



# 中华人民共和国出入境检验检疫行业标准

SN/T 4393—2015

## 进出口化妆品中喹诺酮药物测定 液相色谱-串联质谱法

Determination of quinolones in cosmetics for import and export—  
LC-MS/MS method

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中 华 人 民 共 和 国  
国家质量监督检验检疫总局 发 布

## 前 言

本标准按照 GB/T 1.1—2009 给出的规则起草。

本标准由国家认证认可监督管理委员会提出并归口。

本标准起草单位：中华人民共和国深圳出入境检验检疫局、深圳市检验检疫科学研究院。

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# 进出口化妆品中喹诺酮药物测定 液相色谱-串联质谱法

## 1 范围

本标准规定了化妆品中 25 种喹诺酮药物残留量的液相色谱-串联质谱测定方法。

本标准适用于化妆水类、润肤膏类、面霜类和润肤乳液类化妆品中喹诺酮药物的定量测定和确证。

## 2 规范性引用文件

下列文件对于本文件的应用是必不可少的。凡是注日期的引用文件,仅注日期的版本适用于本文件。凡是不注日期的引用文件,其最新版本(包括所有的修改单)适用于本文件。

GB/T 6682 分析实验室用水规格和试验方法

## 3 方法提要

采用酸性乙腈超声提取试样中的喹诺酮药物,含脂类样品以正己烷脱脂,提取液经浓缩、定容后,液相色谱-串联质谱仪检测和确证,外标法定量。

## 4 试剂和材料

除另有说明外,所用试剂均为优级纯,实验室用水采用 GB/T 6682 规定的一级水。

4.1 乙腈:色谱纯。

4.2 甲醇:色谱纯。

4.3 甲酸:色谱纯。

4.4 乙酸:色谱纯。

4.5 正己烷:色谱纯。

4.6 氯化钠:含量 $\geq 99.5\%$ 。

4.7 0.2%甲酸的乙腈溶液:准确吸取 2 mL 甲酸(4.3),用乙腈定容至 1 L,混匀。

4.8 0.1%甲酸溶液:准确吸取 1 mL 甲酸,用水定容至 1 L,混匀。

4.9 10%乙腈的甲酸-水溶液(1+9,体积比):量取 10 mL 乙腈(4.1)和 90 mL 0.1%甲酸溶液(4.8),混匀。

4.10 标准物质:喹诺酮药物标准品(具体信息参见附录 A),纯度均大于 98%。

4.11 标准储备液的配制:分别准确称取经纯度折算后的适量标准物质(精确到 0.01 g),用甲醇(4.2)稀释,难溶于甲醇的标准品,加少量甲酸(4.3)溶解,再用甲醇定容至刻度,配制浓度为 2.0 g/L 的标准储备溶液。于 $-18\text{ }^{\circ}\text{C}$ 以下避光保存,有效期 12 个月。

4.12 混合标准溶液的配制:准确吸取标准储备液 0.5 mL 于 10 mL 容量瓶中,用甲醇定容至刻度(分两组配制),此标准溶液浓度为 100.0 mg/L,于 $-18\text{ }^{\circ}\text{C}$ 以下冰箱内储存,有效期 6 个月。

4.13 微孔滤膜:0.22  $\mu\text{m}$ ,有机相型。

## 5 仪器和设备

- 5.1 液相色谱-串联质谱联用仪:配有电喷雾离子源(ESI)。
- 5.2 吹氮浓缩仪。
- 5.3 超声波水浴。
- 5.4 涡旋混合器。
- 5.5 低温离心机:可制冷至 4 °C,9 500 r/min。
- 5.6 均质器。
- 5.7 分析天平:感量 0.1 mg 和 0.001 g。
- 5.8 聚丙烯离心管:15 mL 和 50 mL,具塞。
- 5.9 移液枪,10  $\mu$ L~1 000  $\mu$ L,10  $\mu$ L~100  $\mu$ L,1 000  $\mu$ L~5 000  $\mu$ L。

## 6 测定步骤

### 6.1 提取

#### 6.1.1 化妆水类

称取 1.0 g 均匀样品(精确至 0.01 g),置于 50 mL 具塞离心管(5.8)中,准确加入 8 mL 0.2%甲酸的乙腈溶液(4.7),均质 3 min,超声提取 15 min,9 500 r/min 离心 5 min(4 °C 左右),取上清液。残渣再加入 8 mL 0.2%甲酸的乙腈,重复上述提取过程一次,9 500 r/min 离心 5 min 后合并上清液,用 0.2%甲酸的乙腈定容至 20 mL,混匀。准确吸取 1 mL 上述提取液,40 °C 吹氮近干,用乙腈-0.1%甲酸溶液(4.9)定容至 5 mL,过 0.22  $\mu$ m 有机滤膜,液相色谱-质谱仪测定。

#### 6.1.2 润肤霜、膏、乳液类

称取 1.0 g 均匀样品(精确至 0.01 g),置于 50 mL 具塞离心管(5.8)中,加入 2 g 氯化钠(4.6),准确加入 8 mL 0.2%甲酸的乙腈溶液(4.7),均质 3 min,超声提取 15 min,9 500 r/min 离心 5 min(4 °C 左右),取上清液。残渣再加入 8 mL 0.2%甲酸的乙腈,重复上述提取过程一次,9 500 r/min 离心 5 min 后合并上清液,用 0.2%甲酸的乙腈定容至 20 mL,混匀。准确吸取 1 mL 上述提取液,40 °C 吹氮近干,用乙腈-0.1%甲酸溶液(4.9)定容至 5 mL,加入 5 mL 正己烷溶液(4.5),混匀,9 500 r/min 离心 5 min,弃去正己烷层,下层液过 0.22  $\mu$ m 有机滤膜,液相色谱-质谱仪测定。

### 6.2 混合基质标准工作溶液的制备

#### 6.2.1 空白试验

称取 1.0 g 空白试样(精确至 0.01 g)于 50 mL 具塞离心管中,根据 6.1 操作处理后得到基质空白。

#### 6.2.2 基质工作曲线的配制

用基质空白(6.2.1)来配制基质标准工作曲线。

### 6.3 测定

#### 6.3.1 液相色谱参考条件

- a) 色谱柱: $C_{18}$  色谱柱,150 mm $\times$ 2.1 mm (内径),2.7  $\mu$ m,或相当者;

- b) 柱温:40 ℃;
- c) 进样量:10 μL;
- d) 流动相、流速及梯度洗脱条件见表 1。

表 1 流动相、流速及梯度洗脱条件

时间 min	流速 μL/min	水(含 0.1%甲酸) %	乙腈(含 0.1%甲酸) %
0	250	87	13
6.0	250	10	90
9.0	250	10	90
9.1	250	87	13
15.0	250	87	13

6.3.2 质谱参考条件

- a) 离子化模式:电喷雾离子源(ESI),ESI<sup>+</sup> 模式;
- b) 扫描方式:多反应监测(MRM);
- c) 分辨率:单位分辨率;
- d) 其他参考条件参见附录 B。

6.3.3 标准曲线的绘制

取空白样品按照 6.1 处理,用所得的样品溶液将混合标准溶液(4.12)稀释得到的浓度为 0 μg/L、5 μg/L、10 μg/L、20 μg/L、50 μg/L、100 μg/L、200 μg/L 的标准工作液,按浓度由低到高的顺序进样检测,以定量离子峰面积-浓度作图,得到标准曲线。

6.4 定性

在相同实验条件下,样品中待测物质的保留时间,与基质标准溶液的保留时间偏差在±2.5%之内;每种化合物的质谱定性离子至少应包括一个母离子和两个子离子,且样品中各组分定性离子的相对丰度与浓度接近的基质混合标准工作溶液中对应的定性离子的相对丰度进行比较,偏差不超过表 2 规定的范围,则可判定为样品中存在对应的待测物。

表 2 定性确证时相对离子丰度的最大允许偏差

相对离子丰度	>50%	>20%~50%	>10%~20%	≤10%
允许的最大偏差	±20%	±25%	±30%	±50%

6.5 定量

待测样液中喹诺酮药物的响应值应在标准曲线线性范围内,超过线性范围则应稀释后再进样分析。喹诺酮药物标准溶液的多反应监测(MRM)色谱图参见附录 C。

## 7 结果计算和表述

试样中喹诺酮药物的含量由色谱数据处理软件或按式(1)计算获得,计算结果需扣除空白值,并保留三位有效数字:

按式(1)计算试样中待测物残留量(mg/kg):

$$X = \frac{A \times c \times V \times 1\,000}{A_s \times m \times 1\,000} \times f \quad \dots\dots\dots (1)$$

式中:

$X$  —— 试样中待测物的含量,单位为毫克每千克(mg/kg);

$A$  —— 样液中待测物的峰面积;

$c$  —— 标准溶液中待测物的浓度,单位为微克每升( $\mu\text{g/L}$ );

$V$  —— 样液最终定容体积,单位为毫升(mL);

$A_s$  —— 标准溶液中待测物的峰面积;

$m$  —— 试样的质量,单位为克(g);

$f$  —— 稀释倍数。

## 8 方法的定量限和回收率

### 8.1 定量限

本方法的定量限:麻保沙星、萘啶酸、吡哌酸、环丙沙星、氧氟沙星、诺氟沙星、丹诺沙星、氟罗沙星、奥比沙星、氟甲喹、二氟沙星、依诺沙星、西诺沙星、恶喹酸、洛美沙星、培氟沙星、沙拉沙星、司帕沙星、恩诺沙星、加替沙星、巴洛沙星、克林沙星、那氟沙星、莫西沙星、妥舒沙星均为 1.0 mg/kg。

### 8.2 回收率

在四个添加浓度范围内,化妆水类、润肤膏类、面霜类和润肤乳液中喹诺酮药物的回收率数据参见附录 D。



附 录 A  
(资料性附录)  
标准信息表

表 A.1 喹诺酮类药物的标准信息表

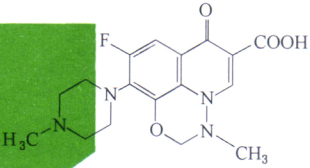
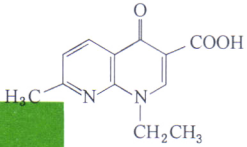
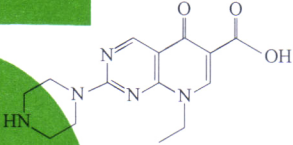
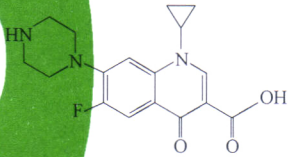
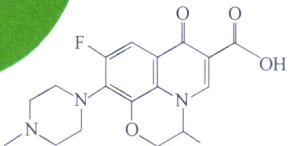
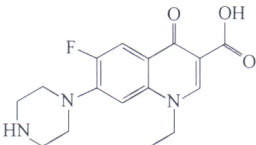
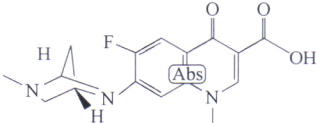
名称	英文	分子式	分子量	结构式	CAS
麻保沙星	Marbofloxacin	$C_{17}H_{19}FN_4O_4$	362.36		115550-35-1
萘啶酸	Nalidixic acid	$C_{12}H_{12}N_2O_3$	232.24		389-08-2
吡哌酸	Pipemidic acid	$C_{14}H_{17}N_3O_3$	303.32		51940-44-4
环丙沙星	Ciprofloxacin	$C_{17}H_{18}FN_3O_3$	331.35		97867-33-9
氧氟沙星(氟嗟酸)	Ofloxacin	$C_{18}H_{20}FN_3O_4$	361.37		82419-36-1
诺氟沙星(氟哌酸)	Norfloxacin	$C_{16}H_{18}FN_3O_3$	319.33		70458-96-7
丹诺沙星(甲磺酸盐)	Danofloxacin mesylate	$C_{19}H_{20}FN_3O_5$	357.15		119478-55-6

表 A.1 (续)

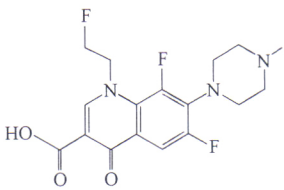
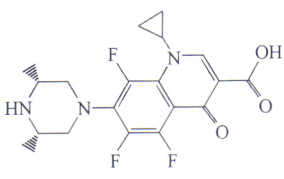
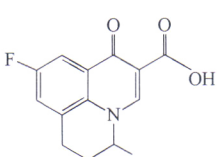
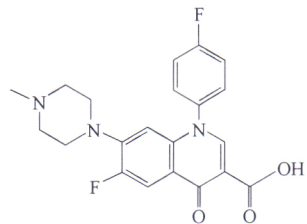
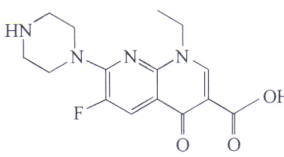
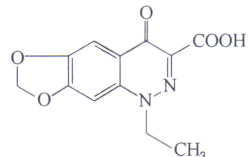
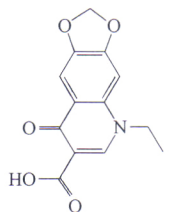
名称	英文	分子式	分子量	结构式	CAS
氟罗沙星	Fleroxacin	$C_{17}H_{18}F_3N_3O_3$	369.34		79660-72-3
奥比沙星	Orbifloxacin	$C_{19}H_{20}F_3N_3O_3$	395.38		113617-63-3
氟甲喹	Flumequine	$C_{14}H_{12}FNO_3$	261.25		42835-25-6
二氟沙星	Difloxacin	$C_{21}H_{19}F_2N_3O_3$	399.39		91296-86-5
依诺沙星(氟啉酸)	Enoxacin	$C_{15}H_{17}FN_4O_3$	320.32		84294-96-2
西诺沙星	Cinoxacin	$C_{12}H_{10}N_2O_5$	262.22		28657-80-9
恶喹酸	Oxloinic acid	$C_{13}H_{11}NO_5$	261.23		14698-29-4

表 A.1 (续)

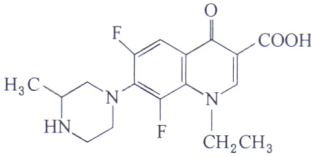
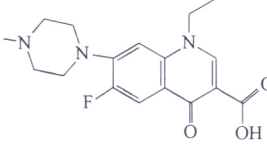
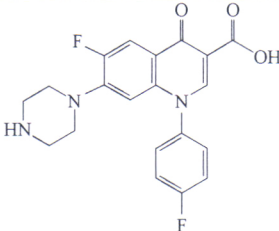
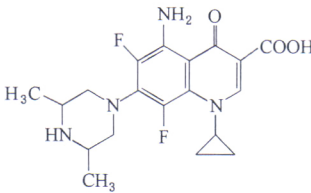
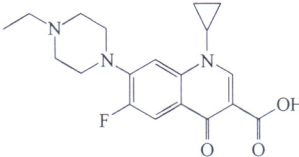
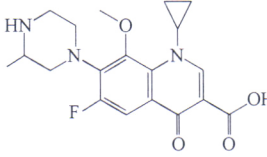
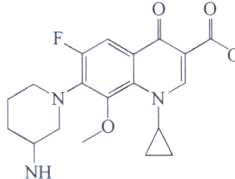
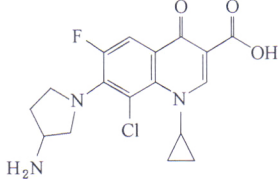
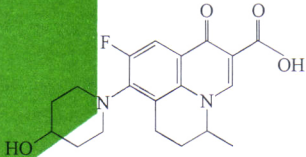
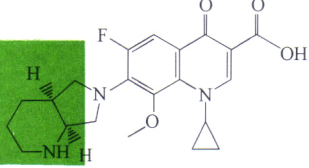
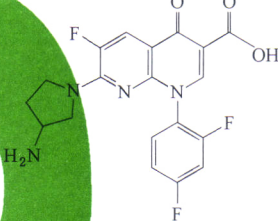
名称	英文	分子式	分子量	结构式	CAS
洛美沙星	Lomefloxacin	$C_{17}H_{19}F_2N_3O_3$	351.35		98079-52-8
培氟沙星	Pefloxacin	$C_{17}H_{20}FN_3O_3$	333.36		149676-40-4
沙拉沙星	Sarafloxacin hydrochloride	$C_{20}H_{17}F_2N_3O_3$	385.36		91296-87-6
司帕沙星	Sparfloxacin	$C_{19}H_{22}F_2N_4O_3$	392.41		110871-86-8
恩诺沙星	Enrofloxacin	$C_{19}H_{22}FN_3O_3$	359.40		93106-60-6
加替沙星	Gatifloxacin	$C_{19}H_{22}FN_3O_4$	375.39		112811-59-3
巴洛沙星	Balofloxacin	$C_{20}H_{24}FN_3O_4$	389.42		151060-21-8

表 A.1 (续)

名称	英文	分子式	分子量	结构式	CAS
克林沙星	Clinafloxacin	$C_{17}H_{17}ClFN_3O_3$	365.79		105956-99-8
那氟沙星	Nadifloxacin	$C_{19}H_{21}FN_2O_4$	360.38		124858-35-1
莫西沙星	Moxifloxacin	$C_{21}H_{24}FN_3O_4$	401.43		192927-63-2
妥舒沙星	Tosufloxacin	$C_{19}H_{15}F_3N_4O_3$	404.11		115964-29-9



附 录 B  
(资料性附录)  
参考质谱条件<sup>1)</sup>

参考质谱条件为:

- a) 电喷雾电压:4 500 V;
- b) 辅助气压力:414.0 kPa;
- c) 雾化气压力:276.0 kPa;
- d) 气帘气压力:172.5 kPa;
- e) 离子源温度:450 ℃;
- f) 碰撞气:氮气;
- g) 时间窗为:保留时间前后各 90 s;
- h) 定性离子对、定量离子对、保留时间、锥孔电压及碰撞能量见表 B.1。

表 B.1 喹诺酮类药物的主要质谱参数

化合物	母离子 ( $m/z$ )	子离子 ( $m/z$ )	保留时间 min	去簇电压 V	入口电压 V	碰撞气电压 V	碰撞池出口电压 V
丹诺沙星	358.2	340.3 *	7.4	51	10	33	24
		255.1		51	10	53	20
恩诺沙星	360.2	342.2 *	7.5	46	10	31	20
		316.4		46	10	27	18
氟甲喹	262.2	202.3	9.6	41	10	45	16
		244.3 *		41	10	27	20
恶喹酸	262.2	216.3	8.8	41	10	41	18
		244.3 *		41	10	25	20
环丙沙星	332.2	231.3	7.3	41	10	49	20
		314.3 *		41	10	29	26
沙拉沙星	386.2	368.2 *	7.8	46	10	31	26
		342.3		46	10	27	28
萘啶酸	233.2	215.3 *	9.5	21	10	19	18
		187.3		21	10	35	16
诺氟沙星	320.3	302.3 *	7.2	46	10	29	26
		276.4		46	10	25	24
依诺沙星	321.30	303.3 *	6.9	41	10	29	24
		232.2		41	10	49	18

1) 非商业性声明:附录 B 所列参考质谱条件是在 API 5000 型液质联用仪上完成的,此处列出试验用仪器型号仅为提供参考,并不涉及商业目的,鼓励标准使用者尝试不同厂家或型号的仪器。

表 B.1 (续)

化合物	母离子 ( <i>m/z</i> )	子离子 ( <i>m/z</i> )	保留时间 min	去簇电压 V	入口电压 V	碰撞气电压 V	碰撞池出口电压 V
洛美沙星	352.1	265.3	7.4	41	10	26	15
		308.3 *		41	10	31	9
氧氟沙星	362.1	261.2	7.2	46	10	37	20
		318.3 *		46	10	29	22
二氟沙星	400.3	382.3 *	7.9	90	10	29	12
		356.3		90	10	29	12
麻保沙星	363.1	320.2	6.9	26	10	23	26
		345.2 *		26	10	29	11
培氟沙星	334.2	290.3	7.2	46	10	25	20
		316.3 *		46	10	29	22
司帕沙星	393.2	292.4	7.8	51	10	35	24
		349.4 *		51	10	29	28
奥比沙星	396.2	295.3	7.6	46	10	33	22
		352.3 *		46	10	25	24
吡哌酸	304.3	217.4 *	4.0	46	10	23	20
		189.0		46	10	32	20
西诺沙星	263.0	245.0 *	8.5	40	10	30	12
		217.0		40	10	30	12
氟罗沙星	370.4	326.4 *	7.2	40	10	30	12
		352.0		40	10	30	12
加替沙星	376.3	332.4 *	7.7	40	10	30	12
		261.4		40	10	30	12
巴洛沙星	390.2	359.3 *	7.9	70	10	23	8
		315.3		70	10	33	8
克林沙星	366.3	348.2 *	7.7	90	10	30	12
		305.2		90	10	31	12
那氟沙星	361.3	343.3 *	9.0	80	10	32	12
		283.3		80	10	53	12
莫西沙星	402.5	384.5 *	7.9	40	10	30	12
		364.5		40	10	30	12
妥舒沙星	405.1	387.2 *	7.9	90	10	31	12
		263.2		90	10	63	12
注：* 为定量离子,对于不同质谱仪器,仪器参数可能存在差异,测定前应将质谱参数优化到最佳。							

## 附录 C

(资料性附录)

## 标准的多反应监测(MRM)色谱图

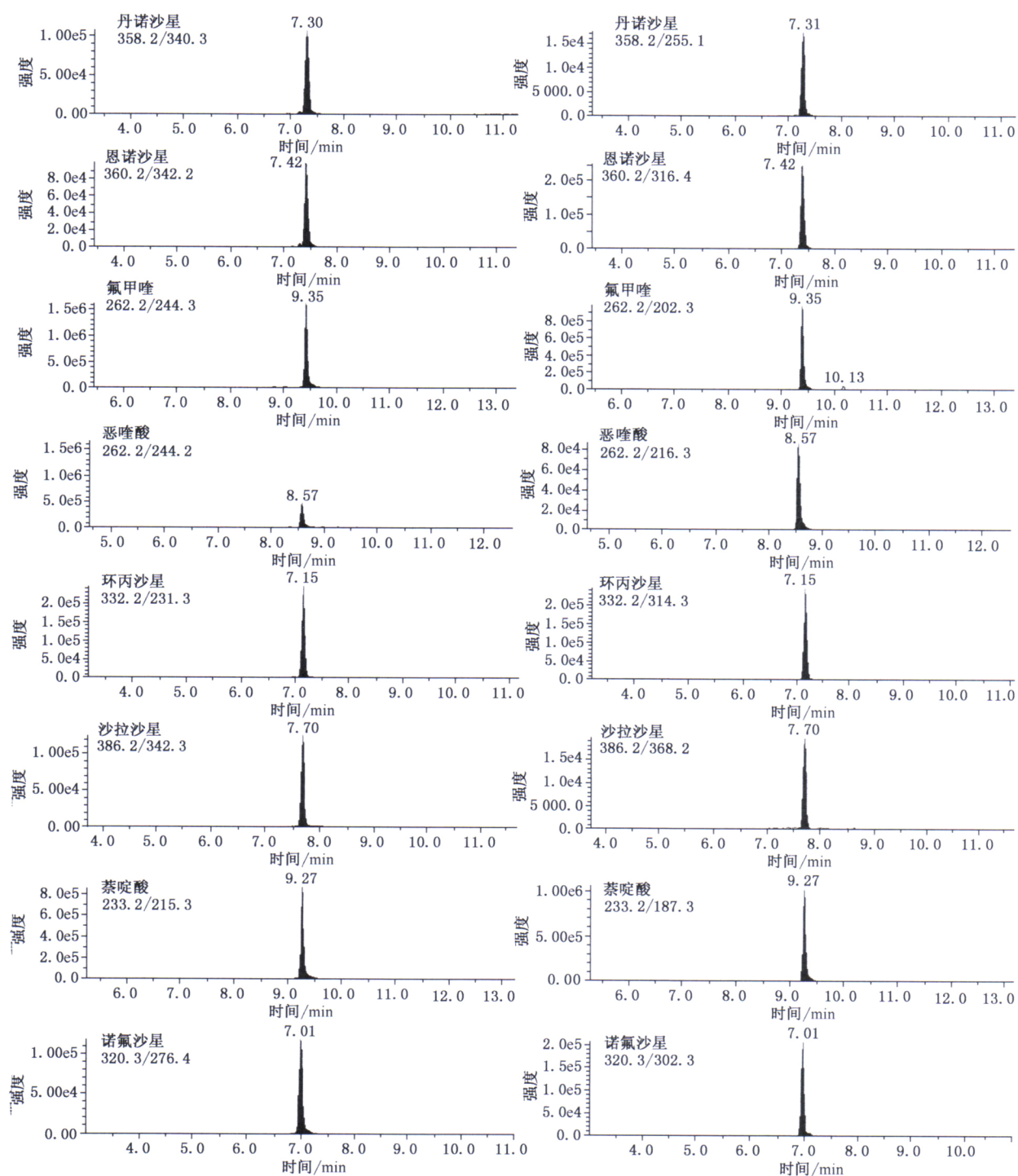


图 C.1 喹诺酮药物标准溶液的多反应监测(MRM)色谱图(1.0 mg/kg)

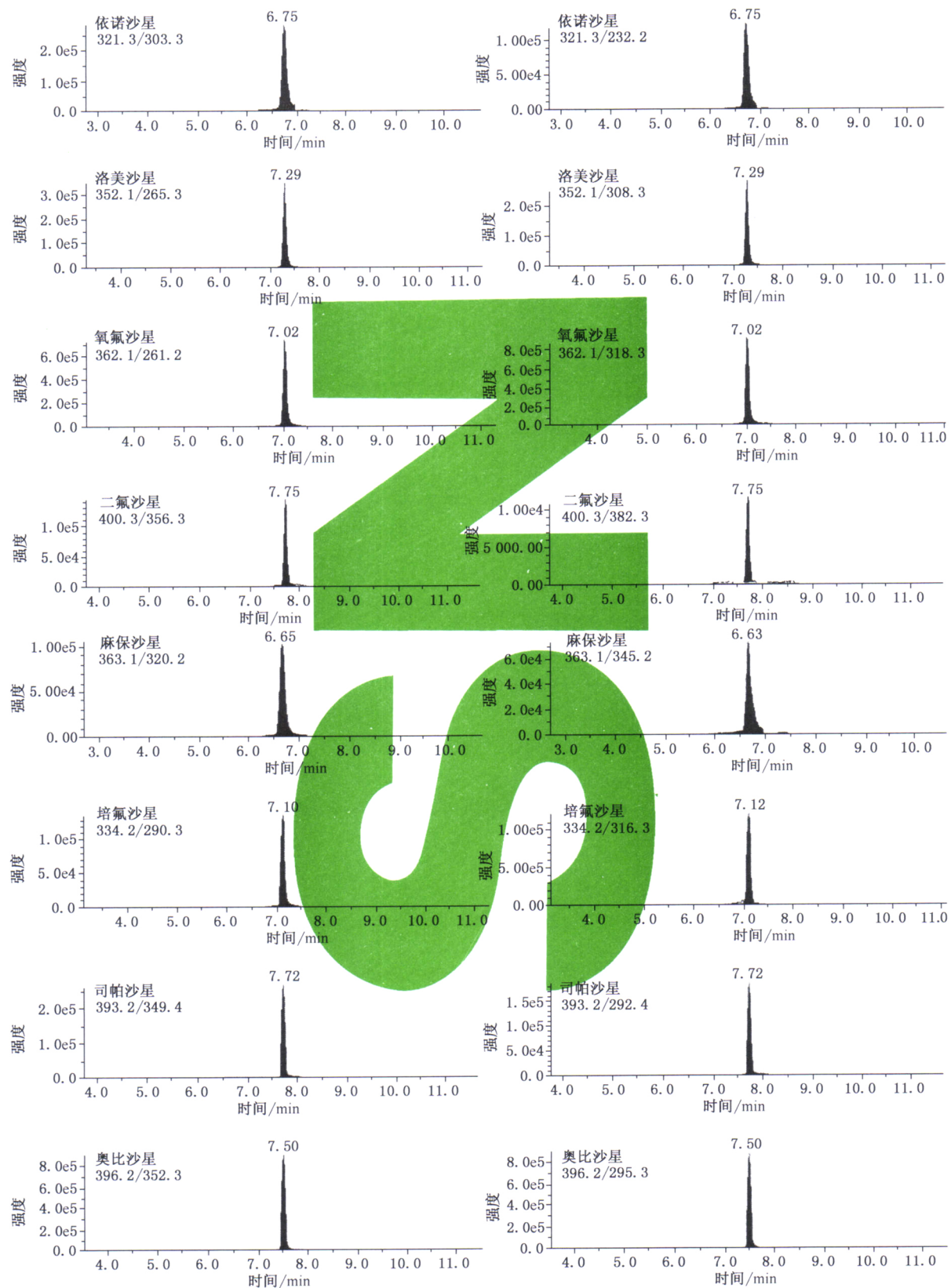


图 C.1 (续)



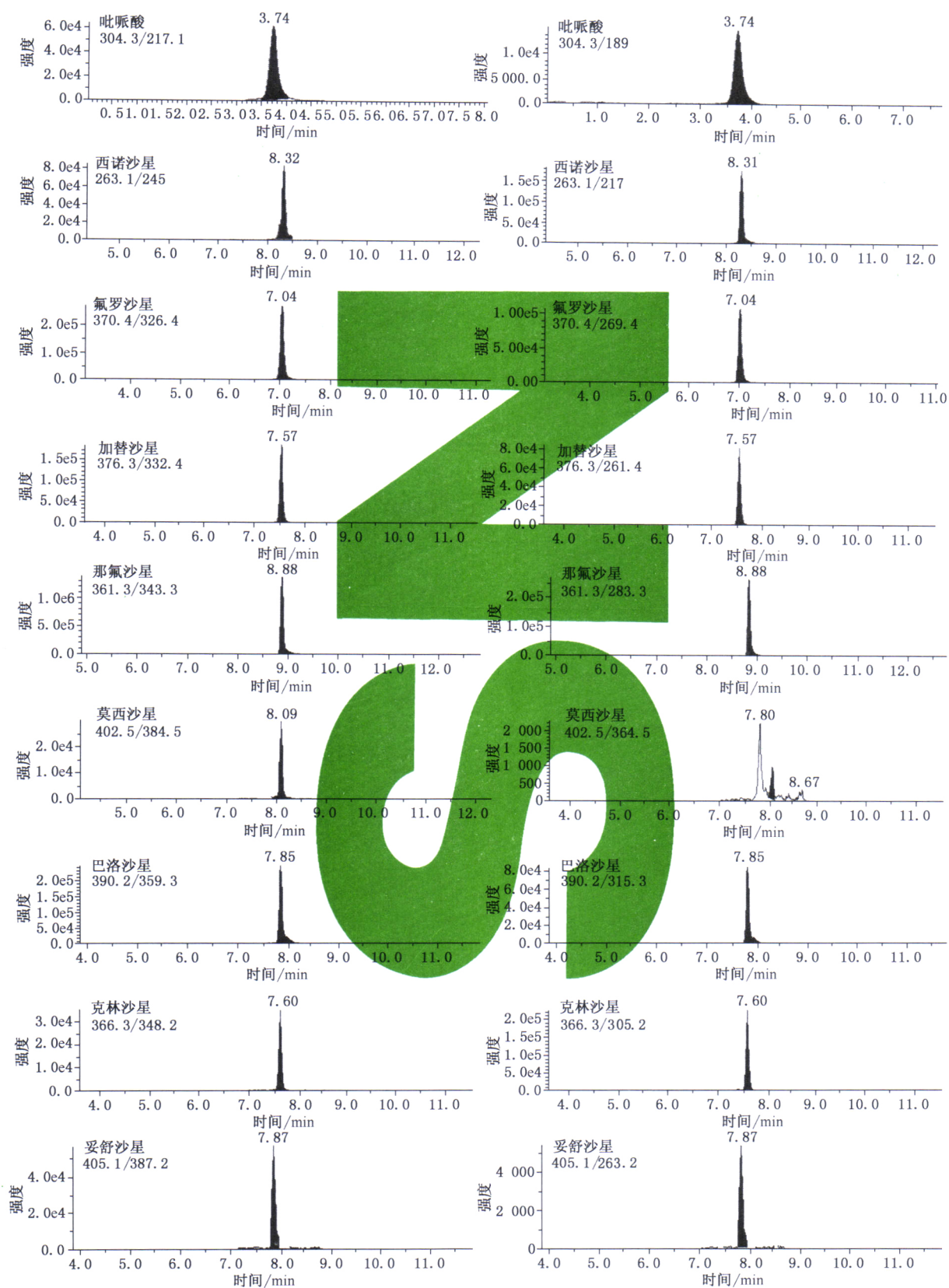


图 C.1 (续)

附 录 D  
(资料性附录)  
回收率数据

表 D.1 不同基质中喹诺酮药物不同添加水平回收率数据

化合物	添加水平 mg/kg	水类化妆品		膏类化妆品		霜类化妆品		乳液类化妆品	
		平均回收率 %	RSD %	平均回收率 %	RSD %	平均回收率 %	RSD %	平均回收率 %	RSD %
丹诺沙星	1.00	96.0	11.1	98.0	11.4	97.5	10.2	98.0	14.0
	2.00	95.8	9.80	96.8	11.4	98.0	10.3	96.8	15.3
	5.00	98.5	15.2	93.0	17.5	92.0	10.3	93.0	19.5
	10.0	94.0	14.9	89.5	9.60	95.0	9.60	89.5	11.3
恩诺沙星	1.00	92.7	11.1	88.0	8.40	94.5	11.5	88.0	11.9
	2.00	91.8	9.30	97.3	8.60	93.3	15.2	97.3	6.80
	5.00	93.7	14.6	96.0	12.8	89.0	14.9	96.0	14.9
	10.0	103	9.20	91.5	13.0	91.0	12.6	91.5	10.8
氟甲喹	1.00	95.0	8.80	104	7.20	93.0	13.9	104	7.50
	2.00	97.5	11.3	97.3	10.7	93.0	15.5	97.3	12.5
	5.00	96.2	11.8	92.0	14.8	83.0	13.0	92.0	15.4
	10.0	100	8.20	96.0	16.4	99.0	8.20	96.0	12.9
恶喹酸	1.00	95.2	11.6	93.0	6.80	94.5	14.7	93.0	9.20
	2.00	97.0	9.60	95.8	8.30	93.5	15.7	95.8	8.60
	5.00	90.8	10.2	94.0	9.90	88.0	8.30	94.0	12.4
	10.0	101	4.50	94.0	15.4	96.5	11.6	94.0	11.0
环丙沙星	1.00	93.4	11.5	97.5	11.5	98.5	10.2	97.5	11.9
	2.00	96.5	9.60	96.3	6.90	95.3	10.3	96.3	11.4
	5.00	103	9.30	90.0	12.3	94.0	12.1	90.0	6.60
	10.0	92.0	12.7	92.5	11.5	96.0	15.1	92.5	13.1
沙拉沙星	1.00	94.5	11.0	94.0	15.0	102	9.30	94.0	15.0
	2.00	93.8	14.5	83.5	6.30	91.5	13.4	83.5	16.9
	5.00	105	11.2	86.0	16.4	91.0	13.6	86.0	13.1
	10.0	92.6	12.6	94.5	10.4	90.0	10.6	94.5	6.60
萘啶酸	1.00	98.8	10.4	92.0	10.8	99.5	10.3	92.0	10.7
	2.00	90.8	12.1	98.5	8.90	92.5	13.8	98.5	6.70
	5.00	95.7	13.8	92.0	15.1	86.0	13.7	92.0	13.5
	10.0	93.1	13.2	98.5	12.6	95.0	16.0	98.5	3.90

表 D.1 (续)

化合物	添加水平 mg/kg	水类化妆品		膏类化妆品		霜类化妆品		乳液类化妆品	
		平均回收率 %	RSD %	平均回收率 %	RSD %	平均回收率 %	RSD %	平均回收率 %	RSD %
诺氟沙星	1.00	97.9	10.7	101	9.50	95.0	12.2	101	11.0
	2.00	92.3	14.5	88.3	9.50	84.8	8.10	88.3	13.2
	5.00	103	10.6	97.0	12.6	93.0	13.5	97.0	15.6
	10.0	98.8	9.30	100	9.90	95.0	10.2	100	15.8
二氟沙星	1.00	101	7.50	93.5	13.3	92.5	14.1	93.5	12.1
	2.00	87.8	6.60	94.5	13.0	93.3	13.5	94.5	9.20
	5.00	93.1	13.9	95.0	14.3	95.0	21.0	95.0	17.7
	10.0	94.5	9.40	90.0	9.50	96.0	8.30	90.0	12.7
麻保沙星	1.00	87.0	9.40	98.0	12.6	96.0	9.40	98.0	6.50
	2.00	97.0	10.9	92.8	17.1	97.0	7.60	92.8	9.80
	5.00	96.9	13.4	90.0	2.00	88.0	9.70	90.0	18.9
	10.0	97.5	8.50	96.5	9.20	101	8.50	96.5	7.40
培氟沙星	1.00	94.2	13.3	95.5	12.1	105	5.40	95.5	11.8
	2.00	92.8	15.2	96.3	6.30	91.8	11.3	96.3	11.6
	5.00	99.3	12.6	93.0	14.3	94.0	13.3	93.0	15.3
	10.0	94.7	12.5	98.0	12.9	99.0	5.60	98.0	10.8
司帕沙星	1.00	96.5	9.80	95.5	9.20	92.5	11.5	95.5	11.7
	2.00	94.3	17.1	97.8	10.3	93.5	7.70	97.8	10.7
	5.00	105	13.0	94.0	12.8	98.0	17.4	94.0	16.6
	10.0	97.5	14.0	86.5	7.80	98.5	9.40	86.5	12.9
奥比沙星	1.00	99.0	7.20	97.5	14.3	96.0	13.0	97.5	9.80
	2.00	96.3	13.6	86.0	8.70	94.8	10.4	86.0	14.2
	5.00	98.4	13.7	95.0	16.9	93.0	12.7	95.0	8.8
	10.0	97.3	11.1	87.0	9.60	95.0	12.4	87.0	13.6
吡哌酸	1.00	96.5	10.7	90.0	10.8	97.5	11.5	90.0	8.40
	2.00	95.0	10.7	91.8	13.3	106	4.90	91.8	13.6
	5.00	101	14.9	89.0	19.1	86.0	17.1	89.0	11.1
	10.0	93.3	13.6	98.5	11.4	95.0	8.20	98.5	9.80
西诺沙星	1.00	90.5	10.3	95.5	9.70	88.5	9.80	95.5	9.10
	2.00	85.8	9.70	90.3	11.7	92.5	14.9	90.3	12.8
	5.00	89.6	12.8	97.0	11.8	87.0	16.6	97.0	16.5
	10.0	95.0	11.0	93.0	13.4	97.0	12.6	93.0	17.9



表 D.1 (续)

化合物	添加水平 mg/kg	水类化妆品		膏类化妆品		霜类化妆品		乳液类化妆品	
		平均回收率 %	RSD %	平均回收率 %	RSD %	平均回收率 %	RSD %	平均回收率 %	RSD %
氟罗沙星	1.00	93.5	12.2	98.0	8.50	101	10.2	98.0	12.5
	2.00	96.8	8.20	87.8	6.20	94.5	16.1	87.8	10.8
	5.00	102	14.5	95.0	15.2	90.0	10.9	95.0	12.8
	10.0	99.3	12.7	94.0	12.9	95.5	14.3	94.0	16.7
加替沙星	1.00	98.0	5.10	101	10.2	101	8.40	101	13.4
	2.00	93.5	12.7	91.8	14.4	94.0	14.4	91.8	12.9
	5.00	97.9	13.5	91.0	15.0	90.0	8.40	91.0	9.20
	10.0	93.9	8.60	93.0	8.70	97.5	14.5	93.0	10.7
依诺沙星	1.00	92.5	10.3	97.0	10.5	98.5	13.2	97.0	7.90
	2.00	95.8	10.4	90.8	10.8	93.8	10.4	90.8	12.4
	5.00	95.3	13.7	92.0	9.20	93.0	15.1	92.0	12.0
	10.0	94.0	9.80	90.5	11.6	102	8.20	90.5	13.3
洛美沙星	1.00	94.5	8.40	93.5	13.9	95.5	15.7	93.5	12.0
	2.00	93.3	7.60	97.3	12.6	96.3	14.2	97.3	13.9
	5.00	95.9	10.5	101	13.4	85.0	13.9	101	19.6
	10.0	92.5	8.50	97.5	13.6	101	8.40	97.5	9.90
氧氟沙星	1.00	91.5	9.60	97.0	11.8	102	10.7	97.0	6.60
	2.00	97.0	9.10	92.5	10.2	94.0	13.8	92.5	10.2
	5.00	105	11.4	95.0	14.6	92.0	13.9	95.0	9.90
	10.0	94.0	12.0	91.5	12.0	95.0	12.7	91.5	3.60
巴洛沙星	1.00	91.5	8.60	93.5	10.4	92.5	9.90	93.5	11.5
	2.00	92.3	14.0	93.0	16.0	91.0	12.2	93.0	11.0
	5.00	98.4	19.7	103	11.9	85.0	13.9	103	11.0
	10.0	101	14.1	98.0	12.4	102	8.90	98.0	11.3
克林沙星	1.00	94.0	10.6	97.0	13.0	96.5	9.30	97.0	11.8
	2.00	100	10.5	102	7.50	92.3	15.2	102	15.1
	5.00	88.8	5.80	90.0	12.1	98.0	11.7	90.0	13.2
	10.0	98.0	13.7	97.0	8.90	101	11.5	97.0	12.9
那氟沙星	1.00	95.5	10.2	99.0	13.1	103	9.10	99.0	15.7
	2.00	91.3	11.9	94.5	12.0	100	8.40	94.5	10.3
	5.00	92.1	11.9	88.0	15.3	99.0	13.2	88.0	17.4
	10.0	99.4	10.6	93.0	15.7	87.5	6.70	93.0	8.50



表 D.1 (续)

化合物	添加水平 mg/kg	水类化妆品		膏类化妆品		霜类化妆品		乳液类化妆品	
		平均回收率 %	RSD %	平均回收率 %	RSD %	平均回收率 %	RSD %	平均回收率 %	RSD %
莫西沙星	1.00	95.8	9.40	97.0	10.8	101	12.4	97.0	5.70
	2.00	88.8	9.80	91.3	7.60	94.8	13.0	91.3	6.70
	5.00	91.7	13.0	92.0	12.0	99.0	13.9	92.0	21.0
	10.0	93.0	10.8	95.5	16.6	97.0	8.00	95.5	14.0
妥舒沙星	1.00	96.4	10.9	96.0	12.9	96.5	15.1	96.0	11.1
	2.00	94.3	13.0	91.8	15.6	98.0	9.40	91.8	7.10
	5.00	101	14.2	93.0	14.9	87.0	13.8	93.0	10.2
	10.0	94.5	11.4	89.0	5.50	96.0	14.1	89.0	14.6



## Foreword

The standard was drafted in accordance with the rules given in the GB/T 1.1—2009.

This standard was proposed by and is under the charge of the Certification and Accreditation Administration of the People's Republic of China.

The standard was drafted by Shenzhen Entry-Exit Inspection and Quarantine Bureau of the People's Republic of China, Shenzhen Institute of Inspection and Quarantine.

The main drafters of this standard are Lin Li, Zhang Yi, Tu Xiaoke, Xie Liqi, Yue Zhengfeng, Kang Haining, Wang Hongju, Luo Yao.

# Determination of quinolones in cosmetics for import and export—LC-MS/MS method

## 1 Scope

This standard applies to 25 quinolone drugs residues in cosmetics by LC-MS/MS method.

This standard applies to water class, paste, cream and emulsion cosmetic quantitative determination of quinolone drugs and those found in.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 6682 Water for analytical laboratory use specification and test methods.

## 3 Principle

Acidic acetonitrile extracted sample residues of quinolone drugs, hexane skim, after concentration, constant volume, LC-MS/MS detection and confirmation, outside the statutory amount.

## 4 Reagents and material

Unless otherwise specified, all reagents used should be of analytical grade. "Water" is deionized.

4.1 Acetonitrile: HPLC grade.

4.2 Methanol: HPLC grade.

4.3 Formic acid: HPLC grade.

4.4 Acetate: HPLC grade.

4.5 n-Hexane: HPLC grade.

4.6 Sodium chloride: content  $\geq 99.5\%$ .

4.7 0.2% acetonitrile formic acid solution: precise lessons of 2 mL acid (4.3), using a constant volume acetonitrile to 1 L, mix well.

4.8 0.1% Formate solution: accurately drawn 1 mL acid, water volume to 1 L, mix well.

4.9 10% Acetonitrile-acid solution (1+9, volume ratio): measure 10 mL of Acetonitrile (4.1) and 90 mL 0.1% acid solution (4.8), mix well.

4.10 Standard substance: quinolone drug standard (for specific information, see Appendix A, purity is greater than 98%.

4.11 Standard stock solution preparation: accurately learn purity respectively after all the calculations, regular standard substance (to 0.01 g), methanol (4.2), diluted and standard of hardly soluble in methanol, add a small amount of acid (4.3) dissolved, and then using a constant volume of methanol to scale, preparation of standard stock solution concentration and 2.0 g/L. You can save at  $-18\text{ }^{\circ}\text{C}$  and protected from light, valid for 12 months.

4.12 Preparation of mixed standard solution: accurate drawing standard stock solution 0.5 mL to 10 mL in a volumetric flask, using a constant volume of methanol to scale, concentration of the standard solution for 100 mg/L, at  $-18\text{ }^{\circ}\text{C}$  below the refrigerator storage, valid for 6 months.

4.13 Microfiltration membranes: 0.22  $\mu\text{m}$ , organic phase.

## 5 apparatus and equipment

5.1 LC-MS/MS system: equipped with electrospray ion source (ESI).

5.2 Nitrogen evaporator.

5.3 Ultrasonic water bath.

5.4 Vortex mixer.

5.5 Low temperature centrifuge: cooled to  $4\text{ }^{\circ}\text{C}$ , 9 500 r/min.

5.6 Homogenizer.

5.7 Analytical balance: 0.1 mg and 0.001 g.

5.8 Tubes: 15 mL and 50 mL.

5.9 Transfer pipet, 10  $\mu\text{L}$ ~1 000  $\mu\text{L}$ , 10  $\mu\text{L}$ ~100  $\mu\text{L}$ , 1 000  $\mu\text{L}$ ~5 000  $\mu\text{L}$ .

## 6 Determination procedure

### 6.1 Sample extraction

#### 6.1.1 water

Get sample 1.0 g (accurate to 0.01 g), 50 mL centrifuge tube (5.8), accurate joined 8 mL 0.2% formic acid in acetonitrile solution (4.7), mix 3 min, Ultrasonic extraction of 15 min at room temperature, 9 500 r/min centrifuge for 5 min at 4  $^{\circ}\text{C}$ , take the supernatant, 0.2% acetonitrile formic acid residue and then add 8 mL, repeat the above extraction process, 9 500 r/min centrifuge for 5 min after the supernatant, add 0.2% formic acid in acetonitrile solution to 20 mL, and mix well. Accurate drawing 1 mL the above extract, nitrogen and nearly 40  $^{\circ}\text{C}$  to blow dry, acetonitrile - 0.1% acid solution (4.9) constant volume to 5 mL, lower liquid 0.22  $\mu\text{m}$  organic membrane, LC-MS/MS measurement.

#### 6.1.2 paste, cream, emulsion

Get sample 1.0 g (accurate to 0.01 g), 50 mL centrifuge tube (5.8). Add 2 g of sodium chloride (4.6), accurate joined 8 mL 0.2% formic acid in acetonitrile solution (4.7), mix 3 min, Ultrasonic extraction of 15 min at room temperature, 9 500 r/min centrifuge for 5 min at 4  $^{\circ}\text{C}$ , take the supernatant, 0.2% acetonitrile formic acid residue and then add 8 mL, repeat the above extraction process, 9 500 r/min centrifuge for 5 min after the supernatant, and 0.2% formic acid in acetonitrile solution to 20 mL, and mix well. Accurate drawing 1 mL the above extract, nitrogen and nearly 40  $^{\circ}\text{C}$  to blow dry, acetonitrile - 0.1% acid solution (4.9) constant volume to 5 mL, add 5 mL of n-hexane solution (4.5) and mix well, 9 500 r/min of 5 min, abandoning the hexane layer, lower liquid 0.22  $\mu\text{m}$  organic membrane, LC-MS/MS measurement.

### 6.2 Mixed substrate preparation of standard working solution

#### 6.2.1 blank test

Get 1.0 g blank sample (accurate to 0.01 g) the 50 mL centrifuge tube, follow the 6.1 matrix preparation processing standard working curve.

#### 6.2.2 standard working solution

With the substrate blank (6.2.1) preparation of matrix standard working curve.



### 6.3 Determination of

#### 6.3.1 LC reference conditions

- a) Column: C<sub>18</sub> column, 150 mmx2.1 mm (i.d.), 2.7 μm, or equivalent;
- b) Temperature: 40 °C ;
- c) Sample size: 10 μL;
- d) Mobile phase flow and gradient elution condition is shown in Table 1.

Table 1 mobile phase flow and gradient Elution condition

Time min	Flow μL/min	Water(0.1% formic acid)	Acetonitrile (0.1% formic acid) %
0	250	87	13
6.0	250	10	90
9.0	250	10	90
9.1	250	87	13
15.0	250	87	13

#### 6.3.2 MS reference conditions

- a) Mode of ionization: electrospray ion source (ESI), the ESI<sup>+</sup> model;
- b) Scanning mode: multiple reaction monitoring (MRM);
- c) Resolution: resolution;
- d) Other reference conditions see Annex B.

#### 6.3.3 standard curve drawing

Take blank samples according to 6.1 processing, with proceeds of samples solution will mixed standard solution (4.12) diluted get of concentration for 0 μg/L, 5 μg/L, 10 μg/L, 20 μg/L, 50 μg/L, 100 μg/L and 200 μg/L of standard work liquid, by concentration by low to high of order into sample detection, to quantitative ion peak area-concentration drawing, get standard curve.

### 6.4 qualitative

In same experiment conditions ,samples in the stay measuring material of retained time, and matrix

Standard solution of retained time Feng deviation in  $\pm 2.5\%$  within; each species compounds of mass spectrum qualitative ion at least should including a parent ion and two child ion, and samples in the component qualitative ion of relative Feng degrees and concentration near of matrix mixed standard work solution in the corresponds to of qualitative ion of relative Feng degrees for comparison, deviation not over Table 2 provides of range, is can found for samples in the exists corresponds to of stay measuring property.

**Table 2** qualitative confirmation relative ion abundance of maximum permissible deviations

AMU	>50%	>20% ~50%	>10% ~20%	$\leq 10\%$
The maximum allowed deviation	$\pm 20\%$	$\pm 25\%$	$\pm 30\%$	$\pm 50\%$

## 6.5 Quantitative

Quinolone drugs in the sample liquid to be measured response values should be within the linear range of the standard curve, exceeds the linear range of the analysis of the sample should be diluted. Quinolone drug standard solution of multiple reaction monitoring (MRM) chromatogram see Annex C.

## 7 result calculation

Quinolone drug concentration in the sample or by chromatography data-processing software (1) calculated from, blank value calculations will be deducted, and keep the two decimal places:

(1) calculate sample test sample residue (mg/kg):

$$X = \frac{A \times c \times V \times 1\,000}{A_s \times m \times 1\,000} \times f \quad \dots\dots\dots (1)$$

In the formula:

$X$  —Test sample in the sample content, expressed in milligrams per kilogram (mg/kg);

$A$  —Like liquid in the peak area of the test sample;

$c$  —in the standard solution for measuring the concentration of units of micrograms per liter ( $\mu\text{g/L}$ );

$V$  —liquid will ultimately mass, expressed in milliliters (mL);

$A_s$ —standard solution in the peak area of the test sample;

$m$  —quality of the sample, expressed in grams (g);

$f$  —dilution ratio.

## 8 Method determination of Limit of quantitation

### 8.1 Limit of quantitation

Determination of limit of quantitation of this method; Marbofloxacin, Nalidixic acid, Pipemidic acid, Ciprofloxacin, Ofloxacin, Norfloxacin, Danofloxacin mesylate, Fleroxacin, Orbifloxacin, Flumequine, Difloxacin, Enoxacin, Cinoxacin, Oxloinic acid, Lomefloxacin, Pefloxacin, Sarafloxacin hydrochloride, Sparfloxacin, Enrofloxacin, Gatifloxacin, Balofloxacin, Balofloxacin, Clinafloxacin, Nadifloxacin, Moxifloxacin, Tosufloxacin 1.0 mg/kg quinolone drugs.

### 8.2 Recovery

Add in four concentrations within the water parts, cream, ointment and lotion data recovery rates of quinolone drugs in Annex D.



Annex A  
(Informative appendix)  
Standard information form

Table A.1 quinolone drugs standard information form

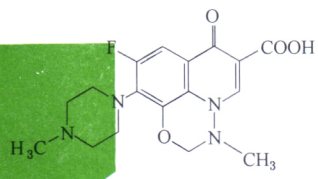
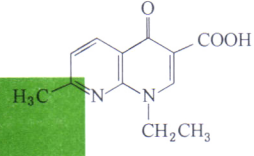
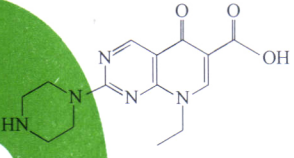
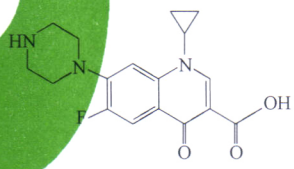
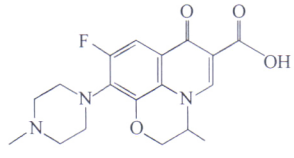
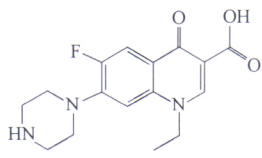
Compound	Molecular formula	Molecular weight	Structural formula	CAS
Marbofloxacin	$C_{17}H_{19}FN_4O_4$	362.36		115550-35-1
Nalidixic acid	$C_{12}H_{12}N_2O_3$	232.24		389-08-2
Pipemidic acid	$C_{14}H_{17}N_5O_3$	303.32		51940-44-4
Ciprofloxacin	$C_{17}H_{18}FN_3O_3$	331.35		97867-33-9
Ofloxacin	$C_{18}H_{20}FN_3O_4$	361.37		82419-36-1
Norfloxacin	$C_{16}H_{18}FN_3O_3$	319.33		70458-96-7

Table A.1 (continued)

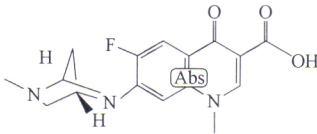
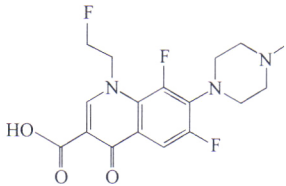
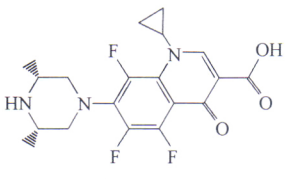
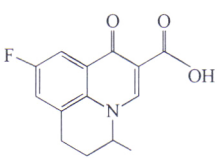
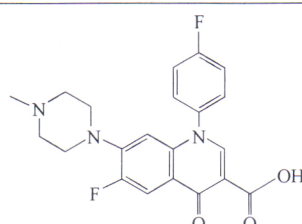
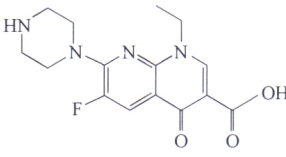
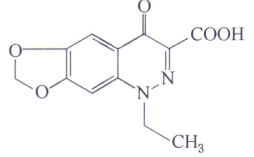
Compound	Molecular formula	Molecular weight	Structural formula	CAS
Danofloxacin mesylate	$C_{19}H_{20}FN_3O_5$	357.15		119478-55-6
Fleroxacin	$C_{17}H_{18}F_3N_3O_3$	369.34		79660-72-3
Orbifloxacin	$C_{19}H_{20}F_3N_3O_3$	395.38		113617-63-3
Flumequine	$C_{14}H_{12}FNO_3$	261.25		42835-25-6
Difloxacin	$C_{21}H_{19}F_2N_3O_3$	399.39		91296-86-5
Enoxacin	$C_{15}H_{17}FN_4O_3$	320.32		84294-96-2
Cinoxacin	$C_{12}H_{10}N_2O_5$	262.22		28657-80-9

Table A.1 (continued)

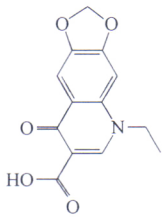
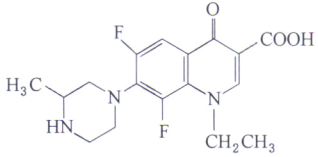
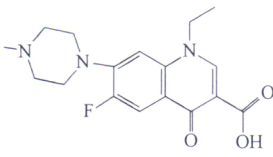
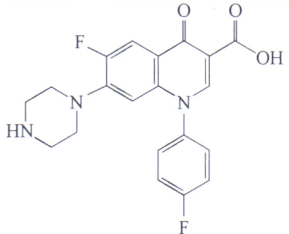
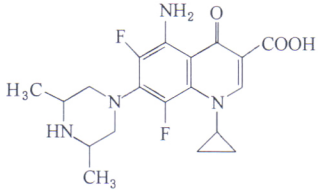
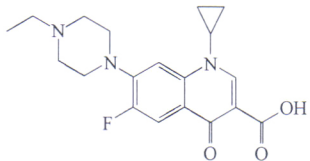
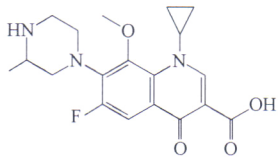
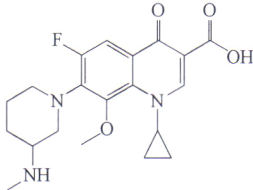
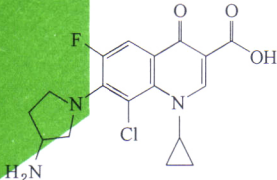
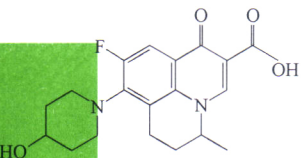
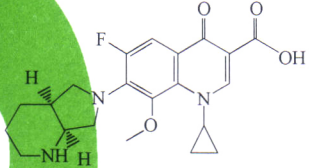
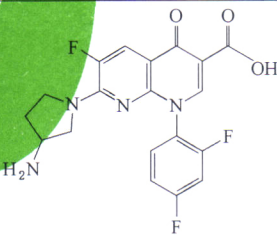
Compound	Molecular formula	Molecular weight	Structural formula	CAS
Oxloinic acid	$C_{13}H_{11}NO_5$	261.23		14698-29-4
Lomefloxacin	$C_{17}H_{19}F_2N_3O_3$	351.35		98079-52-8
Pefloxacin	$C_{17}H_{20}FN_3O_3$	333.36		149676-40-4
Sarafloxacin hydrochloride	$C_{20}H_{17}F_2N_3O_3$	385.36		91296-87-6
Sparfloxacin	$C_{19}H_{22}F_2N_4O_3$	392.41		110871-86-8
Enrofloxacin	$C_{19}H_{22}FN_3O_3$	359.40		93106-60-6
Gatifloxacin	$C_{19}H_{22}FN_3O_4$	375.39		112811-59-3

Table A.1 (continued)

Compound	Molecular formula	Molecular weight	Structural formula	CAS
Balofloxacin	$C_{20}H_{24}FN_3O_4$	389.42		151060-21-8
Clinafloxacin	$C_{17}H_{17}ClFN_3O_3$	365.79		105956-99-8
Nadifloxacin	$C_{19}H_{21}FN_2O_4$	360.38		124858-35-1
Moxifloxacin	$C_{21}H_{24}FN_3O_4$	401.43		192927-63-2
Tosufloxacin	$C_{19}H_{15}F_3N_4O_3$	404.11		115964-29-9

**Annex B**  
(Informative appendix)  
**Reference conditions of mass spectrometry<sup>1)</sup>**

Reference conditions of mass spectrometry:

- a) Electrospray voltage: 4 500 V;
- b) Auxiliary air pressure : 414.0 kPa;
- c) Collision gas pressure: 276.0 kPa;
- d) Curtain air pressure: 172.5 kPa;
- e) Ion source temperature: 450 °C ;
- f) Collision gas: nitrogen;
- g) Dwell time: 90 s;
- h) Qualitative and quantitative ion pairs, ion pair, acquisition time, the tapered hole voltage and energy are shown in Table B.1.

**Table B.1 quinolone drug mass spectrometer parameters**

Compound	Q1 Mass ( <i>m/z</i> )	Q3 Mass ( <i>m/z</i> )	Retention time (min)	DP	EP	CE	CXP
Danofloxacin mesylate	358.2	340.3 *	7.4	51	10	33	24
		255.1		51	10	53	20
Enrofloxacin	360.2	342.2 *	7.5	46	10	31	20
		316.4		46	10	27	18
Flumequine	262.2	202.3	9.6	41	10	45	16
		244.3 *		41	10	27	20
Oxloinic acid	262.2	216.3	8.8	41	10	41	18
		244.3 *		41	10	25	20

1) Non-commercial statement: Appendix B reference mass spectrum conditions are listed in the API on the 5,000-LC-MS instrument completed, test equipment models listed here are provided for reference only and that no commercial purposes, standard users are encouraged to try different manufacturers or models of the instrument.



Table B.1 (continued)

Compound	Q1 Mass ( <i>m/z</i> )	Q3 Mass ( <i>m/z</i> )	Retention time (min)	DP	EP	CE	CXP
Ciprofloxacin	332.2	231.3	7.3	41	10	49	20
		314.3 *		41	10	29	26
Sarafloxacin hydrochloride	386.2	368.2 *	7.8	46	10	31	26
		342.3		46	10	27	28
Nalidixic acid	233.2	215.3 *	9.5	21	10	19	18
		187.3		21	10	35	16
Norfloxacin	320.3	302.3 *	7.2	46	10	29	26
		276.4		46	10	25	24
Enoxacin	321.30	303.3 *	6.9	41	10	29	24
		232.2		41	10	49	18
Lomefloxacin	352.1	265.3	7.4	41	10	26	15
		308.3 *		41	10	31	9
Ofloxacin	362.1	261.2	7.2	46	10	37	20
		318.3 *		46	10	29	22
Difloxacin	400.3	382.3 *	7.9	90	10	29	12
		356.3		90	10	29	12
Marbofloxacin	363.1	320.2	6.9	26	10	23	26
		345.2 *		26	10	29	11
Pefloxacin	334.2	290.3	7.2	46	10	25	20
		316.3 *		46	10	29	22
Sparfloxacin	393.2	292.4	7.8	51	10	35	24
		349.4 *		51	10	29	28
Orbifloxacin	396.2	295.3	7.6	46	10	33	22
		352.3 *		46	10	25	24
Pipemidic acid	304.3	217.4 *	4.0	46	10	23	20
		189.0		46	10	32	20
Cinoxacin	263.0	245.0 *	8.5	40	10	30	12
		217.0		40	10	30	12
Fleroxacin	370.4	326.4 *	7.2	40	10	30	12
		352.0		40	10	30	12
Gatifloxacin	376.3	332.4 *	7.7	40	10	30	12
		261.4		40	10	30	12

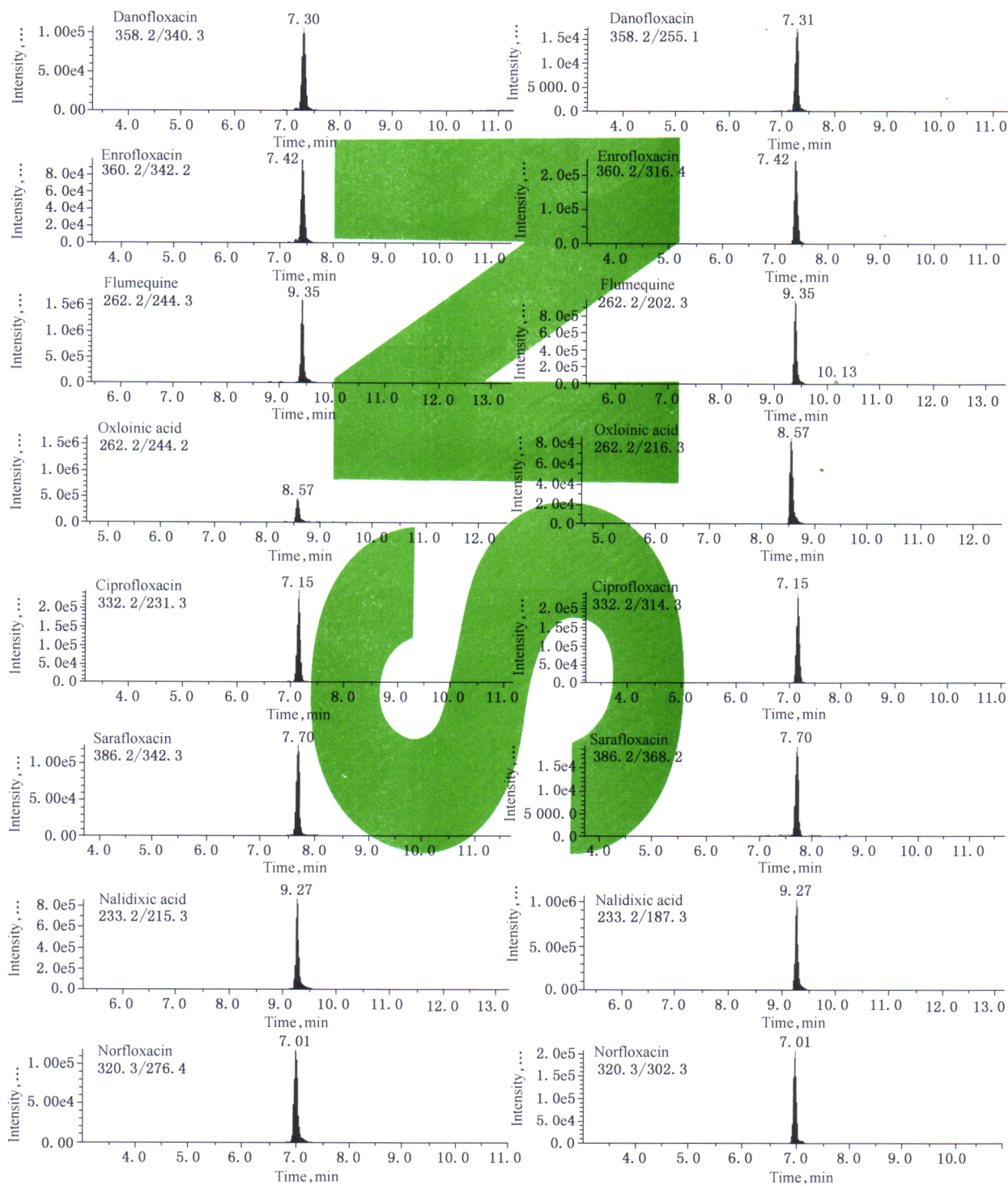
Table B.1 (continued)

Compound	Q1 Mass ( <i>m/z</i> )	Q3 Mass ( <i>m/z</i> )	Retention time (min)	DP	EP	CE	CXP
Balofloxacin	390.2	359.3 *	7.9	70	10	23	8
		315.3		70	10	33	8
Clinafloxacin	366.3	348.2 *	7.7	90	10	30	12
		305.2		90	10	31	12
Nadifloxacin	361.3	343.3 *	9.0	80	10	32	12
		283.3		80	10	53	12
Moxifloxacin	402.5	384.5 *	7.9	40	10	30	12
		364.5		40	10	30	12
Tosufloxacin	405.1	387.2 *	7.9	90	10	31	12
		263.2		90	10	63	12
Note: * for the quantitative ion,for different mass spectrometric instruments,instrument parameters may vary,prior to determination of the mass spectrometer parameters should be optimized to best							

## Annex C

### (Informative appendix)

#### Standard multiple reaction monitoring (MRM) chromatogram



**Figure C.1** quinolone drugs standard solution of multiple reaction monitoring chromatogram(MRM)(1.0 mg/kg)



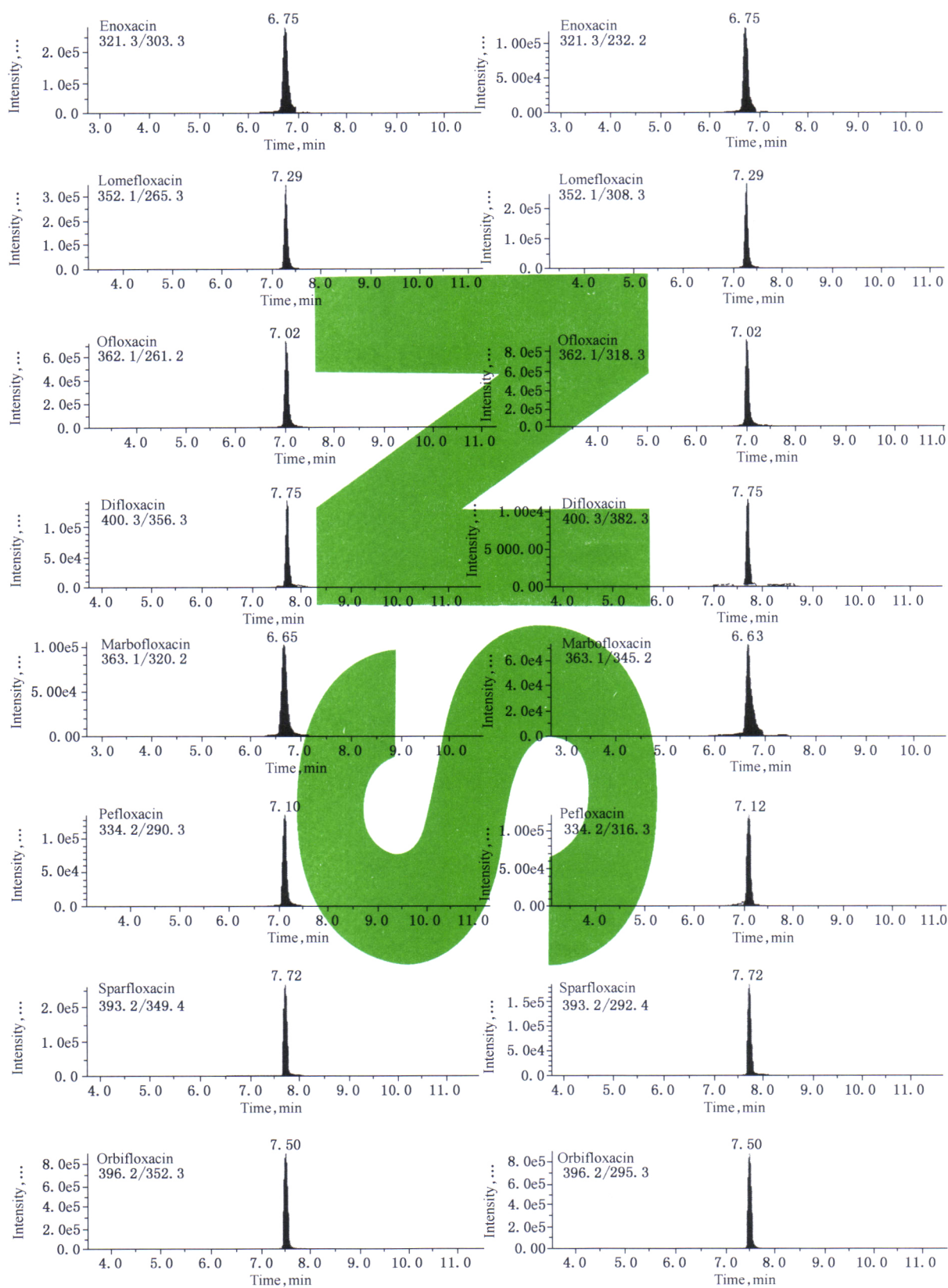


Figure C.1 (continued)

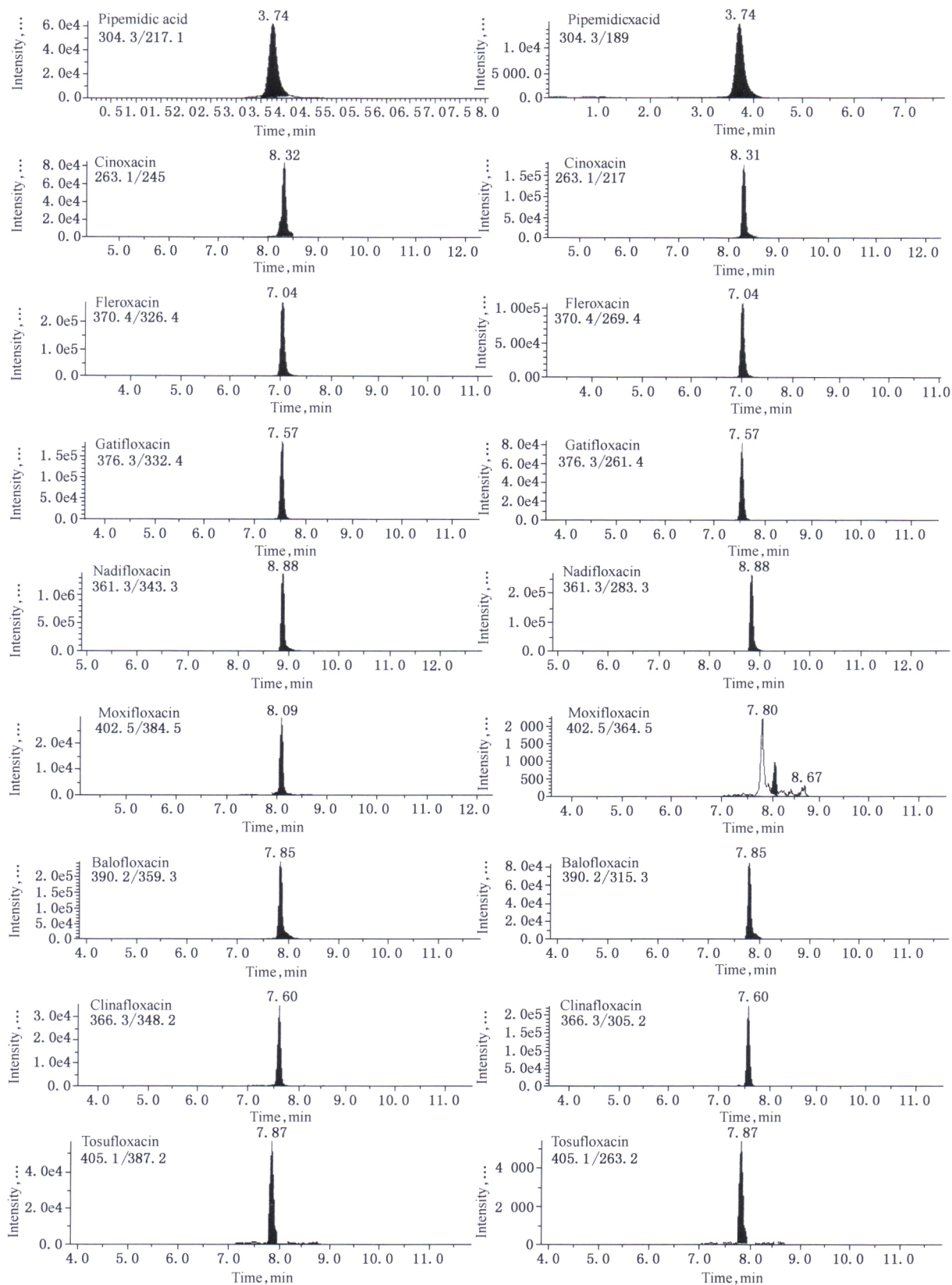


Figure C.1 (continued)

**Annex D**  
**(Informative appendix)**  
**Recovery rates**

**Table D.1 water parts, paste, cream and emulsion recovery rates of quinolone drugs in different levels of data**

Compound	Spiked concentration mg/kg	water		paste		cream		emulsion	
		recovery (%)	RSD (%)	recovery (%)	RSD (%)	recovery (%)	RSD (%)	recovery (%)	RSD (%)
Danofloxacin mesylate	1.00	96.0	11.1	98.0	11.4	97.5	10.2	98.0	14.0
	2.00	95.8	9.80	96.8	11.4	98.0	10.3	96.8	15.3
	5.00	98.5	15.2	93.0	17.5	92.0	10.3	93.0	19.5
	10.0	94.0	14.9	89.5	9.60	95.0	9.60	89.5	11.3
Enrofloxacin	1.00	92.7	11.1	88.0	8.40	94.5	11.5	88.0	11.9
	2.00	91.8	9.30	97.3	8.60	93.3	15.2	97.3	6.80
	5.00	93.7	14.6	96.0	12.8	89.0	14.9	96.0	14.9
	10.0	103	9.20	91.5	13.0	91.0	12.6	91.5	10.8
Flumequine	1.00	95.0	8.80	104	7.20	93.0	13.9	104	7.50
	2.00	97.5	11.3	97.3	10.7	93.0	15.5	97.3	12.5
	5.00	96.2	11.8	92.0	14.8	83.0	13.0	92.0	15.4
	10.0	100	8.20	96.0	16.4	99.0	8.20	96.0	12.9
Oxloinic acid	1.00	95.2	11.6	93.0	6.80	94.5	14.7	93.0	9.20
	2.00	97.0	9.60	95.8	8.30	93.5	15.7	95.8	8.60
	5.00	90.8	10.2	94.0	9.90	88.0	8.30	94.0	12.4
	10.0	101	4.50	94.0	15.4	96.5	11.6	94.0	11.0
Ciprofloxacin	1.00	93.4	11.5	97.5	11.5	98.5	10.2	97.5	11.9
	2.00	96.5	9.60	96.3	6.90	95.3	10.3	96.3	11.4
	5.00	103	9.30	90.0	12.3	94.0	12.1	90.0	6.60
	10.0	92.0	12.7	92.5	11.5	96.0	15.1	92.5	13.1
Sarafloxacin hydrochloride	1.00	94.5	11.0	94.0	15.0	102	9.30	94.0	15.0
	2.00	93.8	14.5	83.5	6.30	91.5	13.4	83.5	16.9
	5.00	105	11.2	86.0	16.4	91.0	13.6	86.0	13.1
	10.0	92.6	12.6	94.5	10.4	90.0	10.6	94.5	6.60



Table D.1 (continued)

Compound	Spiked concentration mg/kg	water		paste		cream		emulsion	
		recovery (%)	RSD (%)	recovery (%)	RSD (%)	recovery (%)	RSD (%)	recovery (%)	RSD (%)
Nalidixic acid	1.00	98.8	10.4	92.0	10.8	99.5	10.3	92.0	10.7
	2.00	90.8	12.1	98.5	8.90	92.5	13.8	98.5	6.70
	5.00	95.7	13.8	92.0	15.1	86.0	13.7	92.0	13.5
	10.0	93.1	13.2	98.5	12.6	95.0	16.0	98.5	3.90
Norfloxacin	1.00	97.9	10.7	101	9.50	95.0	12.2	101	11.0
	2.00	92.3	14.5	88.3	9.50	84.8	8.10	88.3	13.2
	5.00	103	10.6	97.0	12.6	93.0	13.5	97.0	15.6
	10.0	98.8	9.30	100	9.90	95.0	10.2	100	15.8
Difloxacin	1.00	101	7.50	93.5	13.3	92.5	14.1	93.5	12.1
	2.00	87.8	6.60	94.5	13.0	93.3	13.5	94.5	9.20
	5.00	93.1	13.9	95.0	14.3	95.0	21.0	95.0	17.7
	10.0	94.5	9.40	90.0	9.50	96.0	8.30	90.0	12.7
Marbofloxacin	1.00	87.0	9.40	98.0	12.6	96.0	9.40	98.0	6.50
	2.00	97.0	10.9	92.8	17.1	97.0	7.60	92.8	9.80
	5.00	96.9	13.4	90.0	2.00	88.0	9.70	90.0	18.9
	10.0	97.5	8.50	96.5	9.20	101	8.50	96.5	7.40
Pefloxacin	1.00	94.2	13.3	95.5	12.1	105	5.40	95.5	11.8
	2.00	92.8	15.2	96.3	6.30	91.8	11.3	96.3	11.6
	5.00	99.3	12.6	93.0	14.3	94.0	13.3	93.0	15.3
	10.0	94.7	12.5	98.0	12.9	99.0	5.60	98.0	10.8
Sparfloxacin	1.00	96.5	9.80	95.5	9.20	92.5	11.5	95.5	11.7
	2.00	94.3	17.1	97.8	10.3	93.5	7.70	97.8	10.7
	5.00	105	13.0	94.0	12.8	98.0	17.4	94.0	16.6
	10.0	97.5	14.0	86.5	7.80	98.5	9.40	86.5	12.9
Orbifloxacin	1.00	99.0	7.20	97.5	14.3	96.0	13.0	97.5	9.80
	2.00	96.3	13.6	86.0	8.70	94.8	10.4	86.0	14.2
	5.00	98.4	13.7	95.0	16.9	93.0	12.7	95.0	8.8
	10.0	97.3	11.1	87.0	9.60	95.0	12.4	87.0	13.6
Pipemidic acid	1.00	96.5	10.7	90.0	10.8	97.5	11.5	90.0	8.40
	2.00	95.0	10.7	91.8	13.3	106	4.90	91.8	13.6
	5.00	101	14.9	89.0	19.1	86.0	17.1	89.0	11.1
	10.0	93.3	13.6	98.5	11.4	95.0	8.20	98.5	9.80



Table D.1 (continued)

Compound	Spiked concentration mg/kg	water		paste		cream		emulsion	
		recovery (%)	RSD (%)	recovery (%)	RSD (%)	recovery (%)	RSD (%)	recovery (%)	RSD (%)
Cinoxacin	1.00	90.5	10.3	95.5	9.70	88.5	9.80	95.5	9.10
	2.00	85.8	9.70	90.3	11.7	92.5	14.9	90.3	12.8
	5.00	89.6	12.8	97.0	11.8	87.0	16.6	97.0	16.5
	10.0	95.0	11.0	93.0	13.4	97.0	12.6	93.0	17.9
Fleroxacin	1.00	93.5	12.2	98.0	8.50	101	10.2	98.0	12.5
	2.00	96.8	8.20	87.8	6.20	94.5	16.1	87.8	10.8
	5.00	102	14.5	95.0	15.2	90.0	10.9	95.0	12.8
	10.0	99.3	12.7	94.0	12.9	95.5	14.3	94.0	16.7
Gatifloxacin	1.00	98.0	5.10	101	10.2	101	8.40	101	13.4
	2.00	93.5	12.7	91.8	14.4	94.0	14.4	91.8	12.9
	5.00	97.9	13.5	91.0	15.0	90.0	8.40	91.0	9.20
	10.0	93.9	8.60	93.0	8.70	97.5	14.5	93.0	10.7
Enoxacin	1.00	92.5	10.3	97.0	10.5	98.5	13.2	97.0	7.90
	2.00	95.8	10.4	90.8	10.8	93.8	10.4	90.8	12.4
	5.00	95.3	13.7	92.0	9.20	93.0	15.1	92.0	12.0
	10.0	94.0	9.80	90.5	11.6	102	8.20	90.5	13.3
Lomefloxacin	1.00	94.5	8.40	93.5	13.9	95.5	15.7	93.5	12.0
	2.00	93.3	7.60	97.3	12.6	96.3	14.2	97.3	13.9
	5.00	95.9	10.5	101	13.4	85.0	13.9	101	19.6
	10.0	92.5	8.50	97.5	13.6	101	8.40	97.5	9.90
Ofloxacin	1.00	91.5	9.60	97.0	11.8	102	10.7	97.0	6.60
	2.00	97.0	9.10	92.5	10.2	94.0	13.8	92.5	10.2
	5.00	105	11.4	95.0	14.6	92.0	13.9	95.0	9.90
	10.0	94.0	12.0	91.5	12.0	95.0	12.7	91.5	3.60
Balofloxacin	1.00	91.5	8.60	93.5	10.4	92.5	9.90	93.5	11.5
	2.00	92.3	14.0	93.0	16.0	91.0	12.2	93.0	11.0
	5.00	98.4	19.7	103	11.9	85.0	13.9	103	11.0
	10.0	101	14.1	98.0	12.4	102	8.90	98.0	11.3
Clinafloxacin	1.00	94.0	10.6	97.0	13.0	96.5	9.30	97.0	11.8
	2.00	100	10.5	102	7.50	92.3	15.2	102	15.1
	5.00	88.8	5.80	90.0	12.1	98.0	11.7	90.0	13.2
	10.0	98.0	13.7	97.0	8.90	101	11.5	97.0	12.9

Table D.1 (continued)

Compound	Spiked concentration mg/kg	water		paste		cream		emulsion	
		recovery (%)	RSD (%)	recovery (%)	RSD (%)	recovery (%)	RSD (%)	recovery (%)	RSD (%)
Nadifloxacin	1.00	95.5	10.2	99.0	13.1	103	9.10	99.0	15.7
	2.00	91.3	11.9	94.5	12.0	100	8.40	94.5	10.3
	5.00	92.1	11.9	88.0	15.3	99.0	13.2	88.0	17.4
	10.0	99.4	10.6	93.0	15.7	87.5	6.70	93.0	8.50
Moxifloxacin	1.00	95.8	9.40	97.0	10.8	101	12.4	97.0	5.70
	2.00	88.8	9.80	91.3	7.60	94.8	13.0	91.3	6.70
	5.00	91.7	13.0	92.0	12.0	99.0	13.9	92.0	21.0
	10.0	93.0	10.8	95.5	16.6	97.0	8.00	95.5	14.0
Tosufloxacin	1.00	96.4	10.9	96.0	12.9	96.5	15.1	96.0	11.1
	2.00	94.3	13.0	91.8	15.6	98.0	9.40	91.8	7.10
	5.00	101	14.2	93.0	14.9	87.0	13.8	93.0	10.2
	10.0	94.5	11.4	89.0	5.50	96.0	14.1	89.0	14.6