Application Note

Food Testing & Agriculture

An End-To-End Workflow for Quantitative Screening of Multiclass, Multiresidue Veterinary Drugs in Meat Using the Agilent 6470 Triple Quadrupole LC/MS

Authors

Siji Joseph, Aimei Zou, Chee Sian Gan, Limian Zhao, and Patrick Batoon
Agilent Technologies, Inc.

Abstract

A comprehensive LC/MS/MS workflow was developed for targeted screening or quantitation of 210 veterinary drug residues in animal muscle prepared for human consumption, with the intention to accelerate and simplify routine laboratory testing. The workflow ranged from sample preparation through chromatographic separation, MS detection, data processing and analysis, and report generation. The workflow performance was evaluated using three muscle matrices—chicken, pork, and beef—and was assessed on two different Agilent triple quadrupole LC/MS models (an Agilent 6470 and a 6495C triple quadrupole LC/MS). A simple sample preparation protocol using Agilent Captiva EMR—Lipid cartridges provided efficient extraction and matrix cleanup. A single chromatographic method using Agilent InfinityLab Poroshell 120 EC-C18 columns with a 13-minute method delivered acceptable separation and retention time distribution across the elution window for reliable triple quadrupole detection and data analysis.

Workflow performance was evaluated based on evaluation of limit of detection (LOD), limit of quantitation (LOQ), calibration curve linearity, accuracy, precision, and recovery, using matrix-matched spike samples for a range from 0.1 to 100 µg/L. Calibration curves were plotted from LOQ to 100 µg/L, where all analytes demonstrated linearity R^2 >0.99. Instrument method accuracy values were within 73 to 113%. Target analytes response and retention time %RSD values were ≤19% and ≤0.28% respectively. Analyte recovery and reproducibility at three levels of fortified quality control (QC) samples—1, 10, and 25 µg/kg in meat—were used to validate the method applicability for confident routine screening of veterinary drugs. The recovery repeatability (intrabatch technical replicates) and recovery reproducibility (interbatch technical replicates) were calculated using QC samples, and the results were within acceptable limits of 20 and 32%, respectively.[1] The workflow method performance results across the chicken, beef, and pork muscle matrices showed excellent overlap, and confirm the method applicability for routine multiresidue screening in various animal origin matrices.

Introduction

Veterinary (vet) drugs are commonly used to improve the growth and health outcomes of farm animals. Improper use of vet drugs in animal farming can result in the accumulation of these drugs in animal-derived foods, causing adverse effects to consumers. Global regulations define limits for vet drugs in food of animal origin to protect public health. As a gold standard for chemical quantitation, triple quadrupole LC/MS (LC/MS/MS) is a widely accepted technique for this analysis. However, laboratories traditionally use chemistry-specific extraction procedures and run individual LC/MS analyses based on compound class. This can be inefficient for productive lab operations and result in diminished throughput and high operating costs. To streamline day-to-day operation, a comprehensive workflow has been developed for the accurate and reliable analysis of >200 multiclass veterinary drugs in various animal-origin food matrices using LC/MS/MS. The end-to-end workflow includes sample extraction and matrix cleanup, chromatographic separation, MS detection, target quantitation, and reporting templates. Table 1 lists the veterinary drug classes covered using this workflow.

Table 1. Classification of 210 vet drugs based on functional use/chemical class, and the number of target compounds in each class.

No.	Functional Use/Chemical Class	Number of Targets
1	Anesthetic	1
2	Anthelmintic	16
3	Anthelmintic/Avermectins	3
4	Anthelmintic/Benzimidazoles	14
5	Anthelmintic/Nitroimidazoles	5
6	Anti-herbivore	1
7	Anti-inflammatory	2
8	Antibiotic	7
9	Antibiotic/Aminoglycosides	5
10	Antibiotic/Amphenicols	3
11	Antibiotic/Beta-Lactam	16
12	Antibiotic/Macrolides	10
13	Antibiotic/Quinolones	10
14	Antibiotic/Sulfonamides	27
15	Antibiotic/Tetracycline	6
16	Antiemetic	1
17	Antimicrobial	6
18	Antimicrobial /Furans	1
19	Coccidiostats	14
20	Dopamine receptor	1
21	Fungicides and dyes	3
22	Growth promoters/Anabolic steroids	3
23	Growth promoters/Beta-agonists	4
24	Growth promoters/Corticosteroids	4
25	Hormones	9
26	Insecticide	15
27	NSAIDs	14
28	Quinoxalines	1
29	Tranquilizer	8

Experimental

Standards and reagents

Veterinary drug standards were purchased from Sigma-Aldrich (St. Louis, MO, USA), Toronto Research Chemicals (Ontario, Canada), and Alta Scientific (Tianjin, China). Agilent LC/MS-grade acetonitrile (ACN), methanol (MeOH), and water were used for the study. All other solvents used were HPLC-grade from Sigma-Aldrich. LC/MS additives for mobile phases were also purchased from Sigma-Aldrich. Stock solutions of individual veterinary standards were prepared from powdered or liquid veterinary drug standards at 1,000 or 2,000 µg/mL using an appropriate dissolving solvent (methanol, dimethyl sulfoxide, acetonitrile, or water individually or in combination). A few stock standard solutions were purchased as ready-made solutions with a concentration of 100 µg/mL from the above-listed suppliers.

A comprehensive standard mix (1 µg/mL of each target analyte in 50/50 acetonitrile/water) was prepared from individual stock solutions and used for this experiment.

Sample preparation

Chicken, beef, and pork muscle matrices were used to assess the method performance. Fresh chicken (antibiotic-free), beef, and pork were obtained from local grocery stores. Samples were homogenized using a domestic blender. A 2±0.1 g portion of blended meat was weighed in a 50 mL conical polypropylene tube. Homogenized meat samples were stored at –20 °C, if not analyzed immediately.

Sample preparation was based on solvent extraction followed by Agilent Captiva EMR—Lipid (p/n 5190-1003) SPE cleanup. Sample elution was aided using the Agilent positive pressure manifold system (PPM-48, p/n 5191-4101).

Pre-extraction (matrix-spiked) QC samples were fortified by spiking appropriate veterinary standard solution into the homogenized muscle matrices at three levels: 1 µg/kg for low QC (LQC), 10 µg/kg for mid QC (MQC), and 25 µg/kg for high QC (HQC) in meat. Pre-extraction LQC and MQC samples were used to evaluate method recovery and reproducibility. After spiking standards into the matrix, samples were vortexed for 30 seconds and equilibrated for 15 to 20 minutes. This allowed the spiked standards to infiltrate the sample matrix and equilibrate before sample extraction.

The sample preparation procedure is summarized in Figure 1. The detailed procedure is included in the workflow guide included with the Comprehensive Veterinary Drug dMRM Solution (G5368AA).

Postextraction calibration standards

Matrix blank was prepared using unfortified meat samples. Matrix-matched calibration standards were prepared by spiking appropriate standards into the matrix blank. The targeted concentrations of calibration levels in muscle matrix were 0.1, 0.25, 0.5, 1.0, 2.5, 5.0, 10.0, 25.0, 50.0, and 100.0 µg/kg. Considering the 1:10 dilution factor introduced during sample preparation, the actual matrix-matched calibration standard levels were 0.01, 0.025, 0.05, 0.10, 0.25, 0.5, 1.0, 2.5, 5.0, and 10.0 µg/L in matrix blank extract.

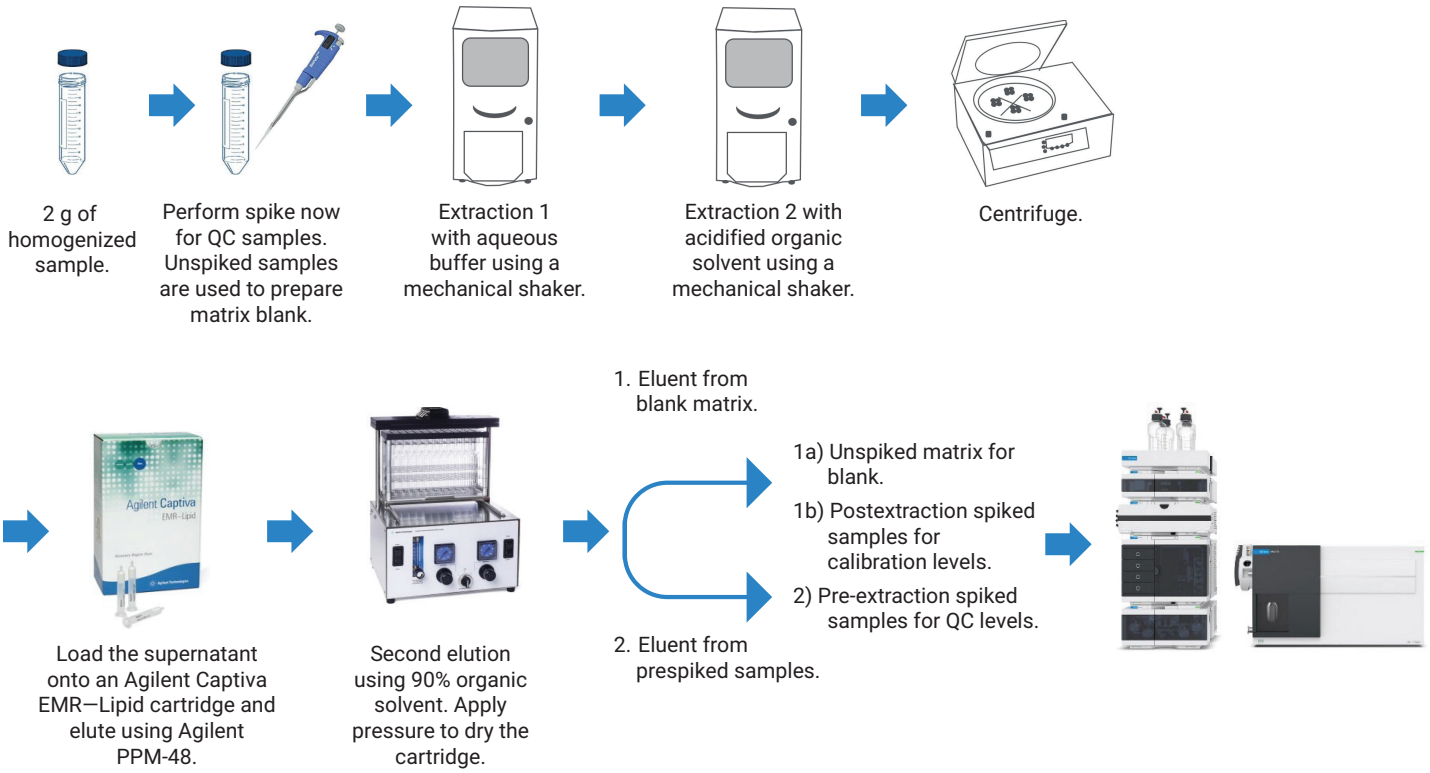

Figure 1. Flowchart of sample extraction and Agilent Captiva EMR—Lipid cleanup protocol. (The size of images is not to any scale.)

Neat solutions at 0.1, 1.0, and 2.5 µg/L in 50/50 acetonitrile/water were used to evaluate matrix effects by comparing the responses in the corresponding matrix-matched calibration standards.

Instrumentation

Chromatographic separation was performed using an Agilent InfinityLab Poroshell 120 EC-C18 column (p/n 695575-302) installed on an Agilent 1290 Infinity II LC. The individual modules of the 1290 Infinity II LC were:

- Agilent 1290 Infinity II high-speed pump (G4220A)
- Agilent 1290 Infinity autosampler (G4226A)
- Agilent 1290 Infinity thermostatted column compartment (G1316C)

The LC system was equipped with a 20 µL injection loop and multiwash capability. Mobile phase A was water with 4.5 mM ammonium formate, 0.5 mM ammonium fluoride, and 0.1% formic acid; and mobile phase B was 50/50 ACN/MeOH with 4.5 mM ammonium formate, 0.5 mM ammonium fluoride, and 0.1% formic acid.

A 6470 LC/TQ with an Agilent Jet Stream (AJS) ion source was operated in dynamic MRM (dMRM) mode. The LC/TQ autotune was performed in unit mode with *report m/z <100* mode enabled. Data acquisition and processing were performed using Agilent MassHunter software (version 10.0). Please refer to the workflow guide included with the Comprehensive Veterinary Drug dMRM Solution, for more information on non-Agilent laboratory equipment and supplies used in this study. The methods for the 6470 LC/TQ and 6495C LC/TQ are included in the Comprehensive Veterinary Drug dMRM Solution, allowing users to copy and use the acquisition method directly.

Application of the workflow for the screening of veterinary drugs

Reporting limits are implemented from different regulatory organizations to control the veterinary drug residues in animal-origin food matrices. Depending on the regulatory organization and sample matrix, the acceptable residue limit of veterinary drugs may vary. The 210 targeted veterinary drugs were selected based on a combinatory study of the vet drug monitoring lists recommended by US FDA-CFR,[2] US FSIS,[3] EU,[4] and AOAC.[5] A Venn diagram of target distribution across various organizations is given in Figure 2. Of the total 210 target analytes, 168 of them have maximum residue limits (MRLs) established in three muscle matrices regulated by AOAC, EU, and US regulation/guidelines. The remaining 42 targets with no MRL established are specified under *monitoring* category in muscle matrix per the requirement of these regulations/guidelines. The workflow applicability for a specific regulation/guideline-based routine screening is demonstrated by evaluating the analytical characteristics of the appropriate fortified QC samples.

Results and discussion

Simple workflow method for the screening of multiclass veterinary drugs

A sensitive and robust workflow for vet drug analysis is beneficial for users to perform routine screening following various regulatory guidelines. The applicability of the newly developed workflow for guideline-based routine analysis is demonstrated by carrying out a screening of chicken muscle matrix for the AOAC recommended target list. Out of 168 targets, 86 targets are specifically required for chicken screening, with results summarized in Table 2 (found at the end of this document). The sensitivity of the workflow method was established using postextraction spiked calibration levels, and applicability for routine screening was demonstrated using recovery analysis at three pre-extraction QC levels: 1 (LQC), 10 (MQC), and 25 µg/kg (HQC). Based on the MRL value of a target, one of the QC levels was chosen to demonstrate the screening aspects. The MRL for most targets (85 out of 86) listed in the AOAC guidelines for chicken matrix is ≥10 µg/kg, and recovery analysis using MQC (10 µg/kg) is appropriate to screen all these targets.

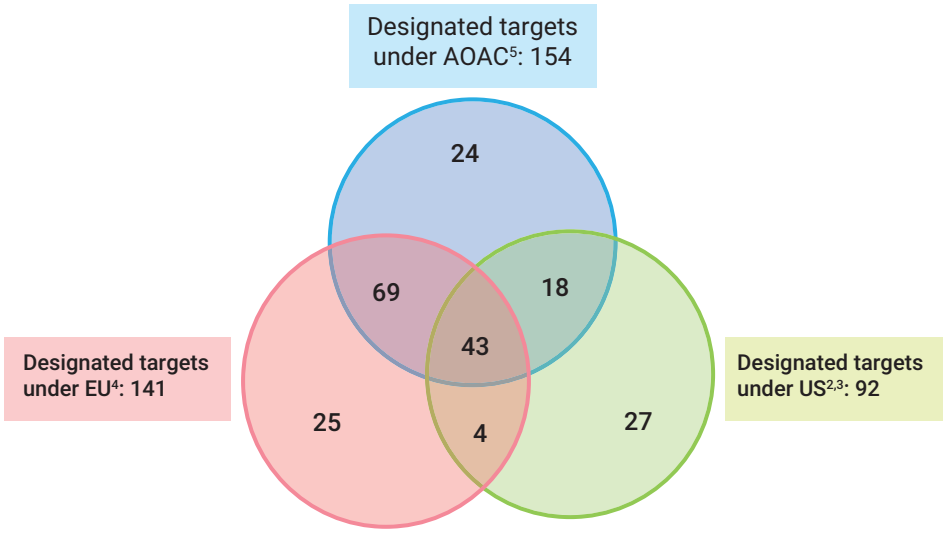

Figure 2. Venn diagram of 210 targets distribution across various regulations.

For the target prednisone, the MRL in chicken matrix is ~1 µg/kg, and for this target, LQC (1 µg/kg) was used to estimate target performance metrics such as recovery, repeatability, and reproducibility. Similarly, for cefalexin, the MRL is 200 µg/kg, and HQC was used to assess the target performance. In summary, the proposed workflow method can successfully be used to screen all 86 targets in chicken matrix as per AOAC guidelines. The results on intraday repeatability and interday reproducibility of recovery values confirmed the consistent and reproducible results for confident day-to-day screening analysis.

LC/TQ method development and performance evaluation

Compound-specific parameters including precursor ion, most abundant product ions, and collision energies were optimized using the MassHunter MRM Optimizer. Two or three target-specific MRM transitions were selected for each compound to satisfy regulatory requirements for identification and confirmation by LC/MS/MS. The method included in the Comprehensive Veterinary Drug dMRM Solution is comprised of MRM transitions for each compound and all relevant MS parameters.

Chromatographic separation using the InfinityLab Poroshell EC-C18 column resulted in good separation and retention time distribution of 210 veterinary drugs with a 13-minute gradient. The 0.5 mL/min flow rate offered easy desolvation of target ions on the AJS source. The addition of ammonium fluoride in the mobile phase helped to improve the sensitivity of negative ionization and reduced the formation of adducts. A dMRM method with a cycle time of 750 ms was used, with dwell times between 7 to 370 ms.

Typical chromatographic peak widths observed were between 8 to 12 seconds. Figure 3 shows a representative MRM chromatogram for all veterinary drug targets postspiked at 2.5 µg/L concentration in chicken matrix.

Early-eluted polar compounds such as piperazine, amprolium, and nicotine have acceptable peak shapes. However, a few of the mectins, such as emamectin and moxidectin, eluted towards the end of the chromatographic run. Targets such as 2,4,6-triamino-pyrimidine-5-carbonitrile, amoxicillin, baquiloprim, cefapirin, cotinine, deacetylcefapirin, dicloxacillin, dicyclanil, diminazene, ractopamine, salbutamol (albuterol), sulfaguanidine, tilmicosin, and zilpaterol showed split peaks. This issue can be overcome by using a higher aqueous solvent percentage in the final, ready-to-inject sample.

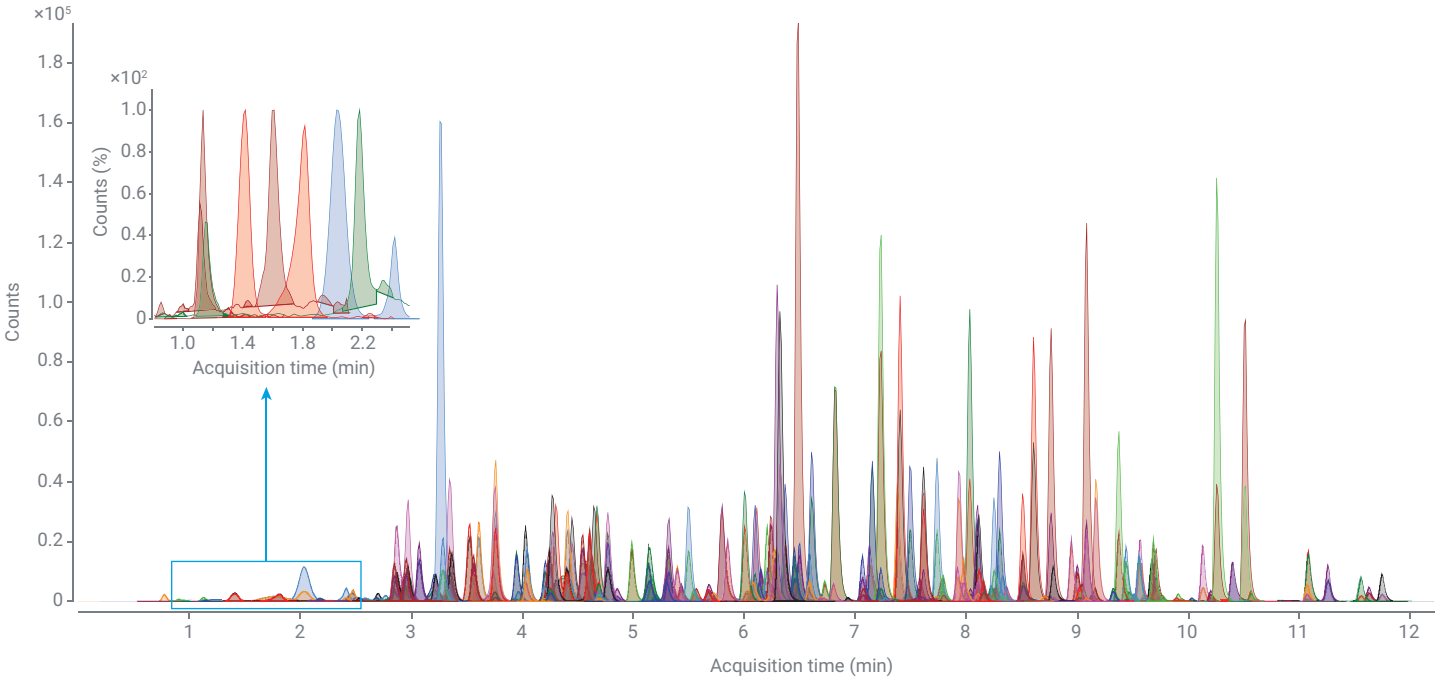

Figure 3. MRM chromatogram of 210 veterinary drug targets postspiked at 2.5 µg/L in blank chicken matrix. Considering the dilution factor was 1:10, this 2.5 µg/L postspike is equivalent to 25 µg/kg spike in chicken. The symmetric sharp peaks demonstrate the efficient chromatographic separation of targets within the retention time window. The inset plot is the zoomed-in view of normalized peaks corresponding to six early-eluting targets.

The workflow performance was assessed based on method sensitivity, linearity, accuracy, precision, analyte recovery, repeatability, and reproducibility. Workflow performance was evaluated using five batch analyses in three different muscle matrices (3× batches for chicken matrix, 1× batch for beef, and 1× batch for pork, respectively). Two different model instruments, the 6470 LC/TQ and 6495C LC/TQ, were used to verify the workflow method performance. The results were cross-verified with a second set of instruments from both models. The batch run for each sample matrix included solvent blank, matrix blank, matrix-matched calibration standards, and pre-extraction QC samples. Matrix-matched calibration standards were run in triplicate and matrix-spiked QC samples were run in duplicate. Neat QC samples were also run to assess the matrix effect.

LOD, LOQ, and calibration curve linearity

LOD and LOQ were established using the various lower levels of postextraction calibration levels. For each compound, the minimum signal-to-noise ratio (S/N) defined for LOD was >3, and >10 for LOQ, using the peak height and the auto-RMS algorithm embedded in Agilent MassHunter Quantitative Analysis software. For claiming LOQ, additional measures such as target selectivity for sample matrix and analyte response reproducibility were also considered. The LOD and LOQ calculation based only on S/N may be impacted if there is matrix contribution due to the endogenous presence of targets in the matrix. When there was a contribution from the matrix to the target analyte, LOD was defined as the three-fold peak area of matrix contribution, and LOQ was defined as the five-fold area of matrix contribution. Analyte response reproducibility calculated from three replicate injections was another important consideration for LOQ, and %RSD was less than the typical acceptance criteria of 25%. Considering the regulatory MRLs requirement for most vet drugs, the lowest postspiking level in matrix extract was 0.01 µg/L, corresponding to 0.1 µg/kg in meat. However, the intensity of many target MRM signals showed the potential to reach lower LODs and LOQs.

A calibration curve for each target was generated using postextraction samples from the defined LOQ to the highest spiked level. For example, for a target with LOD at 0.1 µg/kg, the calibration curve was constructed from 0.25 to 100 µg/kg; for a target with LOD at 1 µg/kg, the calibration curve range was 2.5 to 100 µg/kg; for a target with LOD at 10 µg/kg, the calibration curve range was 25 to 100 µg/kg. To determine the best linearity response function, various regression models were evaluated, and the best calibration model was with Type: *Linear*, Origin: *Ignore*, Weight: *1/x*. All targets met the calibration curve linearity requirement of R^2 >0.99. Table 2 shows the LOD, LOQ, and calibration curve data of all targets in the chicken matrix.

Instrument method accuracy and precision

The average accuracy value for each postextraction (matrix-matched) calibration level was calculated from triplicate injections. Observed accuracy values for all targets across the calibration range were well within the range of 70 to 120%.

Precision was determined by calculating percent relative standard deviation (%RSD) of the target response and retention time (RT) using triplicate injections for the postextraction calibration levels. Good RTs and response precision values for all targets in all matrices were observed. Response %RSD for all targets in the chicken matrix was <20%, and RT %RSD of all targets was within 0.5%. The precision results confirm the reproducibility of the elution profile and MS detection. For targets having LOQs at 25 µg/kg, the RT %RSD and area %RSD were calculated at 25 µg/L.

Target recovery/extraction efficiency

In this experiment, the impact of sample preparation on target recovery was assessed using three levels of pre-extraction QC samples (LQC, MQC, and HQC). Percent recovery was calculated using "target response" in pre-extraction QCs and "measured response" using postextraction spiked calibration curve equations. Figure 4 shows a MRM chromatogram overlay for the three targets trimethoprim, oxibendazole, and febantel for postextraction sample (black trace) and pre-extraction sample (blue trace) at a concentration corresponding to 1 µg/L in chicken. The response counts comparison between postextraction calibration level and pre-extraction QC samples indicates good recovery (106 ±1%) of these targets. For LQC and MQC, the average recoveries were calculated from duplicate injections of three technical preparations, while for HQC, the average recoveries were calculated from duplicate injections on one technical preparation. Recovery values of over 97% of the targets met the acceptable range of 60 to 120%. Recovery values for targets such as amproilum, cefapirin, erythromycin, malachite green, narasin, and nicotine were within a range of 30 to 60%. However, the results were reproducible over three different batches of study. The results for all target recoveries are listed in Table 2.

Workflow intrabatch repeatability

In this study, the variation of target recovery results between technical preparations of QC levels within a batch was estimated. Recovery repeatability was measured as %RSD of recovery values calculated using intraday technical preparations of QC levels using the chicken matrix. Sample preparation conditions were kept as constant as possible. Captiva EMR—Lipid extraction was performed in triplicate each technical preparation of LQC (1 µg/kg) and MQC (10 µg/kg) levels. Each technical preparation was injected into the mass spectrometer in duplicates. The %RSD was calculated for each QC level and expressed as repeatability. Typically, the acceptable recovery repeatability limit at 10 ppb is 21% and at 1 ppb the limit is 30%.[1] The recovery repeatability %RSD values of all targets were within the acceptable limits, and the results are included in Table 2.

The recovery value of a few targets was less than 60%; however, the recovery repeatability for these targets was within 10% RSD, demonstrating consistent behavior with each technical preparation. These results confirm the repeatability of analyte recovery using Captiva EMR—Lipid sample preparation.

Workflow interbatch reproducibility

In this study, precision of recovery results obtained among three different chicken matrix batches across different laboratory conditions was assessed. The potential variables for the sample preparation and analysis were kept as different as possible, including different lots of sample matrix, different analysts, different instruments, different days, and different laboratory environments. Target recovery reproducibility was measured for all three pre-extraction spiked levels: LQC (1 µg/kg), MQC (10 µg/kg), and HQC (25 µg/kg). Each technical preparation was injected in duplicate, and %RSD of calculated concentrations resulting under different laboratory conditions was reported as reproducibility.

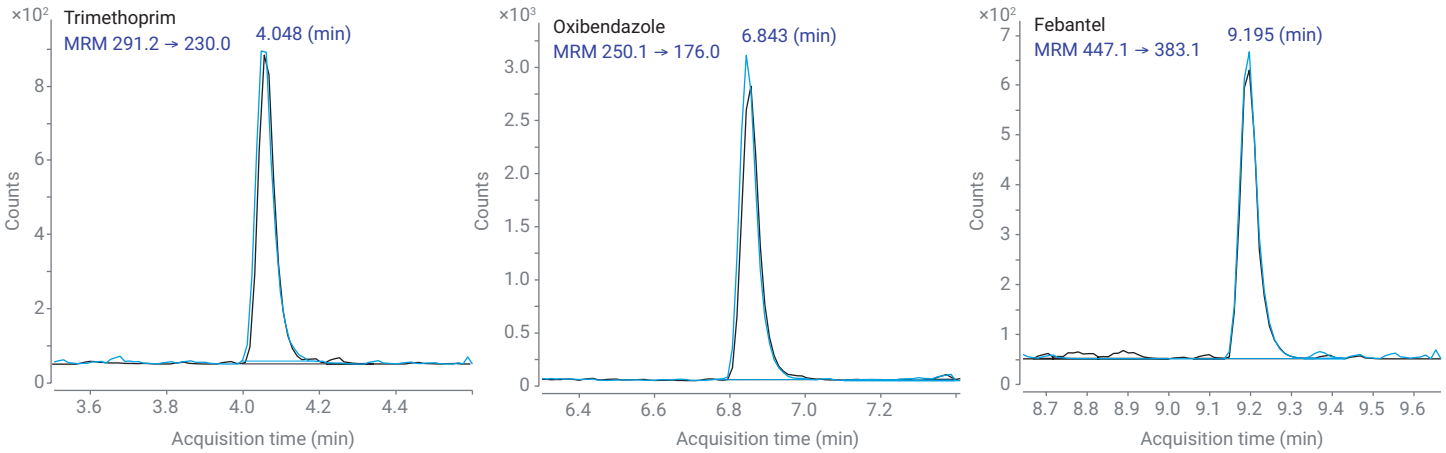

Figure 4. MRM chromatograms overlay of three selected veterinary drug targets corresponding to 1 µg/kg in chicken across the method retention window. The black trace is the MRM for 1 µg/L postspike calibration level, the blue trace is for 1 µg/kg prespike.

The observed results are summarized in Table 2. All 210 targets met the recovery reproducibility limit[1] of <32% RSD and among that, results of >91% of targets were within 15% RSD. The recovery reproducibility results confirm the precision of Captiva EMR—Lipid sample preparation across different laboratory conditions.

Matrix effect assessment

Matrix effect (ME) was assessed by the ratio of target response in postspiked samples to that in corresponding neat standards. Typically, there is no strict requirement on acceptable ME criteria, because the matrix effect can be corrected by the matrix-matched calibration curve. However, the matrix effect is an important parameter for method sensitivity and reliability assessment. In this study, ME was investigated using the postspiked calibration levels at 2.5 µg/L level in comparison to the corresponding neat standards. Within the total of 210, >93% of targets did not show any significant matrix suppression; for these targets, ME was >75%. Approximately 3% of targets resulted in ME within 50 to 70%, indicating low ion suppression; 1% of targets showed ME within 25 to <50%, indicating relatively medium level ion suppression; and 3% of targets exhibited significant ion suppression with MEs <25%. Targets such as cyromazine, dicyclanil, sulfacetamide, sulfaguanidine, sulfisomidine, and tolfenamic acid were affected by low ion suppression. Targets such as erythromycin and fluralaner were affected with relatively medium level ion suppression, and 2,4,6-triamino-pyrimidine-5-carbonitrile, amprolium, cotinine, deacetylcefapirin, metronidazole, metronidazole-OH, and nicotine showed significant ion suppression.

Method performance comparison across three muscle matrices

The performance results from chicken, beef, and pork muscles were in good agreement. As an example, the recovery results for targets in chicken, beef, and pork muscle at 10 µg/kg are shown in Figure 5. The recoveries of >97% of targets in chicken were within the acceptable range of 60 to 120%, while the recoveries of >94% of targets in beef and pork meet the criteria. The results verified the workflow applicability for various meat matrices. Dipyrone hydrate and cefuroxime showed matrix interference in beef and pork matrices, and quantitation results were negatively impacted. Acepromazine, chlorpromazine, and propionyl promazine showed poor recoveries in beef and pork matrix, but still with acceptable 7% RSD reproducibility.

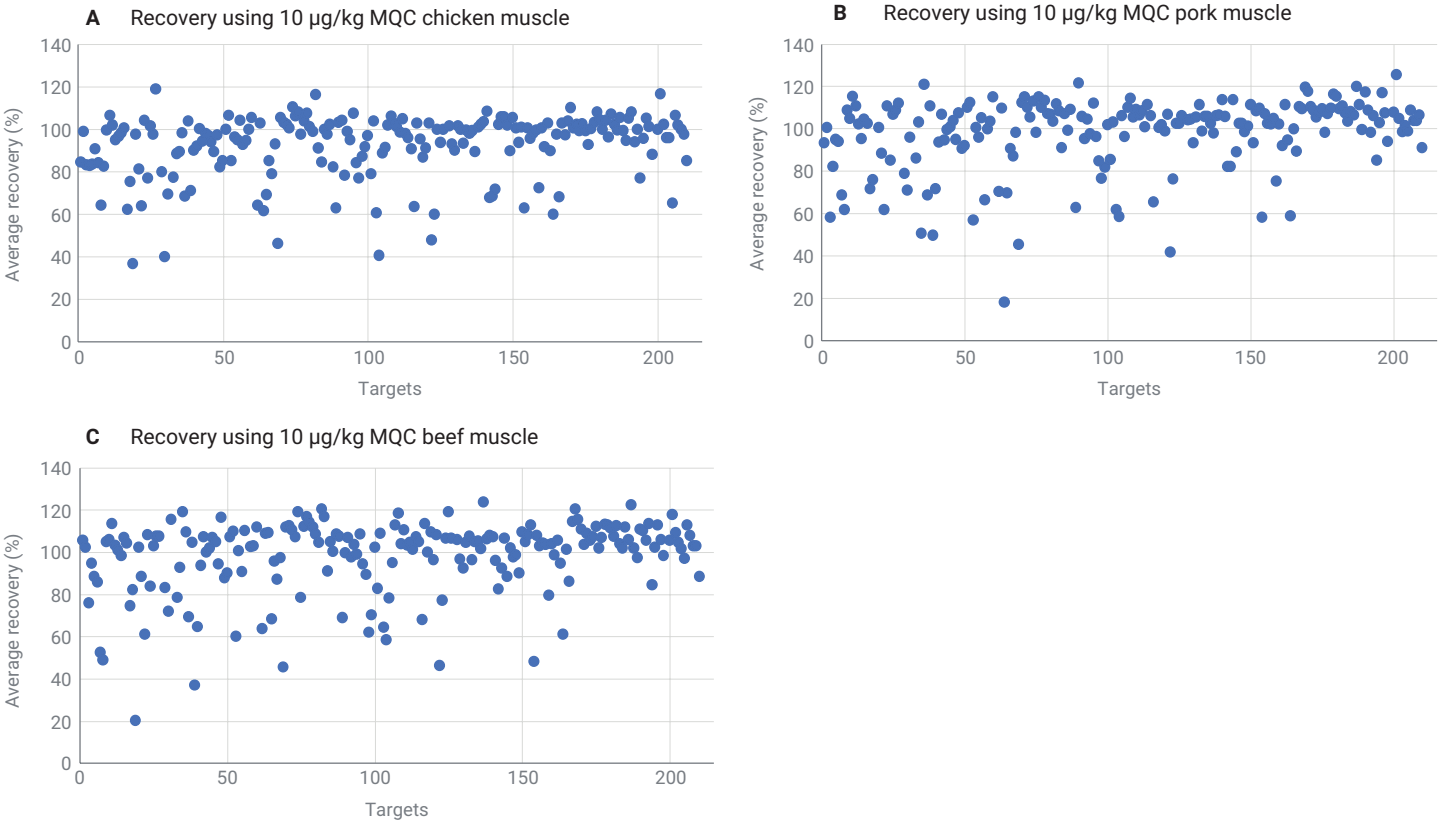

Figure 5. Target recovery from chicken (A), pork (B), and beef (C) muscle matrices using 10 µg/kg prespiked MQC samples.

Conclusion

This study describes a highly sensitive and reproducible workflow for fast and reliable screening and quantitation of 210 multiclass veterinary drugs in meat using a 6470 LC/TQ. The workflow uses a solid/liquid extraction with Captiva EMR—Lipid sample cleanup followed by analysis using a 1290 Infinity II LC coupled to a 6470 LC/TQ. The applicability of the workflow solution for routine veterinary drug screening analysis was demonstrated by performing screening of AOAC-listed targets in chicken matrix.

A simple sample preparation protocol based on solvent extraction and Captiva EMR—Lipid cleanup provides highly efficient, selective, and reproducible matrix/lipid removal without impacting the target analyte recoveries. The 13-minute LC method using an InfinityLab Poroshell EC-C18 column offered good chromatographic separation and even RT distribution of all targets. LC/TQ data acquisition was in dMRM mode with fast polarity switching for the most efficient use of instrument cycle time. The method's sensitivity helped to achieve sub-5 ng/mL LODs for most analytes.

The workflow performance was verified using two different triple quadrupole models (6470 LC/TQ and 6495C LC/TQ). The method performance evaluation based on calibration curve linearity, accuracy, precision, and recovery results from both models was in alignment with the additional benefit of improved sensitivity on the 6495C LC/TQ. The method was cross-verified using a second set of instruments on both models. The workflow applicability in other meat matrices was demonstrated in beef and pork.

Table 2. Target screening results based on AOAC guidelines in a chicken matrix.

No.	Compound Name	RT (min)	Functional Use/ Chemical Classes	CAS Number	AOAC MRL (µg/kg)	LOD (µg/L)	Linear calibration curve Range with R^2 > 0.99 (µg/L)	MQC Recovery (%) (*LQC, #HQC)	MQC Recovery Repeatability (%) (*LQC)	MQC Recovery Reproducibility (%) (*LQC, #HQC)
1	2, 4, 6-triamino-pyrimidine-5-carbonitrile	1.58	Insecticide	465531-97-9	N/A	5	10 to 100	85	8%	5%
2	2,4-DMA [Amitraz Metabolite]	4.34	Insecticide	33089-74-6	N/A	0.1	0.25 to 100	99	1%	1%
3	2-Quinoxalinecarboxylic acid [QCA]	4.13	Quinoxalines	879-65-2	N/A	5	10 to 100	83	6%	13%
4	4-epi-oxytetracycline	4.26	Antibiotic/ Tetracycline	14206-58-7	200	0.5	1 to 100	83	5%	14%
5	4-epi-tetracycline	4.17	Antibiotic/ Tetracycline	79-85-6	200	0.25	0.5 to 100	83	1%	15%
6	5-Hydroxy thiabendazole	3.52	Anthelmintic/ Benzimidazoles	948-71-0	N/A	0.25	0.5 to 100	91	1%	3%
7	5-Hydroxyflunixin	8.29	NSAIDs	75369-61-8	N/A	0.1	0.25 to 100	84	2%	10%
8	Acepromazine	7.34	Tranquilizer	61-00-7	N/A	0.1	0.25 to 100	64	7%	11%
9	Acetyl isovaleryl tylosin [Tylvalosin]	8.71	Antibiotic/ Macrolides	63409-12-1	40	1	2.5 to 100	82	1%	10%
10	Albendazole	8.01	Anthelmintic/ Benzimidazoles	54965-21-8	N/A	0.1	0.25 to 100	100	1%	2%
11	Albendazole sulfone	6.14	Anthelmintic/ Benzimidazoles	75184-71-3	N/A	0.25	0.5 to 100	107	2%	6%
12	Albendazole sulfoxide	5.54	Anthelmintic/ Benzimidazoles	54029-12-8	N/A	1	2.5 to 100	102	2%	3%
13	Albendazole-2-aminosulfone	3.71	Anthelmintic/ Benzimidazoles	80983-34-2	N/A	0.5	1 to 100	95	2%	4%
14	Alpha Zearalanol	8.25	Hormones	26538-44-3	N/A	2.5	5 to 100	97	12%	6%
15	Altrenogest	8.96	Hormones	850-52-2	N/A	0.25	0.5 to 100	98	2%	2%
16	Aminoflubendazole	6.08	Anthelmintic/ Benzimidazoles	82050-13-3	50	0.1	0.25 to 100	101	0%	1%
17	Amoxicillin	2.78	Antibiotic/ Beta-Lactam	26787-78-0	10	2.5	5 to 100	62	9%	23%
18	Ampicillin	3.94	Antibiotic/ Beta-Lactam	69-53-4	10	2.5	5 to 100	75	2%	16%
19	Amprolium	1.19	Antimicrobial	13082-85-4	500	1	2.5 to 100	36	7%	14%

No.	Compound Name	RT (min)	Functional Use/ Chemical Classes	CAS Number	AOAC MRL (µg/kg)	LOD (µg/L)	Linear calibration curve Range with $R^2 > 0.99$ (µg/L)	MQC Recovery (%) (*LQC, #HQC)	MQC Recovery Repeatability (%) (*LQC)	MQC Recovery Reproducibility (%) (*LQC, #HQC)
20	Azaperone	5.76	Tranquilizer	1649-18-9	N/A	0.1	0.25 to 100	98	2%	1%
21	Azithromycin	6.16	Antibiotic/ Macrolides	83905-01-5	N/A	0.25	0.5 to 100	81	2%	3%
22	Baquiloprim	2.63	Antimicrobial	102280-35-3	N/A	0.5	1 to 100	64	2%	5%
23	Betamethasone	7.77	Growth promoters/ Corticosteroids	378-44-9	N/A	0.5	1 to 100	104	3%	3%
24	Cabergoline	4.58	Dopamine receptor	81409-90-7	N/A	0.25	0.5 to 100	77	3%	4%
25	Carazolol	6.06	Tranquilizer	57775-29-8	N/A	0.1	0.25 to 100	102	1%	1%
26	Carbadox	4.41	Antimicrobial	6804-07-5	N/A	0.5	1 to 100	98	3%	4%
27	Carprofen	9.00	NSAIDs	53716-49-7	N/A	10	25 to 100	119	0%	4%
28	Cefalexin	3.91	Antibiotic/ Beta-Lactam	15686-71-2	200	10	25 to 100	74 (#)	_	29% (#)
29	Cefalonium	3.91	Antibiotic/ Beta-Lactam	5575-21-3	N/A	5	10 to 100	80	20%	15%
30	Cefapirin	3.19	Antibiotic/ Beta-Lactam	21593-23-7	N/A	0.5	1 to 100	40	6%	32%
31	Cefazolin	4.31	Antibiotic/ Beta-Lactam	25953-19-9	N/A	5	10 to 100	70	16%	6%
32	Cefoperazone	5.14	Antibiotic/ Beta-Lactam	62893-19-0	N/A	10	25 to 100	88 (#)	_	10% (#)
33	Cefquinome	3.69	Antibiotic/ Beta-Lactam	84957-30-2	N/A	1	2.5 to 100	77	9%	6%
34	Ceftiofur	6.27	Antibiotic/ Beta-Lactam	80370-57-6	N/A	1	2.5 to 100	89	5%	11%
35	Cefuroxime	4.40	Antibiotic/ Beta-Lactam	55268-75-2	N/A	5	10 to 100	89	17%	11%
36	Chloramphenicol	6.24	Antibiotic/ Amphenicols	56-75-7	N/A	2.5	5 to 100	98	4%	5%
37	Chlorhexidine	7.08	Antimicrobial	55-56-1	N/A	0.25	0.5 to 100	69	4%	1%
38	Chlormadinone	9.45	Hormones	1961-77-9	N/A	1	2.5 to 100	104	2%	1%
39	Chlorpromazine	8.06	Tranquilizer	50-53-3	N/A	0.1	0.25 to 100	71	12%	13%
40	Chlortetracycline	5.94	Antibiotic/ Tetracycline	57-62-5	200	1	2.5 to 100	90	2%	9%
41	Ciprofloxacin	4.43	Antibiotic/ Quinolones	85721-33-1	N/A	0.25	0.5 to 100	92	2%	2%
42	Clenbuterol	5.28	Growth promoters/ Beta-Agonists	37148-27-9	N/A	0.1	0.25 to 100	100	2%	4%
43	Clindamycin	6.45	Antibiotic/ Macrolides	18323-44-9	N/A	5	10 to 100	94	1%	3%
44	Clopidol	3.56	Coccidiostats	2971-90-6	5000	0.5	1 to 100	98	3%	1%
45	Closantel	10.54	Anthelmintic	57808-65-8	N/A	1	2.5 to 100	97	3%	2%
46	Colchicine	6.72	NSAIDs	64-86-8	N/A	0.5	1 to 100	94	3%	3%
47	Cotinine	2.35	Insecticide	486-56-6	N/A	0.5	1 to 100	89	2%	2%
48	Coumaphos	9.58	Anthelmintic	56-72-4	N/A	1	2.5 to 100	97	3%	10%
49	Cyromazine	2.47	Anthelmintic	66215-27-8	100	1	2.5 to 100	82	3%	3%
50	Danofloxacin	4.63	Antibiotic/ Quinolones	112398-08-0	200	0.1	0.25 to 100	85	1%	2%
51	Dapson	4.67	Antibiotic/ Sulfonamides	80-08-0	N/A	0.1	0.25 to 100	100	3%	3%
52	Dapson N-Acetyl	5.40	Antibiotic/ Sulfonamides	565-20-8	N/A	0.5	1 to 100	107	2%	1%
53	Deacetylcefapirin	2.30	Antibiotic/ Beta-Lactam	104557-24-6	N/A	5	10 to 100	85	8%	2%

No.	Compound Name	RT (min)	Functional Use/ Chemical Classes	CAS Number	AOAC MRL (µg/kg)	LOD (µg/L)	Linear calibration curve Range with R^2 > 0.99 (µg/L)	MQC Recovery (%) (*LQC, #HQC)	MQC Recovery Repeatability (%) (*LQC)	MQC Recovery Reproducibility (%) (*LQC, #HQC)
54	Diaveridine	3.73	Antimicrobial	5355-16-8	50	0.1	0.25 to 100	97	2%	1%
55	Diazinon	9.64	Insecticide	333-41-5	N/A	0.25	0.5 to 100	95	2%	8%
56	Diclofenac	9.14	NSAIDs	15307-86-5	N/A	0.5	1 to 100	104	5%	7%
57	Dicloxacillin	8.11	Antibiotic/ Beta-Lactam	3116-76-5	300	5	10 to 100	93	2%	23%
58	Dicyclanil	2.93	Insecticide	112636-83-6	N/A	0.5	1 to 100	95	2%	2%
59	Difloxacin	5.29	Antibiotic/ Quinolones	98106-17-3	300	0.25	0.5 to 100	100	1%	1%
60	Diflubenzuron	9.11	Insecticide	35367-38-5	N/A	2.5	5 to 100	105	7%	3%
61	Dimetridazole	3.66	Coccidiostats	551-92-8	N/A	10	25 to 100	87 (#)	_	7% (#)
62	Diminazene	2.96	Coccidiostats	536-71-0	N/A	2.5	5 to 100	64	9%	8%
63	Dinitolmide [Zoalene]	5.56	Coccidiostats	148-01-6	3000	2.5	5 to 100	103	1%	5%
64	Dipyrone hydrate- metabolite [4-Methylaminoantipyrine]	3.34	NSAIDs	519-98-2	N/A	0.1	0.25 to 100	62	2%	3%
65	Doxycycline	6.26	Antibiotic/ Tetracycline	564-25-0	100	0.5	1 to 100	69	3%	17%
66	Emamectin B1a benzoate	10.09	Anthelmintic/ Avermectins	121124-29-6	N/A	0.25	0.5 to 100	79	2%	4%
67	Emamectin B1b benzoate	9.90	Anthelmintic/ Avermectins	121424-52-0	N/A	2.5	5 to 100	85	7%	5%
68	Enrofloxacin	4.74	Antibiotic/ Quinolones	93106-60-6	100	0.25	0.5 to 100	93	2%	2%
69	Erythromycin	7.40	Antibiotic/ Macrolides	114-07-8	100	0.5	1 to 100	46	7%	3%
70	Ethopabate	6.60	Coccidiostats	59-06-3	500	0.1	0.25 to 100	106	2%	3%
71	Famphur	8.18	Insecticide	52-85-7	N/A	1	2.5 to 100	103	4%	6%
72	Febantel	9.15	Anthelmintic/ Benzimidazoles	58306-30-2	N/A	0.25	0.5 to 100	102	6%	2%
73	Fenbendazole	8.59	Anthelmintic/ Benzimidazoles	43210-67-9	N/A	0.1	0.25 to 100	100	1%	3%
74	Fenbendazole Sulfoxide [Oxfendazole]	6.44	Anthelmintic/ Benzimidazoles	53716-50-0	N/A	0.25	0.5 to 100	110	1%	1%
75	Firocoxib	7.96	NSAIDs	189954-96-9	N/A	2.5	5 to 100	106	5%	6%
76	Florfenicol	5.55	Antibiotic/ Amphenicols	73231-34-2	100	0.5	1 to 100	108	5%	4%
77	Fluazuron	10.17	Insecticide	86811-58-7	N/A	0.5	1 to 100	98	2%	4%
78	Flubendazole	7.72	Anthelmintic/ Benzimidazoles	31430-15-6	50	0.1	0.25 to 100	104	1%	5%
79	Flugestone acetate	8.35	Hormones	2529-45-5	N/A	1	2.5 to 100	108	3%	2%
80	Flumequine	7.39	Antibiotic/ Quinolones	42835-25-6	400	0.1	0.25 to 100	101	2%	1%
81	Flunixin	8.75	NSAIDs	38677-85-9	N/A	0.1	0.25 to 100	99	2%	1%
82	Fluralaner	9.89	Insecticide	864731-61-3	N/A	2.5	5 to 100	116	4%	9%
83	Furazolidone	4.68	Antimicrobial/Furans	67-45-8	N/A	2.5	5 to 100	91	4%	16%
84	Gamithromycin	6.44	Antibiotic/ Aminoglycosides	145435-72-9	N/A	0.25	0.5 to 100	85	11%	1%
85	Gonadotropin	7.57	Hormones	33515-09-2	N/A	0.5	1 to 100	100	4%	4%
86	Halofuginone	6.44	Coccidiostats	55837-20-2	10	0.5	1 to 100	98	1%	3%
87	Haloperidol	7.11	Tranquilizer	52-86-8	N/A	0.1	0.25 to 100	102	1%	1%
88	Haloxon	8.58	Anthelmintic	321-55-1	N/A	2.5	5 to 100	82	8%	10%
89	Imidocarb	3.20	Coccidiostats	27885-92-3	N/A	0.5	1 to 100	63	3%	7%

No.	Compound Name	RT (min)	Functional Use/ Chemical Classes	CAS Number	AOAC MRL (µg/kg)	LOD (µg/L)	Linear calibration curve Range with R^2 > 0.99 (µg/L)	MQC Recovery (%) (*LQC, #HQC)	MQC Recovery Repeatability (%) (*LQC)	MQC Recovery Reproducibility (%) (*LQC, #HQC)
90	Ipronidazole	6.04	Anthelmintic/ Nitroimidazoles	14885-29-1	N/A	5	10 to 100	103	13%	11%
91	Ipronidazole-OH	4.85	Anthelmintic/ Nitroimidazoles	35175-14-5	N/A	1	2.5 to 100	104	3%	1%
92	Isometamidium	5.98	Anthelmintic	20438-03-3	N/A	2.5	5 to 100	78	3%	10%
93	Josamycin	8.22	Antibiotic/ Macrolides	16846-24-5	40	0.5	1 to 100	99	3%	2%
94	Ketamine	4.74	Anesthetic	6740-88-1	N/A	0.1	0.25 to 100	95	2%	1%
95	Ketoprofen	8.20	NSAIDs	22071-15-4	N/A	0.5	1 to 100	107	1%	4%
96	Kitasamycin A5 [Leucomycin A5]	7.70	Antibiotic/ Aminoglycosides	18361-45-0	200	1	2.5 to 100	84	1%	4%
97	Lasalocid A	10.99	Coccidiostats	25999-31-9	20	0.25	0.5 to 100	77	2%	4%
98	Leuco Crystal violet	10.36	Fungicides and dyes	603-48-5	N/A	0.5	1 to 100	87	3%	1%
99	Leucomalachite green	10.48	Fungicides and dyes	129-73-7	N/A	0.1	0.25 to 100	92	0%	4%
100	Levamisole	3.58	Anthelmintic	14769-73-4	10	0.25	0.5 to 100	97	2%	2%
101	Lincomycin	3.74	Antibiotic/ Aminoglycosides	154-21-2	100	0.1	0.25 to 100	79	1%	2%
102	Lufenuron	10.11	Insecticide	103055-07-8	N/A	10	25 to 100	104	5%	0%
103	Maduramicin Ammonium	11.59	Coccidiostats	79356-08-4	100	1	2.5 to 100	61	1%	4%
104	Malachite green	8.21	Fungicides and Dyes	10309-95-2	N/A	0.1	0.25 to 100	40	2%	10%
105	Malathion	8.92	Insecticide	121-75-5	N/A	0.25	0.5 to 100	89	2%	4%
106	Marbofloxacin	4.00	Antibiotic/ Quinolones	115550-35-1	N/A	0.25	0.5 to 100	91	4%	2%
107	Mebendazole	7.49	Anthelmintic/ Benzimidazoles	31431-39-7	N/A	0.1	0.25 to 100	102	1%	6%
108	Mefenamic acid	9.68	Anti-inflammatory	61-68-7	N/A	0.25	0.5 to 100	106	1%	6%
109	Megestrol acetate	9.43	Hormones	595-33-5	N/A	0.25	0.5 to 100	103	5%	1%
110	Melengestrol acetate	9.55	Hormones	2919-66-6	N/A	0.25	0.5 to 100	101	4%	3%
111	Meloxicam	8.10	NSAIDs	71125-38-7	N/A	0.1	0.25 to 100	99	1%	5%
112	Methylprednisolone	7.78	Growth promoters/ Corticosteroids	83-43-2	N/A	0.5	1 to 100	105	3%	3%
113	Metoserpate	6.55	Tranquilizer	1178-28-5	20	0.25	0.5 to 100	98	3%	3%
114	Metronidazole	3.22	Anthelmintic/ Nitroimidazoles	443-48-1	N/A	0.5	1 to 100	96	5%	4%
115	Metronidazole-OH	2.77	Anthelmintic/ Nitroimidazoles	4812-40-2	N/A	2.5	5 to 100	91	8%	5%
116	Monensin	11.22	Coccidiostats	17090-79-8	10	0.5	1 to 100	63	1%	2%
117	Monepantel	9.45	Anthelmintic	851976-50-6	N/A	1	2.5 to 100	103	1%	23%
118	Morantel tartrate	5.27	Anthelmintic	20574-50-9	N/A	0.5	1 to 100	95	2%	2%
119	Moxidectin	11.04	Anthelmintic/ Avermectins	113507-06-5	N/A	5	10 to 100	87	14%	23%
120	Nafcillin	8.02	Antibiotic/ Beta-Lactam	147-52-4	N/A	0.5	1 to 100	91	2%	5%
121	Nalidixic acid	7.21	Antibiotic	389-08-2	N/A	0.1	0.25 to 100	103	3%	1%
122	Narasin	11.71	Coccidiostats	55134-13-9	15	0.5	1 to 100	48	2%	7%
123	Neo-Spiramycin	5.71	Antibiotic/ Macrolides	70253-62-2	200	0.5	1 to 100	60	5%	4%
124	Nequinate	9.35	Anthelmintic	13997-19-8	100	0.1	0.25 to 100	100	4%	1%
125	Netobimin	7.06	Anthelmintic	88255-01-0	100	2.5	5 to 100	94	8%	16%
126	Nicarbazine	8.76	Coccidiostats	587-90-6	200	0.5	1 to 100	100	2%	2%

No.	Compound Name	RT (min)	Functional Use/ Chemical Classes	CAS Number	AOAC MRL (µg/kg)	LOD (µg/L)	Linear calibration curve Range with $R^2 > 0.99$ (µg/L)	MQC Recovery (%) (*LQC, #HQC)	MQC Recovery Repeatability (%) (*LQC)	MQC Recovery Reproducibility (%) (*LQC, #HQC)
127	Nicotine	1.44	Anti-herbivore	54-11-5	N/A	10	25 to 100	54 (#)	_	20% (#)
128	Niflumic Acid	9.07	Anti-inflammatory	4394-00-7	N/A	0.25	0.5 to 100	102	3%	1%
129	Nitroxynil	6.67	Anthelmintic	1689-89-0	N/A	2.5	5 to 100	93	5%	3%
130	Norfloxacin	4.28	Antibiotic/ Quinolones	70458-96-7	N/A	0.25	0.5 to 100	90	3%	1%
131	Norgestomet	9.31	Hormones	472-54-8	N/A	1	2.5 to 100	102	3%	3%
132	Novobiocin	9.75	Antibiotic	303-81-1	1000	1	2.5 to 100	100	2%	5%
133	Olaquindox	3.00	Growth promoters/ Anabolic steroids	23696-28-8	N/A	0.5	1 to 100	93	2%	2%
134	Oleandomycin	7.03	Antibiotic/ Aminoglycosides	3922-90-5	150	0.25	0.5 to 100	100	1%	2%
135	Orbifloxacin	4.97	Antibiotic/ Quinolones	113617-63-3	20	0.25	0.5 to 100	98	2%	1%
136	Ormetoprim	4.39	Antibiotic	6981-18-6	100	0.25	0.5 to 100	99	5%	1%
137	Oxacillin	7.51	Antibiotic/ Beta-Lactam	66-79-5	300	5	10 to 100	89	11%	11%
138	Oxibendazole	6.79	Anthelmintic/ Benzimidazoles	20559-55-1	N/A	0.1	0.25 to 100	101	1%	1%
139	Oxolinic acid	6.29	Antibiotic/ Quinolones	14698-29-4	100	0.25	0.5 to 100	102	2%	1%
140	Oxyclozanide	9.49	Anthelmintic	2277-92-1	N/A	2.5	5 to 100	103	4%	2%
141	Oxyphenbutazone	8.09	NSAIDs	129-20-4	N/A	0.5	1 to 100	108	2%	2%
142	Oxytetracycline	4.46	Antibiotic/ Tetracycline	79-57-2	200	1	2.5 to 100	68	3%	19%
143	Penicillin G	6.92	Antibiotic/ Beta-Lactam	61-33-6	N/A	1	2.5 to 100	68	2%	20%
144	Penicillin V [Phenoxymethylpenicillin]	7.33	Antibiotic/ Beta-Lactam	87-08-1	25	2.5	5 to 100	72	2%	25%
145	Phenylbutazone	9.01	NSAIDs	50-33-9	N/A	1	2.5 to 100	102	3%	1%
146	Phosalone	9.69	Insecticide	2310-17-0	N/A	1	2.5 to 100	106	5%	3%
147	Phoxim	9.63	Insecticide	14816-18-3	25	2.5	5 to 100	106	8%	2%
148	Piperonyl butoxide Ammonia	10.24	Insecticide	51-03-6	500	0.1	0.25 to 100	102	3%	7%
149	Pirlimycin	5.70	Antibiotic/ Aminoglycosides	79548-73-5	N/A	2.5	5 to 100	90	5%	10%
150	Praziquantel	8.49	Anthelmintic	55268-74-1	N/A	0.1	0.25 to 100	106	3%	2%
151	Prednisolone	7.22	Growth promoters/ Corticosteroids	50-24-8	N/A	0.5	1 to 100	101	0%	6%
152	Prednisone	7.06	Growth promoters/ Corticosteroids	53-03-2	0.7	0.5	1 to 100	102 (*)	24% (*)	24% (*)
153	Progesterone	9.53	Hormones	57-83-0	N/A	0.5	1 to 100	101	3%	1%
154	Propionylpromazin	7.90	Antiemetic	3568-24-9	N/A	0.1	0.25 to 100	63	5%	11%
155	Propyphenazone	7.61	NSAIDs	479-92-5	N/A	0.1	0.25 to 100	101	0%	2%
156	Pyrantel	4.15	Anthelmintic	15686-83-6	N/A	0.5	1 to 100	96	2%	2%
157	Pyrimethamine	6.20	Antimicrobial	58-14-0	50	0.1	0.25 to 100	98	3%	1%
158	Ractopamine	4.55	Growth promoters/ Beta-agonists	97825-25-7	N/A	0.25	0.5 to 100	100	2%	2%
159	Rafoxanide	11.03	Anthelmintic	22662-39-1	N/A	0.5	1 to 100	72	5%	4%
160	Rifaximin	9.00	Antibiotic	80621-81-4	N/A	1	2.5 to 100	101	4%	4%
161	Robenidine	8.48	Coccidiostats	25875-51-8	100	0.5	1 to 100	92	2%	2%
162	Ronidazole	3.34	Anthelmintic/ Nitroimidazoles	7681-76-7	500	0.25	0.5 to 100	103	2%	2%

No.	Compound Name	RT (min)	Functional Use/ Chemical Classes	CAS Number	AOAC MRL (µg/kg)	LOD (µg/L)	Linear calibration curve Range with $R^2 > 0.99$ (µg/L)	MQC Recovery (%) (*LQC, #HQC)	MQC Recovery Repeatability (%) (*LQC)	MQC Recovery Reproducibility (%) (*LQC, #HQC)
163	Salbutamol [Albuterol]	2.93	Growth promoters/ Beta-agonists	18559-94-9	N/A	0.1	0.25 to 100	90	2%	2%
164	Salinomycin	11.52	Coccidiostats	53003-10-4	100	0.5	1 to 100	60	1%	2%
165	Sarafloxacin	5.29	Antibiotic/ Quinolones	98105-99-8	10	0.25	0.5 to 100	98	2%	2%
166	Spiramycin I	6.03	Antibiotic/ Macrolides	24916-50-5	200	0.5	1 to 100	68	5%	4%
167	Sulfabenzamide	5.99	Antibiotic/ Sulfonamides	127-71-9	100	0.1	0.25 to 100	103	3%	4%
168	Sulfacetamide	3.06	Antibiotic/ Sulfonamides	144-80-9	100	0.25	0.5 to 100	97	3%	2%
169	Sulfachloropyridazine	5.16	Antibiotic/ Sulfonamides	80-32-0	100	0.25	0.5 to 100	104	2%	9%
170	Sulfaclozine	6.21	Antibiotic/ Sulfonamides	102-65-8	100	0.5	1 to 100	110	3%	6%
171	Sulfadiazine [Silvadene]	3.36	Antibiotic/ Sulfonamides	68-35-9	100	0.25	0.5 to 100	101	1%	4%
172	Sulfadimethoxine	6.39	Antibiotic/ Sulfonamides	122-11-2	100	0.1	0.25 to 100	102	1%	3%
173	Sulfadimidine [Sulfamethazine]	4.54	Antibiotic/ Sulfonamides	57-68-1	100	0.25	0.5 to 100	99	1%	4%
174	Sulfadoxine	5.49	Antibiotic/ Sulfonamides	2447-57-6	100	0.1	0.25 to 100	102	2%	1%
175	Sulfaethoxypyridazine	5.84	Antibiotic/ Sulfonamides	963-14-4	100	0.1	0.25 to 100	99	3%	6%
176	Sulfaguanidine	1.82	Antibiotic/ Sulfonamides	57-67-0	100	0.5	1 to 100	93	1%	2%
177	Sulfamerazine	3.94	Antibiotic/ Sulfonamides	127-79-7	100	0.25	0.5 to 100	100	2%	3%
178	Sulfameter [sulfamethoxydiazine]	4.40	Antibiotic/ Sulfonamides	651-06-9	100	0.25	0.5 to 100	103	1%	4%
179	Sulfamethizole	4.43	Antibiotic/ Sulfonamides	144-82-1	100	0.25	0.5 to 100	108	3%	5%
180	Sulfamethoxazole	5.39	Antibiotic/ Sulfonamides	723-46-6	100	0.25	0.5 to 100	105	3%	5%
181	Sulfamethoxypyridazine	4.60	Antibiotic/ Sulfonamides	80-35-3	100	0.25	0.5 to 100	100	3%	4%
182	Sulfamonomethoxine	5.14	Antibiotic/ Sulfonamides	1220-83-3	100	0.25	0.5 to 100	104	3%	7%
183	Sulfamoxole	4.24	Antibiotic/ Sulfonamides	729-99-7	100	0.25	0.5 to 100	96	2%	6%
184	Sulfanitran	7.25	Antibiotic/ Sulfonamides	122-16-7	100	5	10 to 100	107	6%	7%
185	Sulfaphenazole	6.26	Antibiotic/ Sulfonamides	526-08-9	100	0.25	0.5 to 100	102	3%	3%
186	Sulfapyridine	3.75	Antibiotic/ Sulfonamides	144-83-2	100	0.25	0.5 to 100	100	3%	3%
187	Sulfaquinoxaline	6.44	Antibiotic/ Sulfonamides	59-40-5	100	0.1	0.25 to 100	105	3%	7%
188	Sulfathiazole	3.55	Antibiotic/ Sulfonamides	72-14-0	100	0.25	0.5 to 100	99	2%	4%
189	Sulfisomidine	3.27	Antibiotic/ Sulfonamides	515-64-0	100	0.25	0.5 to 100	95	2%	2%
190	Sulfisoxazole	5.67	Antibiotic/ Sulfonamides	127-69-5	100	0.5	1 to 100	105	2%	5%

No.	Compound Name	RT (min)	Functional Use/ Chemical Classes	CAS Number	AOAC MRL (µg/kg)	LOD (µg/L)	Linear calibration curve Range with $R^2 > 0.99$ (µg/L)	MQC Recovery (%) (*LQC, #HQC)	MQC Recovery Repeatability (%) (*LQC)	MQC Recovery Reproducibility (%) (*LQC, #HQC)
191	Sulindac	7.97	Antibiotic/ Sulfonamides	38194-50-2	100	0.25	0.5 to 100	108	1%	2%
192	Teflubenzuron	10.01	Insecticide	83121-18-0	N/A	5	10 to 100	94	4%	5%
193	Testosterone	8.49	Growth promoters/ Anabolic steroids	58-22-0	N/A	0.25	0.5 to 100	100	3%	2%
194	Tetracycline	4.67	Antibiotic/ Tetracycline	60-54-8	200	0.5	1 to 100	77	1%	15%
195	Thiabendazole	4.26	Anthelmintic/ Benzimidazoles	148-79-8	N/A	0.1	0.25 to 100	96	4%	3%
196	Thiamphenicol	4.25	Antibiotic/ Amphenicols	15318-45-3	50	0.5	1 to 100	105	2%	6%
197	Tiamulin	7.56	Antibiotic	55297-95-5	100	0.1	0.25 to 100	101	1%	2%
198	Tilmicosin	6.76	Antibiotic/ Macrolides	108050-54-0	75	1	2.5 to 100	88	3%	6%
199	Tolfenamic acid	9.86	NSAIDs	13710-19-5	N/A	10	25 to 100	120 (#)	_	7% (#)
200	Trenbolone	7.91	Growth promoters/ Anabolic steroids	10161-33-8	N/A	0.5	1 to 100	100	4%	4%
201	Trichlorfon [DEP]	5.20	Tranquilizer	52-68-6	N/A	1	2.5 to 100	117	0%	16%
202	Triclabendazole	9.67	Anthelmintic/ Benzimidazoles	68786-66-3	N/A	0.25	0.5 to 100	102	2%	1%
203	Trimethoprim	4.02	Antibiotic	738-70-5	50	0.25	0.5 to 100	96	2%	1%
204	Tripelennamine	6.28	Anthelmintic	91-81-6	N/A	0.1	0.25 to 100	96	3%	1%
205	Tylosin	7.56	Antibiotic/ Macrolides	1401-69-0	100	1	2.5 to 100	65	5%	10%
206	Valnemulin	8.30	Antibiotic	101312-92-9	N/A	0.5	1 to 100	106	5%	3%
207	Vedaprofen	9.00	NSAIDs	71109-09-6	N/A	0.5	1 to 100	102	2%	1%
208	Virginiamycin M1	8.15	Antibiotic/ Macrolides	21411-53-0	100	0.5	1 to 100	100	2%	2%
209	Xylazine	5.11	Tranquilizer	7361-61-7	N/A	0.25	0.5 to 100	98	3%	2%
210	Zilpaterol	2.93	Growth promoters/ Beta-agonists	119520-05-7	N/A	0.25	0.5 to 100	85	2%	4%

References

1. Guidelines for Standard Method Performance Requirements, AOAC Official Methods of Analysis (**2016**) Appendix F.
2. The United States, Code of Federal Regulations (CFR) - Title 21, Tolerance of Residues in New Animal Drugs in Food, *Part 556, volume 6*, April 1, **2019**.
3. The United States, Chemical contaminants of public health concern used by the Food Safety and Inspection Service (FSIS), **2017**.
4. Official Journal of the European Union, Pharmacologically active substances and their classification regarding maximum residue limits (MRL), Commission Regulation (EU) No 37/**2010**.
5. AOAC guidelines on "Screening and identification method for regulated veterinary drug residues in food", *Version 7*, June 20, **2018**.

www.agilent.com/chem

DE.8459606481

Printed in the USA, October 22, 2020
5994-1932EN

Agilent
Trusted Answers