *Salmonella* control programmes in poultry stocks.

Detection of *Campylobacter* on the eggshell underlines the need to observe good kitchen hygiene when handling eggs.

Wild boar are a reservoir of various zoonotic pathogens and also frequent carriers of ESBL/AmpC-forming *E. coli*.

Dried leaf and grass products may contain potentially pathogenic germs. The BfR has published a health opinion on pathogenic bacteria in leaf and grass products, in which it advises consumers about the risks which can emanate from these products (https://www.bfr.bund.de/cm/343/gras-und-blattprodukte-zum-verzehr-koennen-mit-krankmachenden-bakterien-verunreinigt-sein.pdf)

The investigations of the Zoonosis Monitoring have confirmed that raw-milk soft cheese harbours a risk of infection with Listeria monocytogenes and STEC. Vulnerable consumer groups such as small children, elderly and immune-deficient people, or pregnant women, should therefore not consume soft cheese made from raw milk.

Analyses of carp-like fish from commercial fisheries without aquaculture indicate that these are not important carriers of multi-resistant pathogens. In order to draw valid conclusions, however, larger sampling volumes must be analysed than under the 2020 Zoonosis Monitoring.

A finding which is viewed favourable is that we observed a decline in detection rates of ESBL/AmpC-forming *E. coli* in layer hens and breeding layer hens.

The results of antimicrobial resistance testing in the 2020 Zoonosis Monitoring reflect that there have been no substantial improvements with regard to the prevalence of resistance in bacterial isolates obtained from the food chains related to broiler chickens, fattening turkeys, and fattening pigs. Resistance rates found in farm animals were highest in broilers and fattening turkeys, which reflects the frequent use of antimicrobials in these animal groups. The results at the same time show that resistant bacteria do not accumulate to a larger extent in animals in the natural terrestrial or aquatic environment, as most of the isolates obtained from wild boar or freshwater fish were sensitive towards the antimicrobial substances tested.

The findings make clear that efforts to reduce the use of antimicrobials in farm animals must be further stepped up, in order to achieve a reduction in resistance rates. A focus herein should be placed on reducing the use of critical antibiotics, in particular of those classified by WHO as HPCIA. The urgency of reducing the use of fluoroquinolones is underlined by the very high rates of resistance to substances of this class in bacterial isolates stemming from the poultry meat food chains. Some of the resistance rates have even still increased in 2020. Use of colistin, too, must be further constrained because of the transferrable resistance genes identified, and because of that substance's enhanced importance in human medicine.

The results of the Zoonoses Monitoring show where official food surveillance has to place the foci. They deliver important information helping government authorities to take suitable measures to reduce the occurrence of zoonotic pathogens.

Having the overriding aim to reduce consumers' exposure to zoonotic pathogens, the Zoonoses Monitoring programme significantly contributes to health protection of consumers.
Consumers can protect themselves from food-borne infections by thoroughly cooking meat and strictly observing kitchen hygiene, which prevents transmission of pathogens from raw meat to ready-to-eat food (such as salad) during preparation of food. In order to prevent bacterial growth in meat and certain ready-to-eat foodstuffs, care should be taken to maintain cooling chains and fix appropriate, short best-before or use-by dates. Vulnerable consumer groups, namely small children, elderly and immune-deficient people, and pregnant women, should refrain from consuming raw minced meat and other raw meat and raw milk products, as well as certain ready-to-eat foods, as these foods harbour a potential health risk. The Federal Institute for Risk Assessment BfR has published information leaflets on how to minimise the risk of infections with Campylobacter, STEC/VTEC, and Listeria, as well as on how to protect oneself from food-borne infections in the private household (https://www.bfr.bund.de/de/start.html).