

(12) 按照专利合作条约所公布的国际申请

(19) 世界知识产权组织
国际局

(43) 国际公布日
2024 年 2 月 29 日 (29.02.2024)



(10) 国际公布号
WO 2024/041654 A1

(51) 国际专利分类号:

C07D 417/14 (2006.01) A01P 3/00 (2006.01)
A01N 43/78 (2006.01)

(21) 国际申请号: PCT/CN2023/115117

(22) 国际申请日: 2023 年 8 月 26 日 (26.08.2023)

(25) 申请语言: 中文

(26) 公布语言: 中文

(30) 优先权:

202211035626.7 2022年8月26日 (26.08.2022) CN

(71) 申请人: 江苏中旗科技股份有限公司(JIANGSU FLAG CHEMICAL INDUSTRY CO., LTD.) [CN/CN]; 中国江苏省南京市化学工业园区长丰河路309号, Jiangsu 210047 (CN)。

(72) 发明人: 杨光富(YANG, Guangfu); 中国湖北省武汉市洪山区珞喻路152号, Hubei 430079 (CN)。周立明(ZHOU, Liming); 中国湖北省武汉市洪山区珞喻路152号, Hubei 430079 (CN)。成传祥(CHENG, Chuanxiang); 中国湖北省武汉市洪山区珞喻路152号, Hubei 430079 (CN)。陈梦迪(CHEN, Mengdi); 中国湖北省武汉市洪山区珞喻路152号, Hubei 430079 (CN)。李鸿浩(LI, Honghao); 中国湖北省武汉市洪山区珞喻路152号, Hubei 430079 (CN)。柴松(CHAI, Song); 中国湖北省武汉市洪山区珞喻路152号, Hubei 430079 (CN)。张璞(ZHANG, Pu); 中国江苏省南京市化学工业园区长丰河路309号, Jiangsu 210047 (CN)。熊姿(XIONG, Zi); 中国江苏省南京市化学工业园区长丰河路309号, Jiangsu 210047 (CN)。吴耀军

(WU, Yaojun); 中国江苏省南京市化学工业园区长丰河路309号, Jiangsu 210047 (CN)。

(74) 代理人: 北京润平知识产权代理有限公司(RUNPING & PARTNERS); 中国北京市海淀区北四环西路9号银谷大厦515室, Beijing 100190 (CN)。

(81) 指定国(除另有指明, 要求每一种可提供的国家保护): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW。

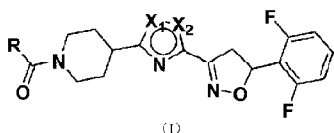
(84) 指定国(除另有指明, 要求每一种可提供的地区保护): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 欧洲 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG)。

本国际公布:

— 包括国际检索报告(条约第21条(3))。

(54) Title: COMPOUND CONTAINING CHAIN-SHAPED CARBOXYLIC ACID AMIDE STRUCTURE, PREPARATION METHOD THEREFOR, USE THEREOF, AND BACTERICIDE

(54) 发明名称: 含链状羧酸酰胺结构的化合物及其制备方法和应用、杀菌剂



(57) Abstract: The present invention relates to the field of pesticide bactericides. Disclosed are a compound containing a chain-shaped carboxylic acid amide structure, a preparation method therefor, use thereof, and a bactericide. The compound has a structure as represented by formula (I). The compound of the present invention has an excellent prevention and treatment effect on plant diseases caused by oomycetes such as cucumber downy mildew, phytophthora infestans, and phytophthora capsici, is equivalent to oxathiapiprolin which is a current commercial oomycete disease prevention and treatment agent, and has a very good market development prospect.

(57) 摘要: 本发明涉及农药杀菌剂领域, 公开了含链状羧酸酰胺结构的化合物及其制备方法和应用、杀菌剂, 该化合物具有式(I)所示的结构。本发明的化合物对黄瓜霜霉菌、致病疫霉菌、辣椒疫霉菌等卵菌引起的植物病害具有优异的防治效果, 与目前商品化卵菌病害防治药剂氟噻唑吡乙酮相当, 具有很好的市场开发前景。

WO 2024/041654 A1

含链状羧酸酰胺结构的化合物及其制备方法和应用、杀菌剂

相关申请的交叉引用

本申请要求 2022 年 08 月 26 日提交的中国专利申请 202211035626.7 的权益，该申请的内容通过引用被合并于本文。

技术领域

本发明涉及农药杀菌剂领域，具体涉及含链状羧酸酰胺结构的化合物及其制备方法和应用、杀菌剂。

背景技术

卵菌是引起植物病害的重要病原菌之一，具有寄生范围广、破坏性强、为害性大、发展迅速等特点。

霜霉菌是最具代表性的卵菌之一，其潜伏期短、可多次侵染，在极短的时间内可导致病害大流行，如该病菌引起的黄瓜霜霉病可以在短短几日内导致黄瓜全部死亡。

一般霜霉菌引起的植物病害可分为以下三类：1)叶病，主要是霜霉病；2)一年生和多年生作物的根和冠病，如土壤潮湿、幼苗枯萎、根、颈和茎腐病；3)全身性疾病，是指由土壤或种子的根部感染、病原体在植物的维管系统中的分布以及症状在生长点或叶片上的表现所引起的疾病。

在温带和热带气候中，大多数一年生或多年生的农业、园艺和观赏作物(如葡萄、黄瓜、马铃薯、烟草、番茄、啤酒花、柑橘、向日葵、蔬菜和大豆)，都可能受到霜霉菌的侵袭，这使得霜霉菌成为一类极具破坏性的植物病原体，其引起的病害也较难防治，因此给农业生产带来极大的损失。长期以来，有效控制它们一直是优先考虑的问题。

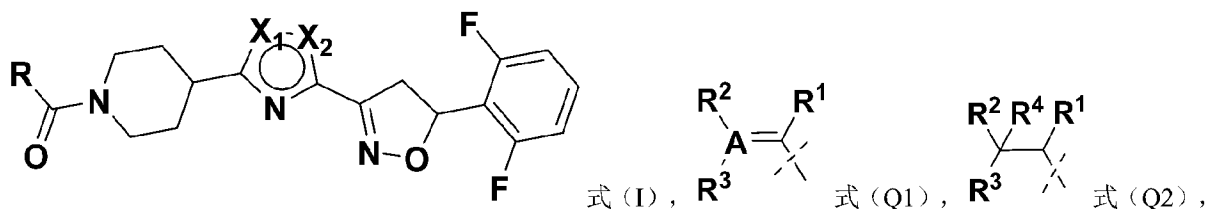
卵菌病害防治日益困难，目前，化学防治依旧是防治举措中最为简便和有效的方法，生产上主要使用的是多作用位点的保护性杀菌剂和单作用位点的内吸性杀菌剂。但随着这些杀菌剂使用时间的延长和长期的不合理使用，使得很多病原菌出现了严重的抗药性。

因此，开发新型的与传统杀菌剂无交互抗性的卵菌杀菌剂成为目前该领域所急需的发展方向。

发明内容

本发明的目的是为了克服现有技术的前述缺陷，提供一类新型的与传统杀菌剂无交互抗性的卵菌杀菌剂。

为了实现上述目的，本发明的第一方面提供一种含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物，该化合物具有式 (I) 所示的结构，



其中，在式 (I) 中， X_1 和 X_2 中的一者为 S，另一者为 CH；

R 为式 (Q1) 所示的结构或式 (Q2) 所示的结构；

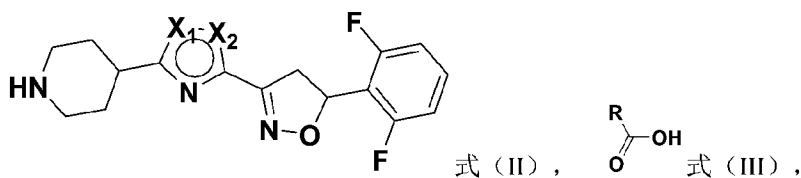
在式 (Q1) 中， R^1 、 R^2 、 R^3 各自独立地选自 H、 C_1 - C_{12} 的烷基、 C_1 - C_{12} 的烷氧基、 C_3 - C_{12} 的环烷基、 C_1 - C_{12} 的烷硫基、由至少一个卤素取代的 C_1 - C_{12} 的烷氧基、由苯基取代的 C_1 - C_{12} 的烷氧基、卤素、苯基、由组合 A 中

的至少一种基团取代的苯基、氰基、硝基、吡啶基、吡唑基、由组合 A 中的至少一种基团取代的吡唑基；或者， R^2 和 R^3 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子作为成环原子的 3-7 元饱和和杂环基；A 为 N 或 CH；且当 A 为 N 时， R^2 和 R^3 中的一者不存在；

在式 (Q2) 中， R^1 、 R^2 、 R^3 、 R^4 各自独立地选自 H、 C_1 - C_{12} 的烷基、 C_1 - C_{12} 的烷氧基、 C_3 - C_{12} 的环烷基、 C_1 - C_{12} 的烷硫基、由至少一个卤素取代的 C_1 - C_{12} 的烷氧基、由苯基取代的 C_1 - C_{12} 的烷氧基、卤素、苯基、由组合 A 中的至少一种基团取代的苯基、氰基、硝基、吡啶基、吡唑基、由组合 A 中的至少一种基团取代的吡唑基，且 R^1 、 R^2 、 R^3 、 R^4 中的至少一者为 C_1 - C_{12} 的烷氧基或 C_1 - C_{12} 的烷硫基；或者， R^2 和 R^3 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子作为成环原子的 3-7 元饱和杂环基；

所述组合 A 由 C_1 - C_{12} 的烷基、卤素、由至少一个卤素取代的 C_1 - C_{12} 的烷基、 C_1 - C_{12} 的烷氧基组成。

本发明的第二方面提供一种制备第一方面中所述的含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物的方法，该方法包括：在缩合反应条件下，将式 (II) 所示的化合物与式 (III) 所示的化合物进行接触反应，



且式 (II) 所示的化合物与式 (III) 所示的化合物中的取代基的定义与第一方面中所述的定义相同。

本发明的第三方面提供第一方面中所述的含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物在防治植物卵菌病害中的应用。

本发明的第四方面提供第一方面中所述的含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物作为农用杀菌剂的应用。

本发明的第五方面提供一种杀菌剂，该杀菌剂由活性成分和辅料组成，所述活性成分包括第一方面所述的含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物。

本发明的化合物对黄瓜霜霉菌、致病疫霉菌、辣椒疫霉菌等卵菌引起的植物病害具有优异的防治效果，与目前商品化卵菌病害防治药剂氟噻唑吡乙酮相当，具有很好的市场开发前景。

具体实施方式

在本文中所披露的范围的端点和任何值都不限于该精确的范围或值，这些范围或值应当理解为包含接近这些范围或值的值。对于数值范围来说，各个范围的端点值之间、各个范围的端点值和单独的点值之间，以及单独的点值之间可以彼此组合而得到一个或多个新的数值范围，这些数值范围应被视为在本文中具体公开。

以下针对本发明的部分基团提供一些示例性的解释，在没有特别说明的情况下，未列举的部分参照如下示例性的解释进行解释。

“卤素”表示氟、氯、溴、碘。

“ C_1 - C_{12} 的烷基”表示碳原子总数为 1-12 的烷基，包括直链烷基、支链烷基，例如可以为碳原子总数为 1、2、3、4、5、6、7、8、9、10、11、12 的直链烷基、支链烷基，例如可以为正丁基、异丁基、叔丁基、正戊基、异戊基、正己基等；“ C_1 - C_{10} 的烷基”的定义与“ C_1 - C_{12} 烷基”的定义相似，不同的是，碳原子总数不同。

“ C_1 - C_{12} 的烷氧基”的定义与“ C_1 - C_{12} 烷基”的定义相似，不同的是，“ C_1 - C_{12} 的烷氧基”通过 O 原子直接与母核连接，表示碳原子总数为 1-12 的烷氧基，包括直链烷氧基、支链烷氧基，例如可以为碳原子总数为 1、2、3、4、5、6、7、8、9、10、11、12 的直链烷氧基、支链烷氧基，示例性地，可以为甲基氧基、乙基氧基、正丙基氧基、

异丙基氧基、正丁基氧基、异丁基氧基、叔丁基氧基、正戊基氧基、异戊基氧基、正己基氧基。“C₁-C₁₀ 的烷氧基”的定义与“C₁-C₁₂ 的烷氧基”的定义相似，不同的是，碳原子总数不同。

“C₁-C₁₂ 的烷硫基”与“C₁-C₁₂ 烷基”的定义相似，不同的是，“C₁-C₁₂ 的烷硫基”通过 S 原子直接与母核连接，表示碳原子总数为 1-12 的烷硫基，包括直链烷硫基、支链烷硫基，例如可以为碳原子总数为 1、2、3、4、5、6、7、8、9、10、11、12 的直链烷硫基、支链烷硫基，示例性地，可以为甲基硫基、乙基硫基、正丙基硫基、异丙基硫基、正丁基硫基、异丁基硫基、叔丁基硫基、正戊基硫基、异戊基硫基、正己基硫基。“C₁-C₁₀ 的烷硫基”的定义与“C₁-C₁₂ 的烷硫基”的定义相似，不同的是，碳原子总数不同。

“C₃-C₁₂ 的环烷基”表示碳原子总数为 3-12 的环烷基，且成环原子均为 C 原子，例如可以为成环碳原子总数为 3、4、5、6、7、8、9、10、11、12，且所述“C₃-C₁₂ 的环烷基”上任意能够被取代的位置直接与母核连接。“C₃-C₁₀ 的环烷基”的定义与“C₃-C₁₂ 的环烷基”的定义相似，不同的是，碳原子总数不同。

“由至少一个卤素取代的 C₁-C₁₂ 的烷氧基”表示“C₁-C₁₂ 的烷氧基”中的至少一个 H 原子由卤素取代，且取代的卤素可以为一种或者多种。“由至少一个卤素取代的 C₁-C₁₀ 的烷氧基”具有与其相似的定义，仅仅是碳原子总数不同而已。

“由至少一个卤素取代的 C₁-C₁₂ 的烷基”表示“C₁-C₁₂ 的烷基”中的至少一个 H 原子由卤素取代，且取代的卤素可以为一种或者多种。“由至少一个卤素取代的 C₁-C₁₀ 的烷基”具有与其相似的定义，仅仅是碳原子总数不同而已。

“由苯基取代的 C₁-C₁₂ 的烷氧基”表示“C₁-C₁₂ 的烷氧基”中的至少一个 H 原子由苯基取代。“由苯基取代的 C₁-C₁₀ 的烷氧基”具有与其相似的定义，仅仅是碳原子总数不同而已。

“R² 和 R³ 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子作为成环原子的 3-7 元饱和杂环基”表示其中成环碳原子总数为 3、4、5、6、7 且含有至少一个 O 原子。

在没有特别说明的情况下，“由组合 A 中的至少一种基团取代的”基团，表示组合 A 中的至少一种基团能够在任意能够被取代的位置进行取代。基团所示的结构式中的虚线表示基团与母核之间的连接位置。

如前所述，本发明的第一方面提供了一种含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物，该化合物具有式 (I) 所示的结构。

根据一种优选的具体实施方式，在式 (I) 中，

X₁ 和 X₂ 中的一者为 S，另一者为 CH；

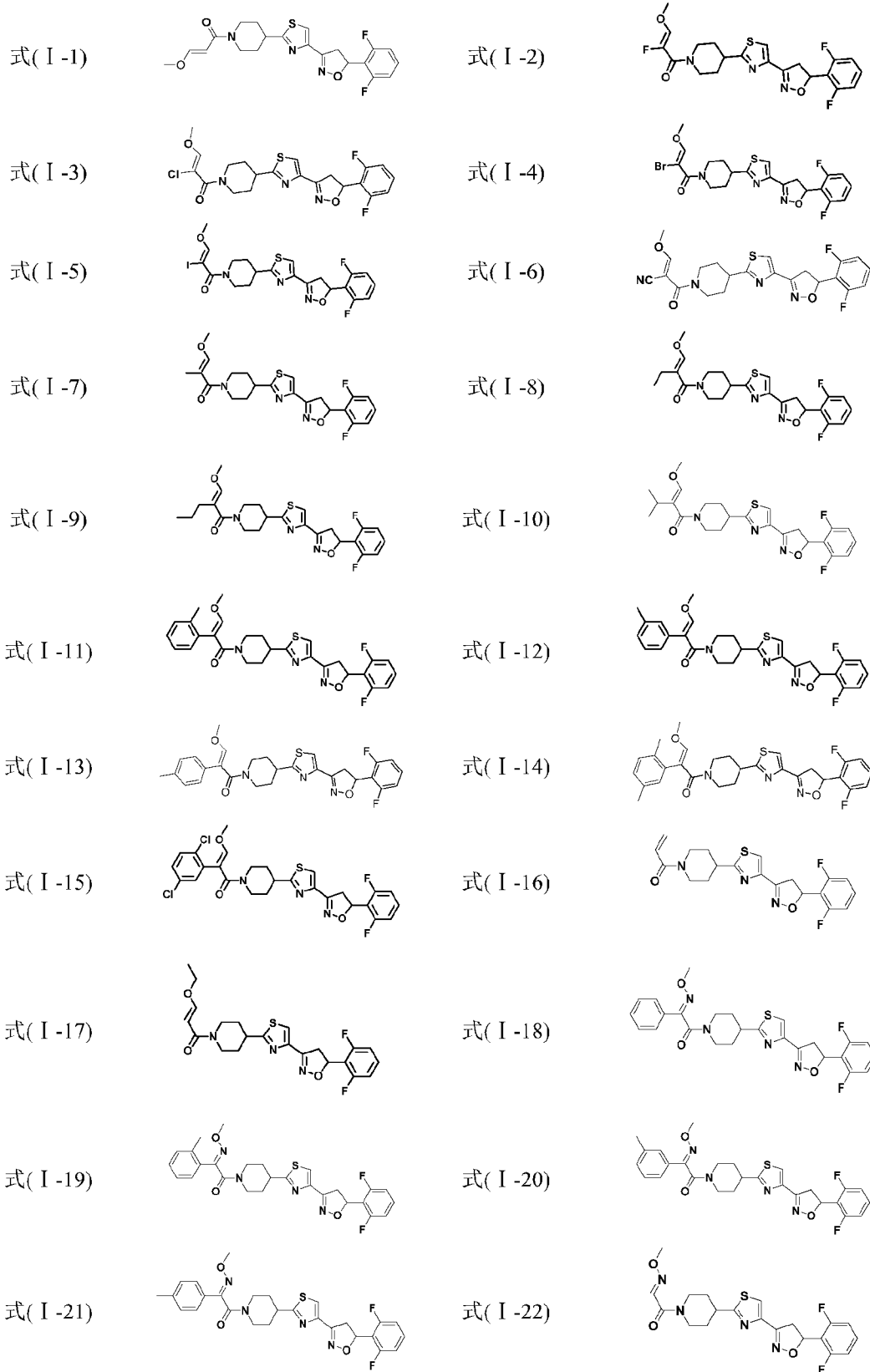
R 为式 (Q1) 所示的结构；在式 (Q1) 中，R¹、R²、R³ 各自独立地选自 H、C₁-C₁₂ 的烷基、C₁-C₁₂ 的烷氧基、C₃-C₁₂ 的环烷基、C₁-C₁₂ 的烷硫基、由至少一个卤素取代的 C₁-C₁₂ 的烷氧基、由苯基取代的 C₁-C₁₂ 的烷氧基、卤素、苯基、由组合 A 中的至少一种基团取代的苯基、氰基、硝基、吡啶基、吡唑基、由组合 A 中的至少一种基团取代的吡唑基；或者，R² 和 R³ 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子作为成环原子的 3-7 元饱和杂环基；

A 为 N 或 CH；且当 A 为 N 时，R² 和 R³ 中的一者不存在；所述组合 A 由 C₁-C₁₂ 的烷基、卤素、由至少一个卤素取代的 C₁-C₁₂ 的烷基、C₁-C₁₂ 的烷氧基组成。

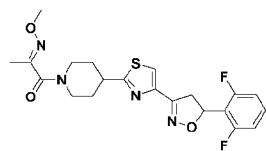
根据另一种优选的具体实施方式，在式 (I) 中，X₁ 和 X₂ 中的一者为 S，另一者为 CH；

R 为式 (Q1) 所示的结构；在式 (Q1) 中，R¹、R²、R³ 各自独立地选自 H、C₁-C₁₀ 的烷基、C₁-C₁₀ 的烷氧基、C₃-C₁₀ 的环烷基、C₁-C₁₀ 的烷硫基、由至少一个卤素取代的 C₁-C₁₀ 的烷氧基、由苯基取代的 C₁-C₁₀ 的烷氧基、卤素、苯基、由组合 A 中的至少一种基团取代的苯基、氰基、硝基、吡啶基、吡唑基、由组合 A 中的至少一种基团取代的吡唑基；或者，R² 和 R³ 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子作为成环原子的 3-7 元饱和杂环基；A 为 N 或 CH；且当 A 为 N 时，R² 和 R³ 中的一者不存在；

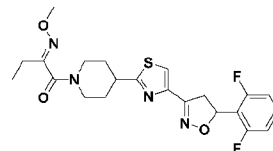
所述组合 A 由 C₁-C₁₀ 的烷基、卤素、由至少一个卤素取代的 C₁-C₁₀ 的烷基、C₁-C₁₀ 的烷氧基组成。
根据一种特别优选的具体实施方式，式 (I) 所示结构的化合物选自以下中的任意一种：



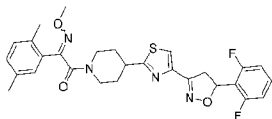
式(I-23)



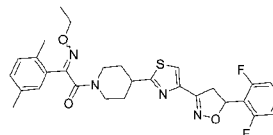
式(I-24)



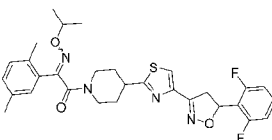
式(I-25)



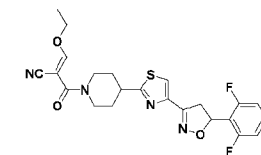
式(I-26)



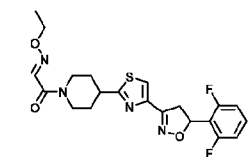
式(I-27)



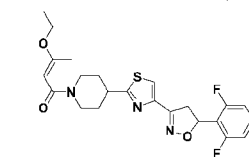
式(I-28)



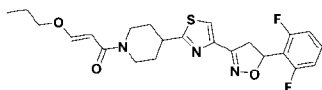
式(I-29)



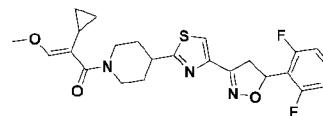
式(I-30)



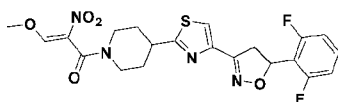
式(I-31)



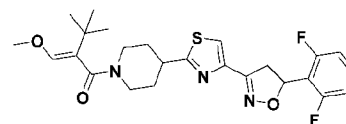
式(I-32)



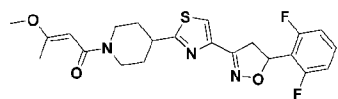
式(I-33)



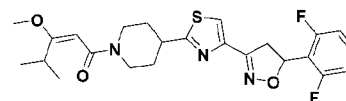
式(I-34)



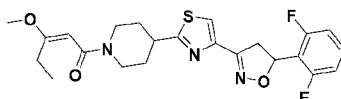
式(I-35)



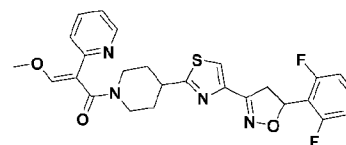
式(I-36)



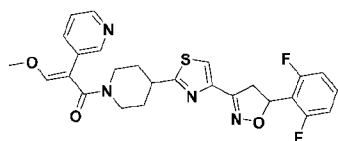
式(I-37)



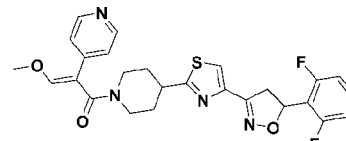
式(I-38)



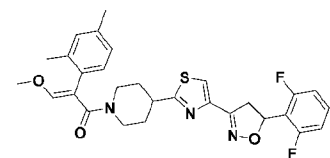
式(I-39)



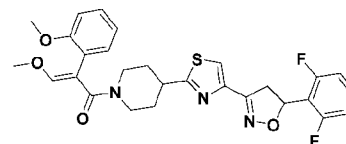
式(I-40)



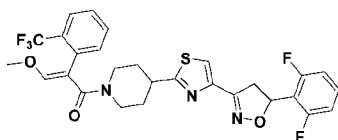
式(I-41)



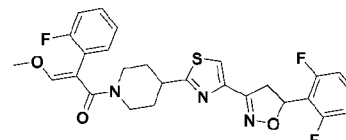
式(I-42)



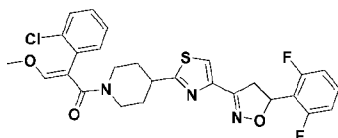
式(I-43)



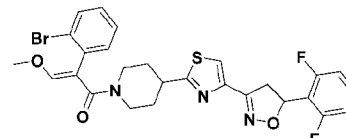
式(I-44)



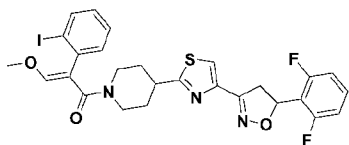
式(I-45)



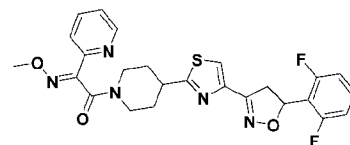
式(I-46)



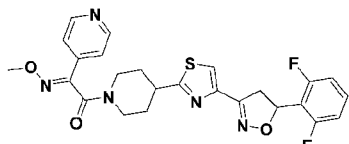
式(I-47)



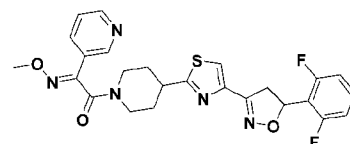
式(I-48)



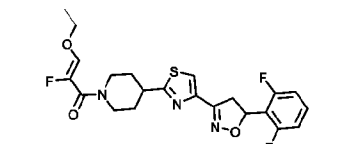
式(I-49)



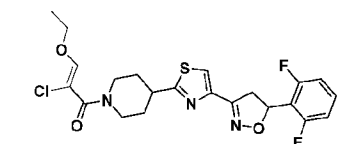
式(I-50)



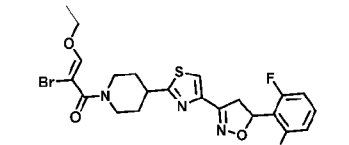
式(I-51)



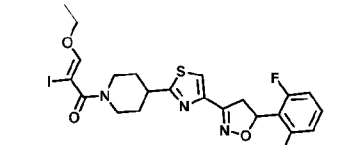
式(I-52)



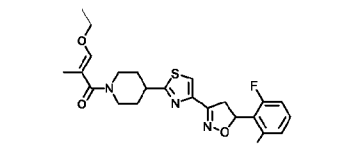
式(I-53)



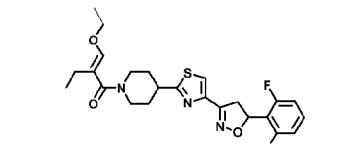
式(I-54)



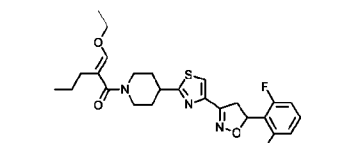
式(I-55)



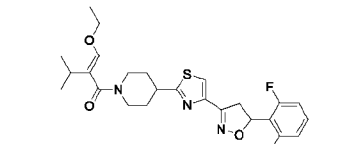
式(I-56)



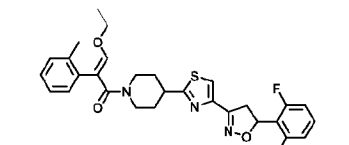
式(I-57)



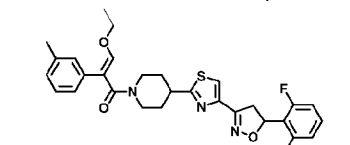
式(I-58)



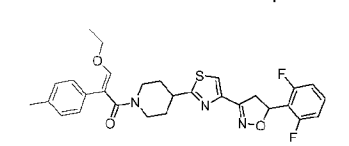
式(I-59)



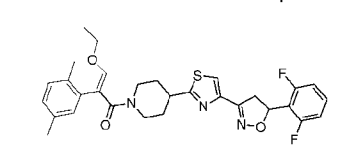
式(I-60)



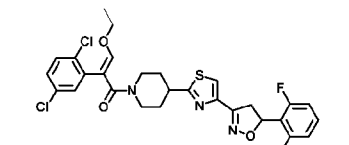
式(I-61)



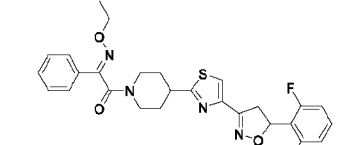
式(I-62)



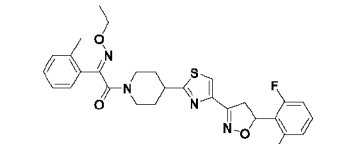
式(I-63)



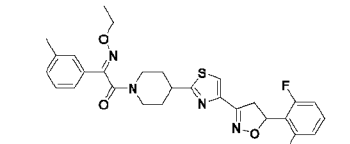
式(I-64)



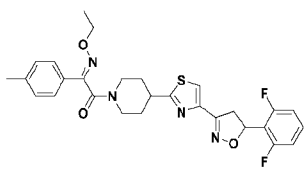
式(I-65)



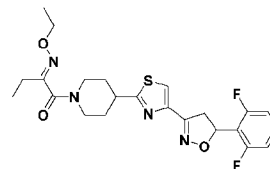
式(I-66)



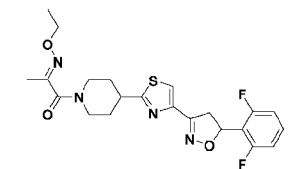
式(I-67)



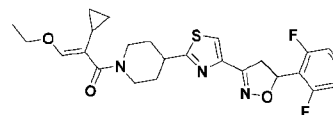
式(I-68)



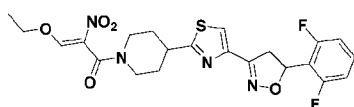
式(I-69)



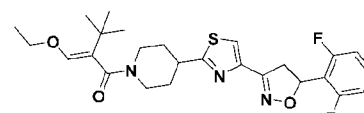
式(I-70)



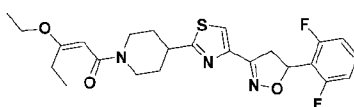
式(I-71)



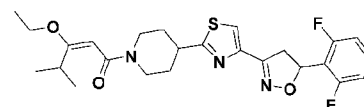
式(I-72)



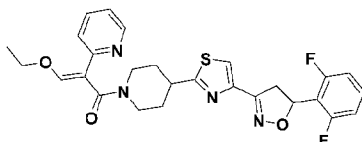
式(I-73)



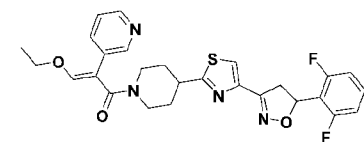
式(I-74)



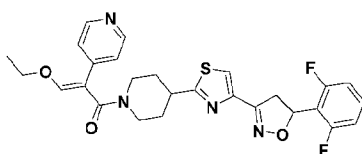
式(I-75)



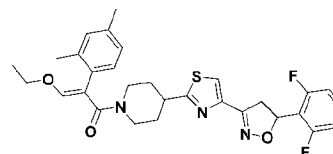
式(I-76)



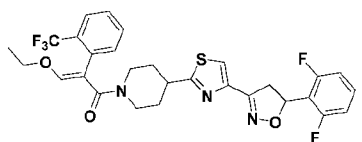
式(I-77)



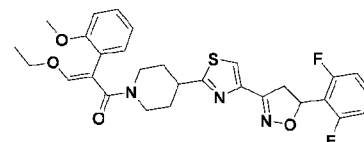
式(I-78)



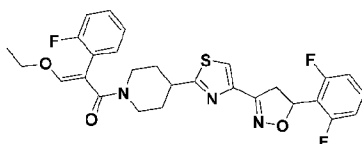
式(I-79)



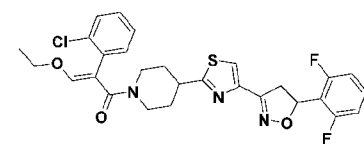
式(I-80)



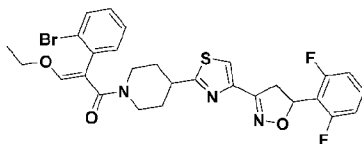
式(I-81)



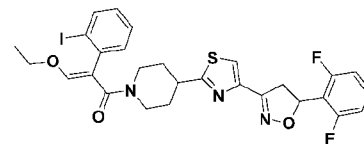
式(I-82)



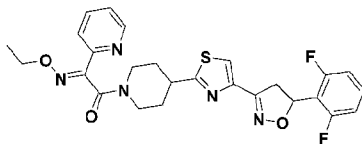
式(I-83)



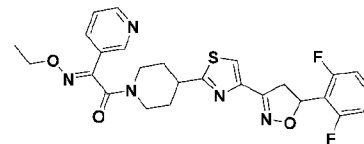
式(I-84)



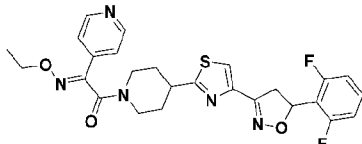
式(I-85)



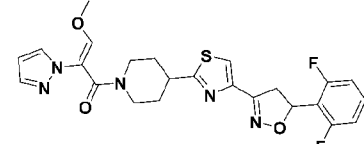
式(I-86)



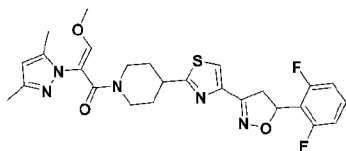
式(I-87)



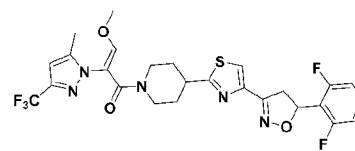
式(I-88)



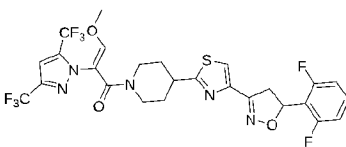
式(I-89)



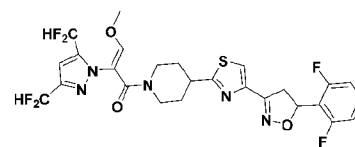
式(I-90)



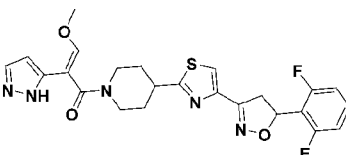
式(I-91)



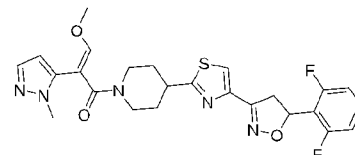
式(I-92)



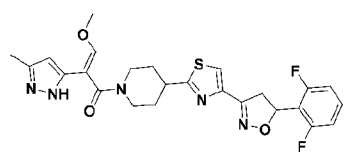
式(I-93)



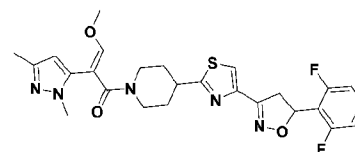
式(I-94)



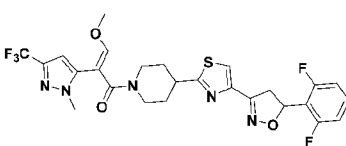
式(I-95)



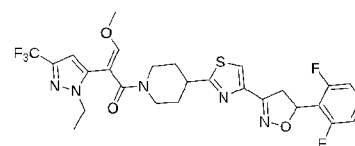
式(I-96)



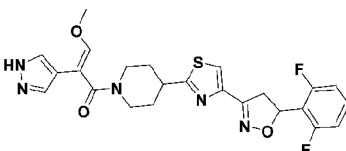
式(I-97)



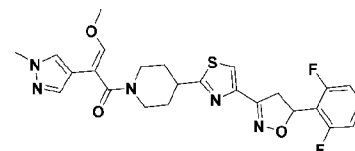
式(I-98)



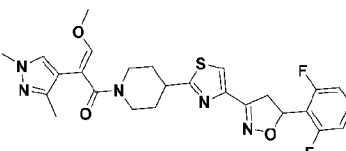
式(I-99)



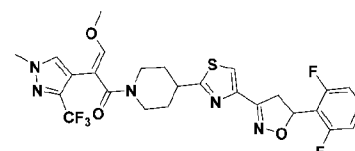
式(I-100)



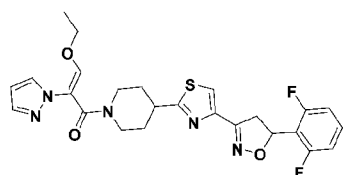
式(I-101)



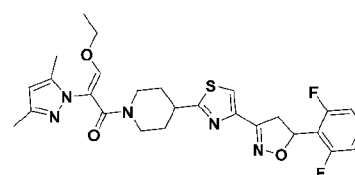
式(I-102)



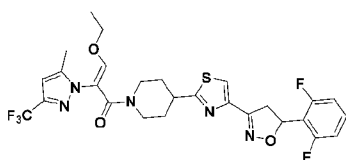
式(I-103)



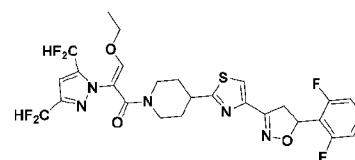
式(I-104)



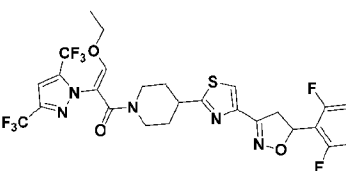
式(I-105)



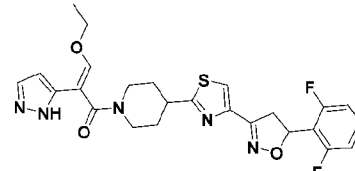
式(I-106)



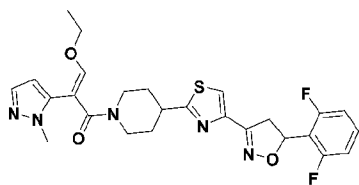
式(I-107)



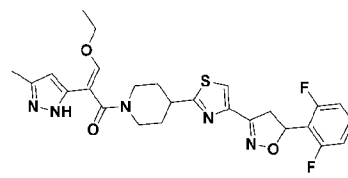
式(I-108)



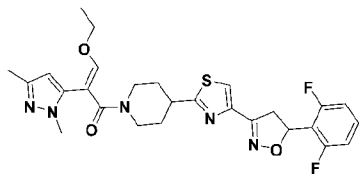
式(I-109)



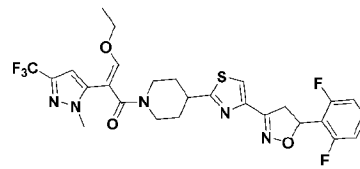
式(I-110)



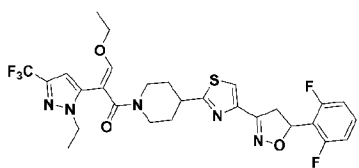
式(I-111)



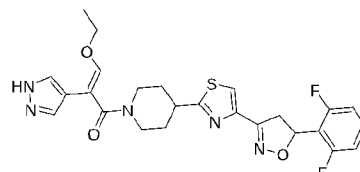
式(I-112)



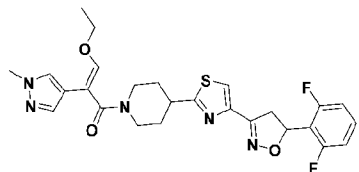
式(I-113)



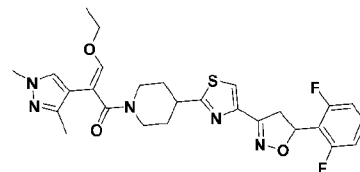
式(I-114)



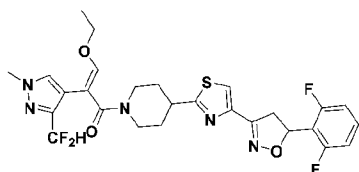
式(I-115)



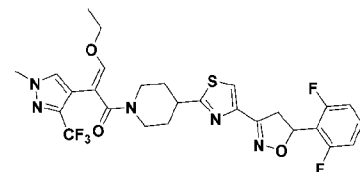
式(I-116)



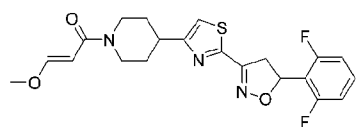
式(I-117)



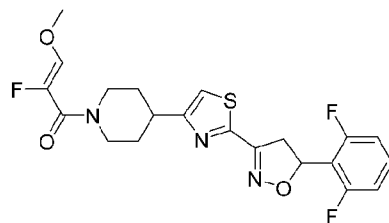
式(I-118)



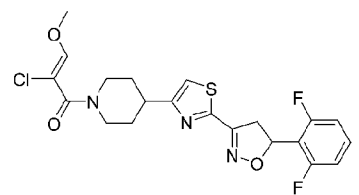
式(I-119)



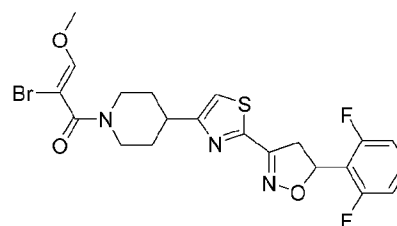
式(I-120)



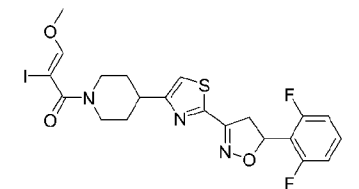
式(I-121)



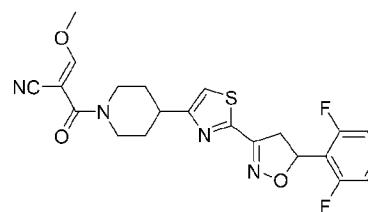
式(I-122)



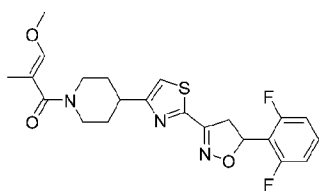
式(I-123)



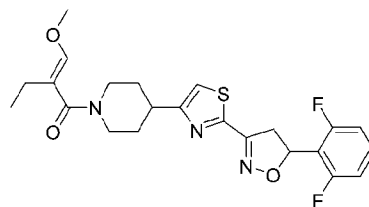
式(I-124)



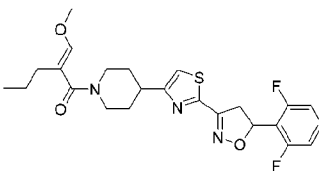
式(I-125)



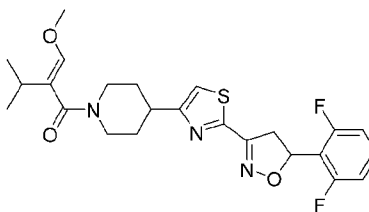
式(I-126)



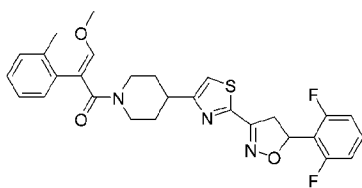
式(I-127)



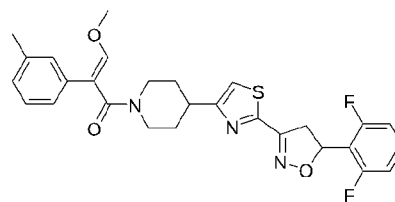
式(I-128)



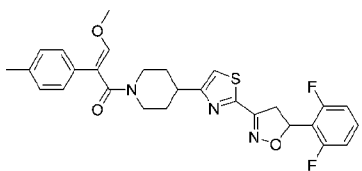
式(I-129)



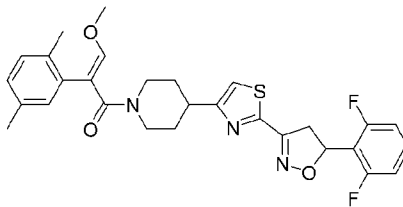
式(I-130)



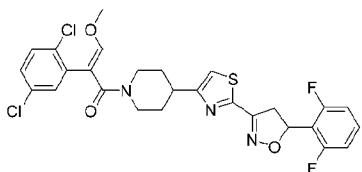
式(I-131)



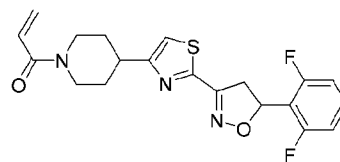
式(I-132)



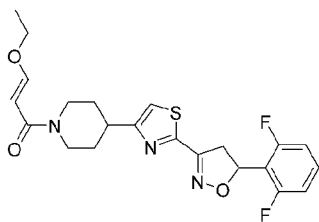
式(I-133)



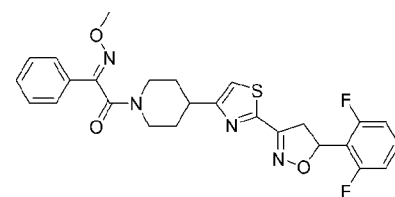
式(I-134)



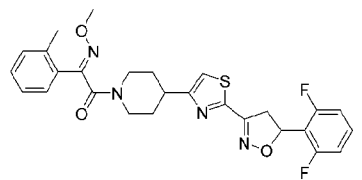
式(I-135)



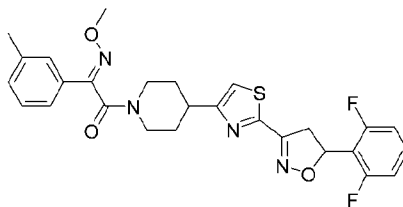
式(I-136)



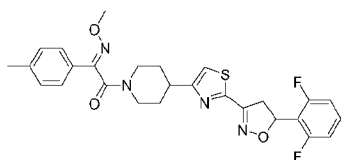
式(I-137)



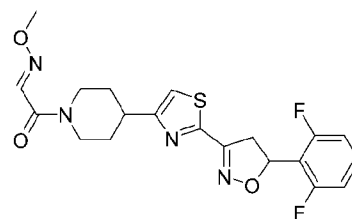
式(I-138)



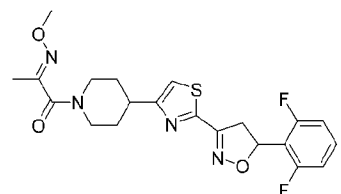
式(I-139)



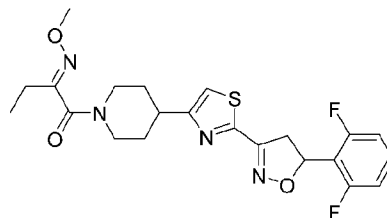
式(I-140)



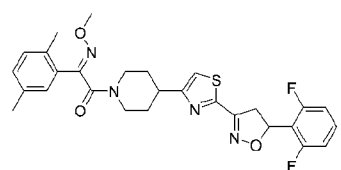
式(I-141)



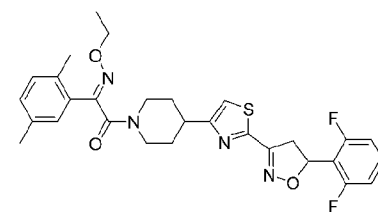
式(I-142)



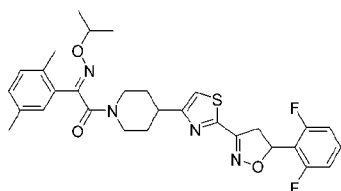
式(I-143)



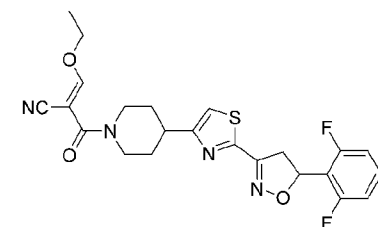
式(I-144)



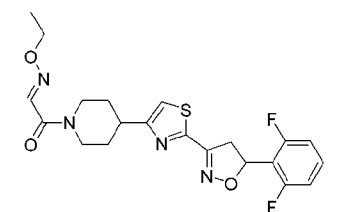
式(I-145)



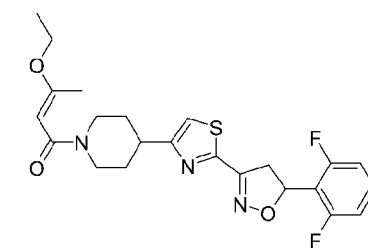
式(I-146)



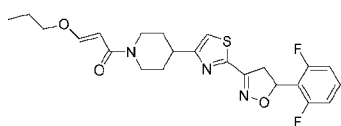
式(I-147)



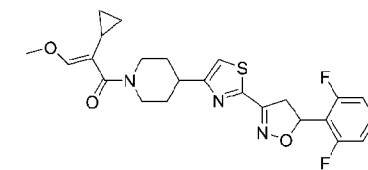
式(I-148)



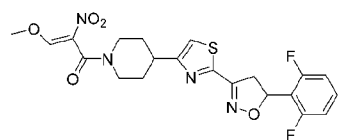
式(I-149)



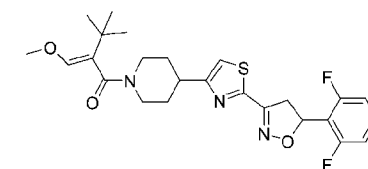
式(I-150)



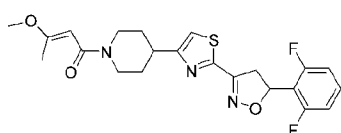
式(I-151)



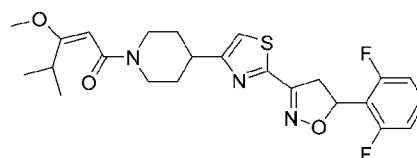
式(I-152)



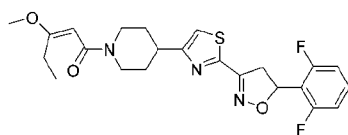
式(I-153)



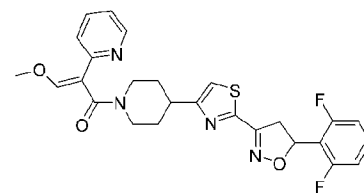
式(I-154)



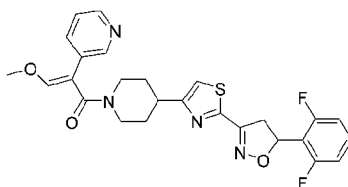
式(I-155)



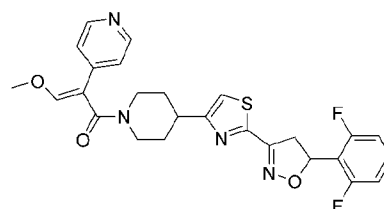
式(I-156)



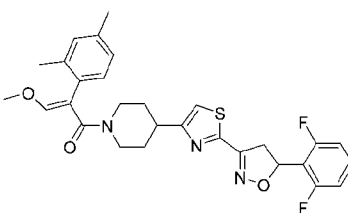
式(I-157)



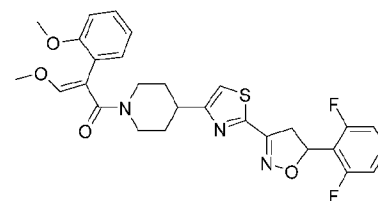
式(I-158)



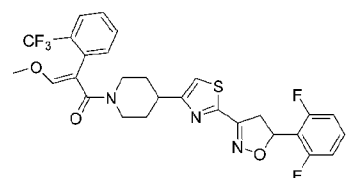
式(I-159)



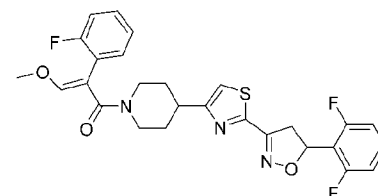
式(I-160)



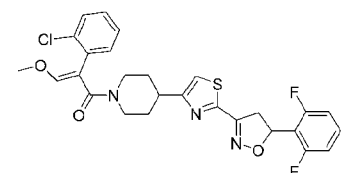
式(I-161)



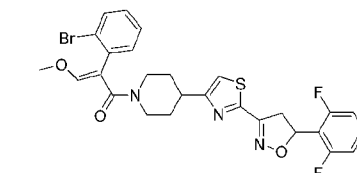
式(I-162)



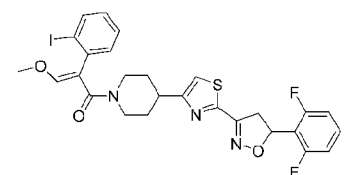
式(I-163)



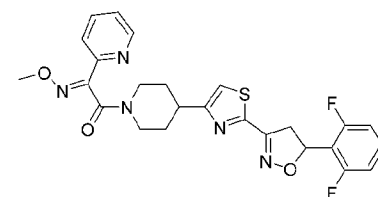
式(I-164)



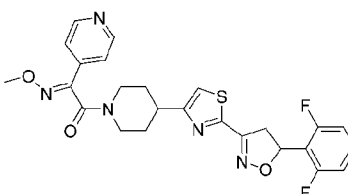
式(I-165)



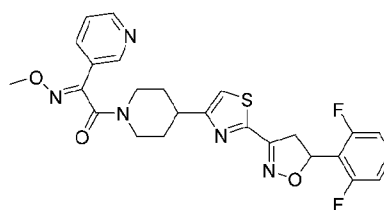
式(I-166)



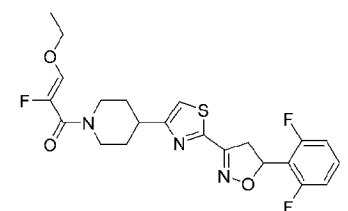
式(I-167)



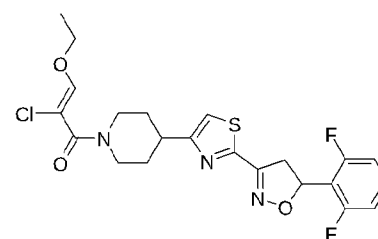
式(I-168)



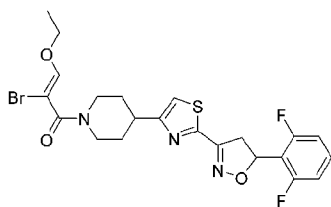
式(I-169)



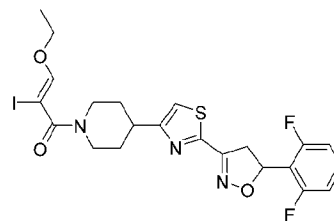
式(I-170)



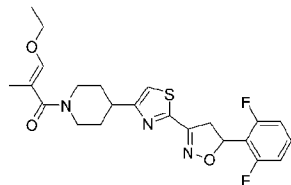
式(I-171)



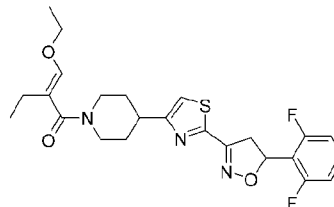
式(I-172)



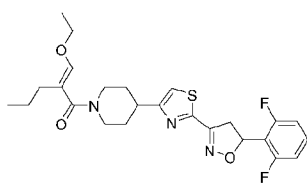
式(I-173)



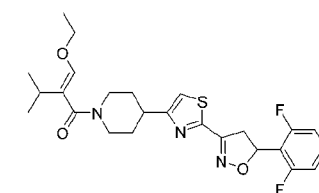
式(I-174)



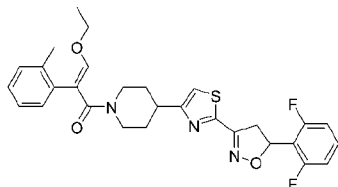
式(I-175)



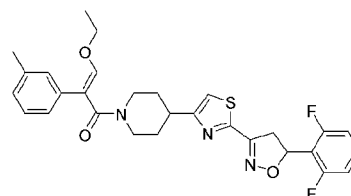
式(I-176)



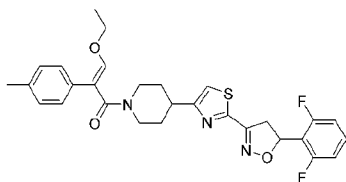
式(I-177)



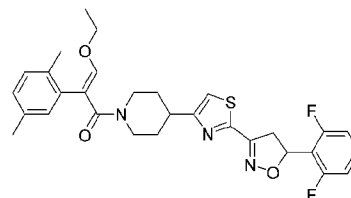
式(I-178)



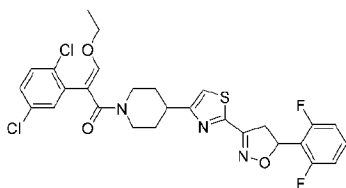
式(I-179)



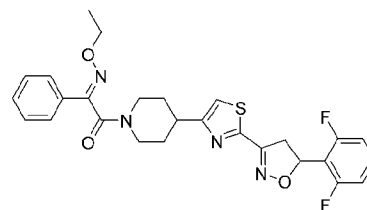
式(I-180)



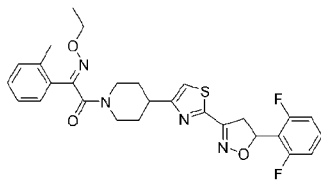
式(I-181)



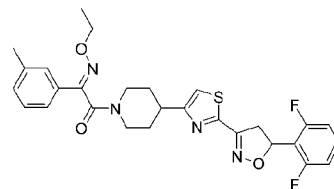
式(I-182)



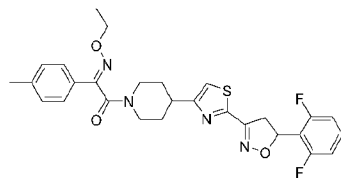
式(I-183)



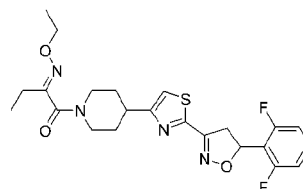
式(I-184)



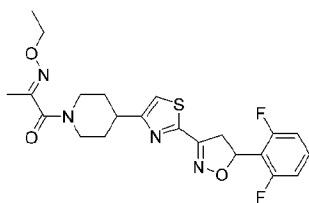
式(I-185)



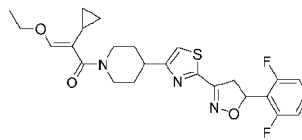
式(I-186)



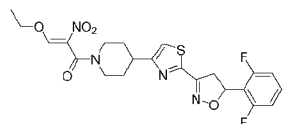
式(I-187)



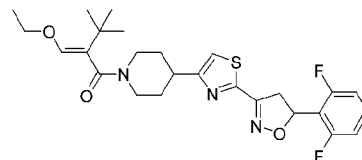
式(I-188)



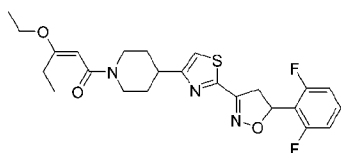
式(I-189)



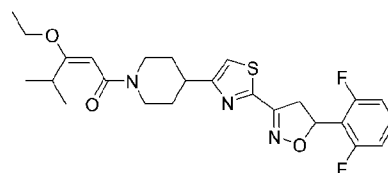
式(I-190)



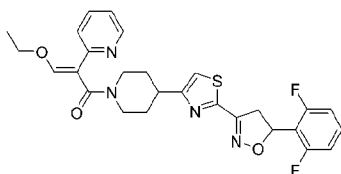
式(I-191)



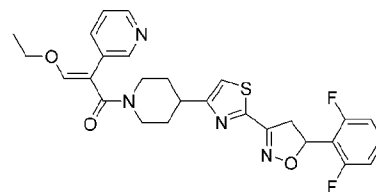
式(I-192)



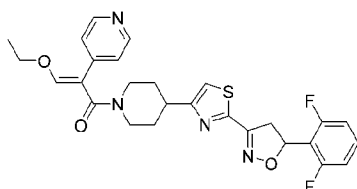
式(I-193)



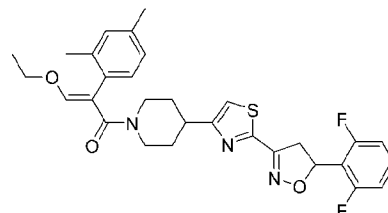
式(I-194)



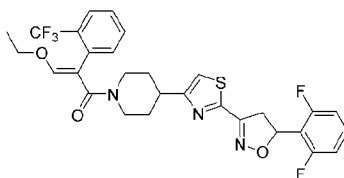
式(I-195)



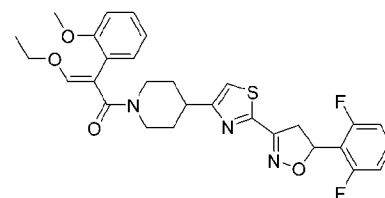
式(I-196)



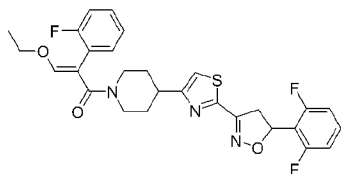
式(I-197)



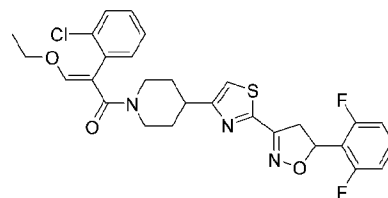
式(I-198)



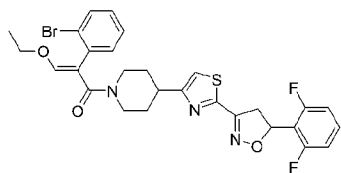
式(I-199)



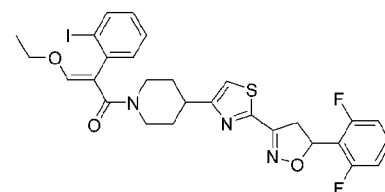
式(I-200)



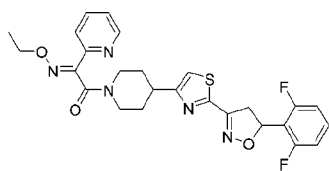
式(I-201)



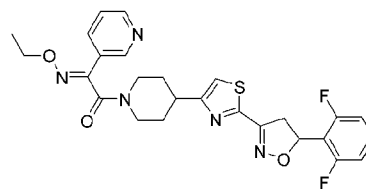
式(I-202)



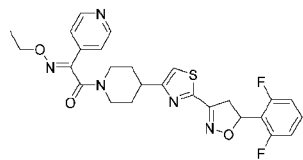
式(I-203)



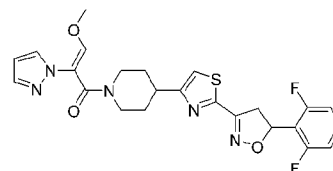
式(I-204)



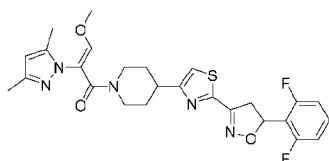
式(I-205)



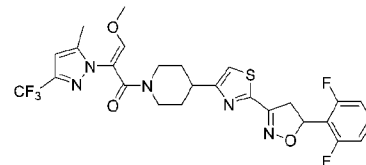
式(I-206)



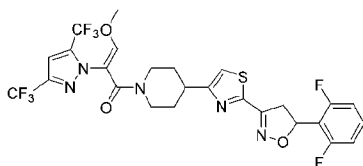
式(I-207)



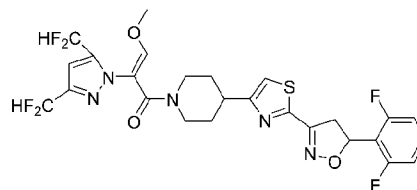
式(I-208)



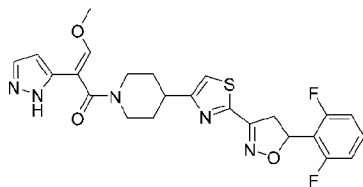
式(I-209)



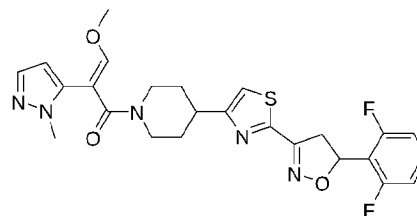
式(I-210)



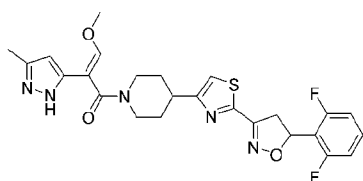
式(I-211)



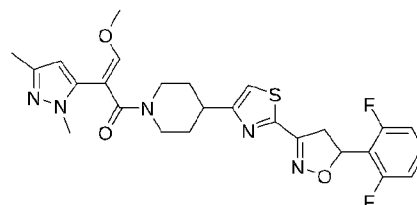
式(I-212)



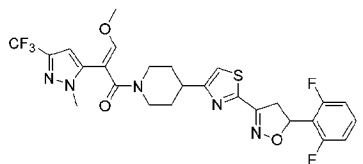
式(I-213)



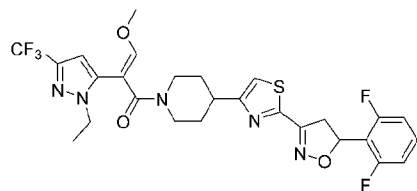
式(I-214)



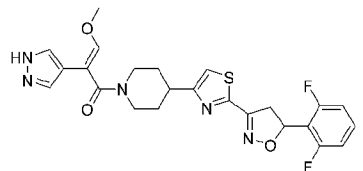
式(I-215)



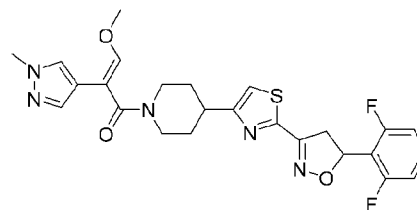
式(I-216)



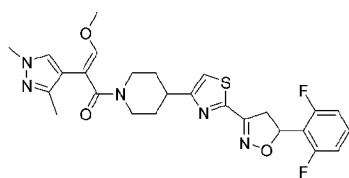
式(I-217)



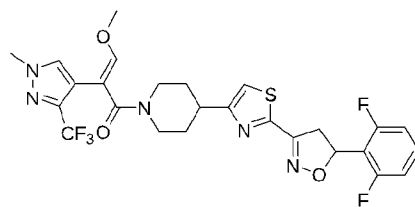
式(I-218)



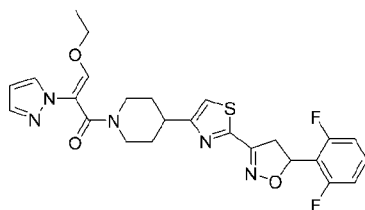
式(I-219)



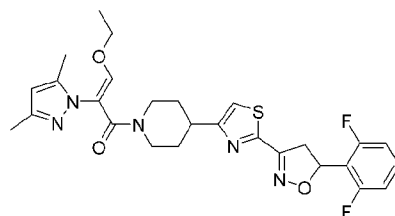
式(I-220)



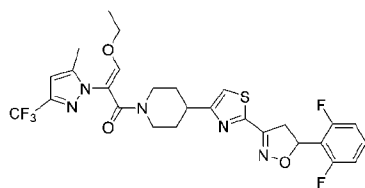
式(I-221)



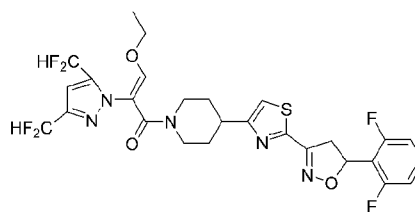
式(I-222)



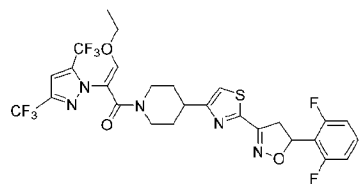
式(I-223)



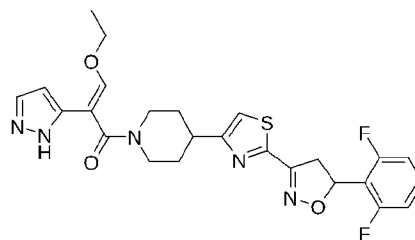
式(I-224)



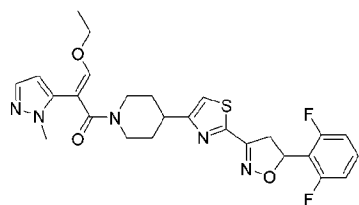
式(I-225)



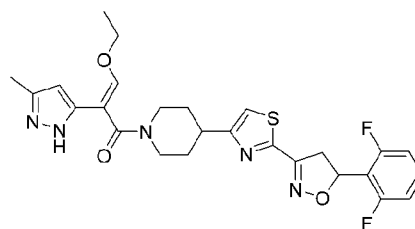
式(I-226)



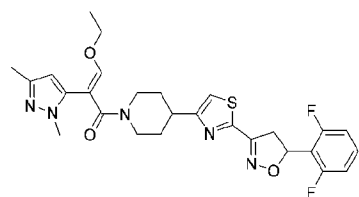
式(I-227)



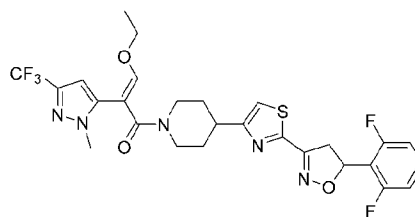
式(I-228)



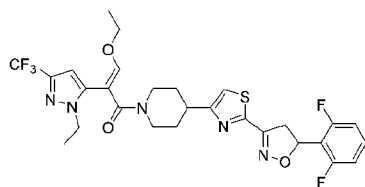
式(I-229)



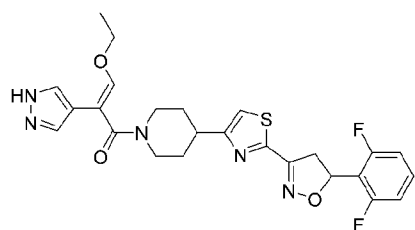
式(I-230)



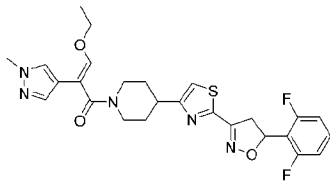
式(I-231)



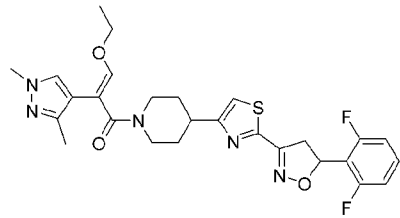
式(I-232)



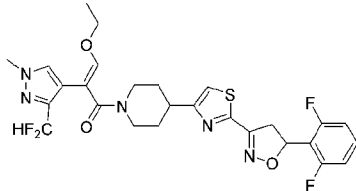
式(I-233)



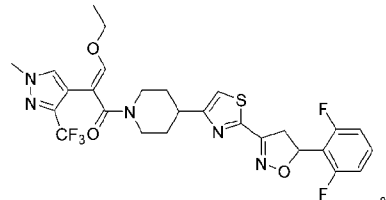
式(I-234)



式(I-235)



式(I-236)



根据一种优选的具体实施方式, 在式(I)中,

X_1 和 X_2 中的一者为 S, 另一者为 CH;

R 为式(Q2)所示的结构; R^1 、 R^2 、 R^3 、 R^4 各自独立地选自 H、 C_1 - C_{12} 的烷基、 C_1 - C_{12} 的烷氧基、 C_3 - C_{12} 的环烷基、 C_1 - C_{12} 的烷硫基、由至少一个卤素取代的 C_1 - C_{12} 的烷氧基、由苯基取代的 C_1 - C_{12} 的烷氧基、卤素、苯基、由组合 A 中的至少一种基团取代的苯基、氰基、硝基、吡啶基、吡唑基、由组合 A 中的至少一种基团取代的吡唑基; 且 R^1 、 R^2 、 R^3 、 R^4 中的至少一者为 C_1 - C_{12} 的烷氧基或 C_1 - C_{12} 的烷硫基, 或者, R^2 和 R^3 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子的 3-7 元饱和杂环基;

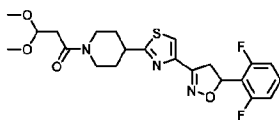
所述组合 A 由 C_1 - C_{12} 的烷基、卤素、由至少一个卤素取代的 C_1 - C_{12} 的烷基、 C_1 - C_{12} 的烷氧基组成。

根据另一种优选的具体实施方式, 在式(I)中, X_1 和 X_2 中的一者为 S, 另一者为 CH;

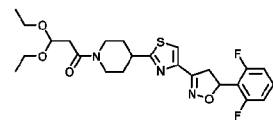
R 为式(Q2)所示的结构; R^1 、 R^2 、 R^3 、 R^4 各自独立地选自 H、 C_1 - C_{10} 的烷基、 C_1 - C_{10} 的烷氧基、 C_3 - C_{10} 的环烷基、 C_1 - C_{10} 的烷硫基、由至少一个卤素取代的 C_1 - C_{10} 的烷氧基、由苯基取代的 C_1 - C_{10} 的烷氧基、卤素、苯基、由组合 A 中的至少一种基团取代的苯基、氰基、硝基、吡啶基、吡唑基、由组合 A 中的至少一种基团取代的吡唑基; 且 R^1 、 R^2 、 R^3 、 R^4 中的至少一者为 C_1 - C_{10} 的烷氧基或 C_1 - C_{10} 的烷硫基, 或者, R^2 和 R^3 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子的 3-7 元饱和杂环基; 所述组合 A 由 C_1 - C_{10} 的烷基、卤素、由至少一个卤素取代的 C_1 - C_{10} 的烷基、 C_1 - C_{10} 的烷氧基组成。

根据另一种特别优选的具体实施方式, 式(I)所示结构的化合物选自以下中的任意一种:

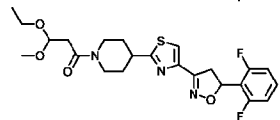
式(II-1)



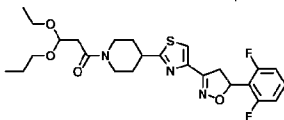
式(II-2)



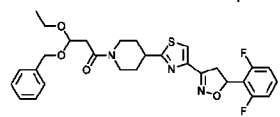
式(II-3)



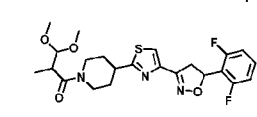
式(II-4)



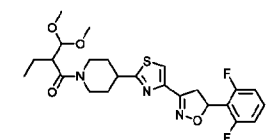
式(II-5)



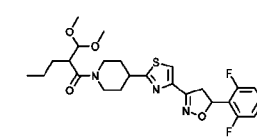
式(II-6)



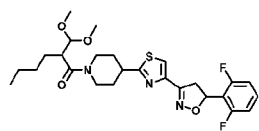
式(II-7)



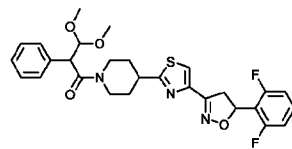
式(II-8)



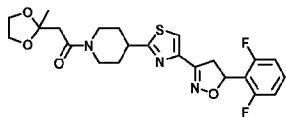
式(II-9)



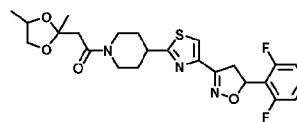
式(II-10)



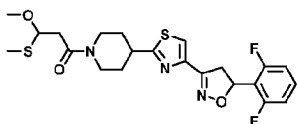
式(II-11)



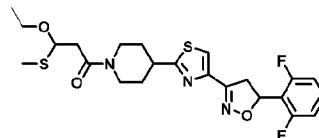
式(II-12)



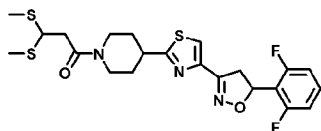
式(II-13)



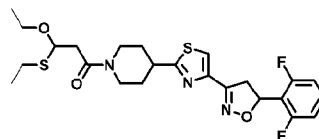
式(II-14)



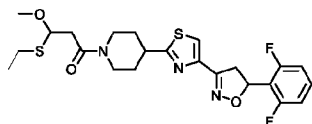
式(II-15)



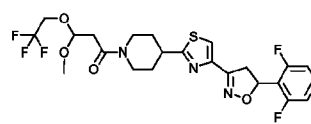
式(II-16)



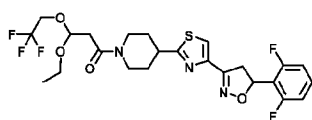
式(II-17)



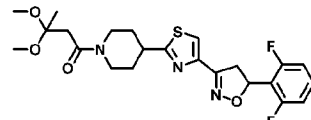
式(II-18)



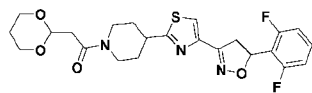
式(II-19)



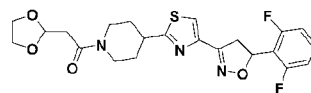
式(II-20)



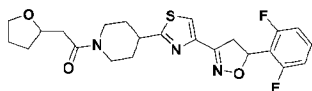
式(II-21)



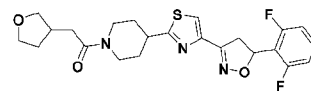
式(II-22)



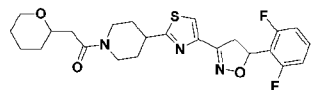
式(II-23)



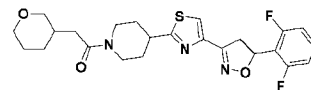
式(II-24)



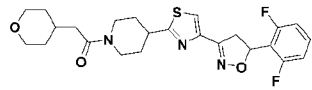
式(II-25)



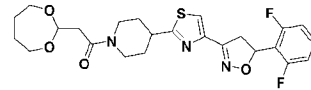
式(II-26)



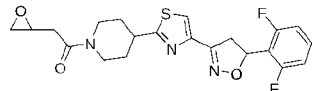
式(II-27)



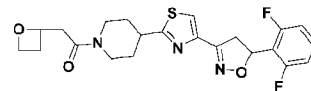
式(II-28)



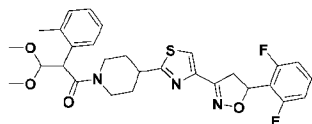
式(II-29)



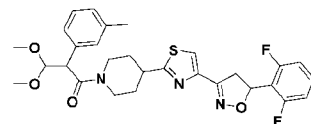
式(II-30)



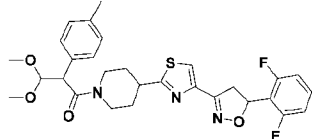
式(II-31)



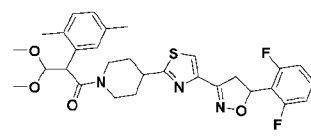
式(II-32)



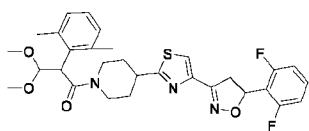
式(II-33)



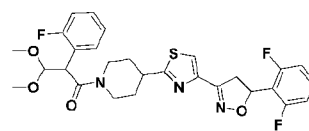
式(II-34)



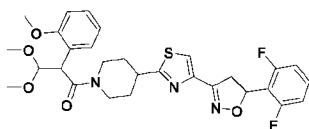
式(II-35)



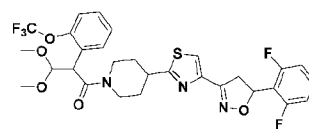
式(II-36)



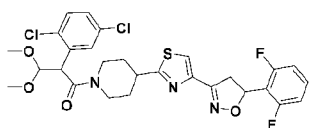
式(II-37)



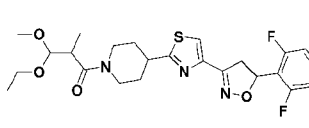
式(II-38)



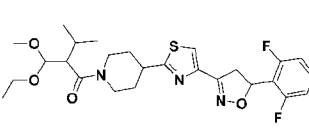
式(II-39)



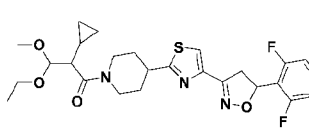
式(II-40)



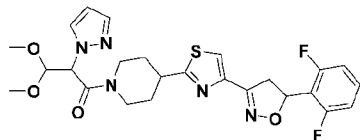
式(II-41)



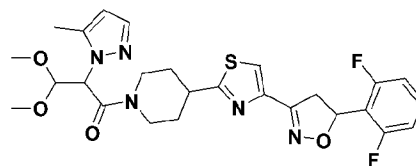
式(II-42)



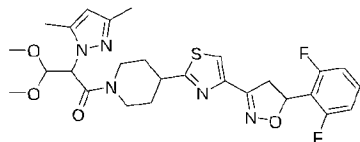
式(II-43)



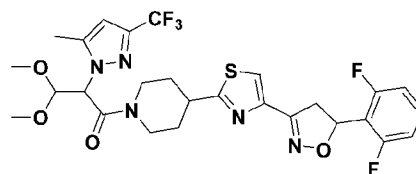
式(II-44)



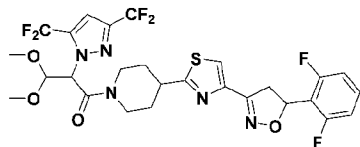
式(II-45)



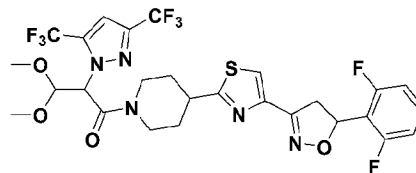
式(II-46)



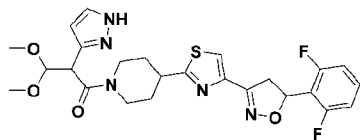
式(II-47)



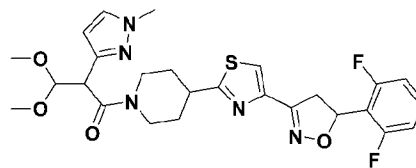
式(II-48)



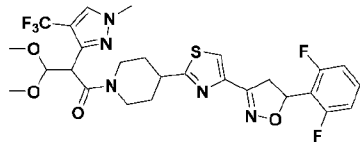
式(II-49)



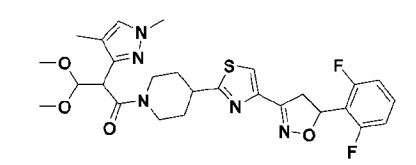
式(II-50)



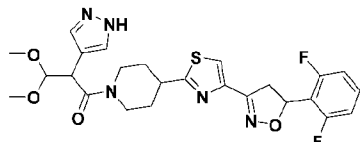
式(II-51)



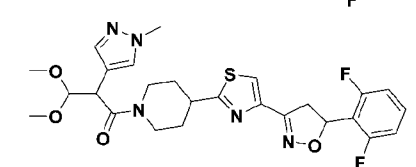
式(II-52)



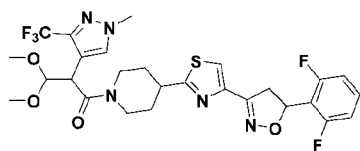
式(II-53)



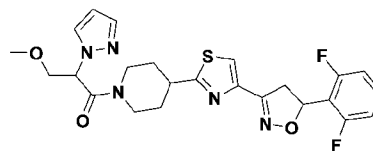
式(II-54)



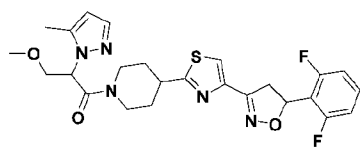
式(II-55)



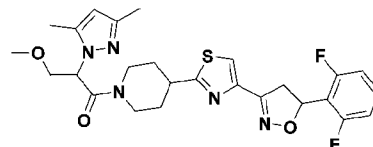
式(II-56)



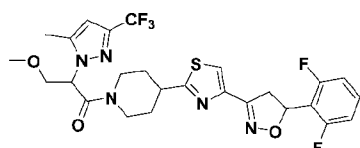
式(II-57)



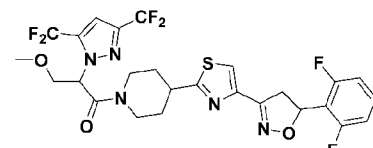
式(II-58)



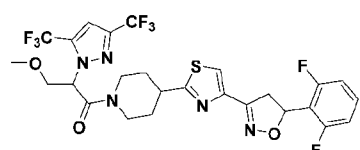
式(II-59)



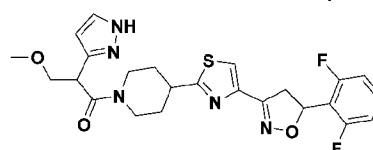
式(II-60)



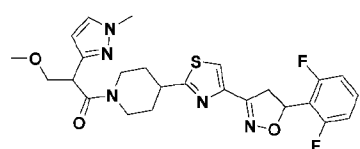
式(II-61)



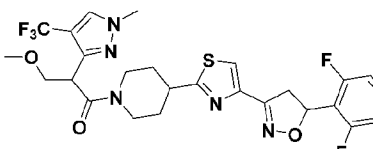
式(II-62)



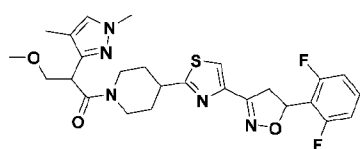
式(II-63)



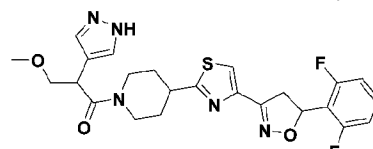
式(II-64)



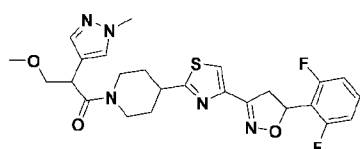
式(II-65)



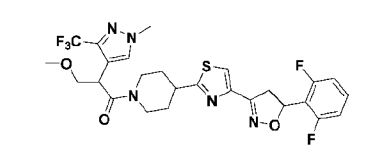
式(II-66)



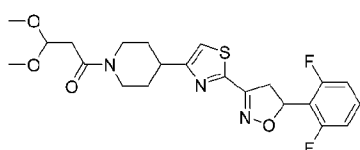
式(II-67)



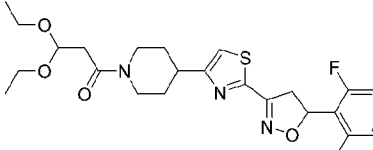
式(II-68)



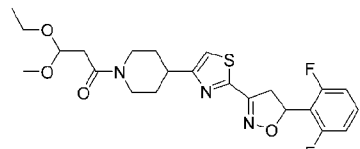
式(II-69)



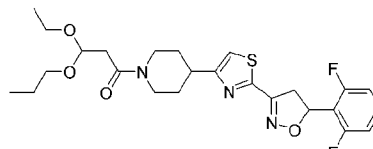
式(II-70)



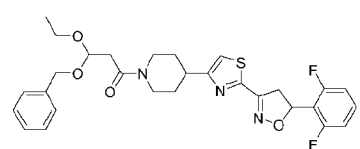
式(II-71)



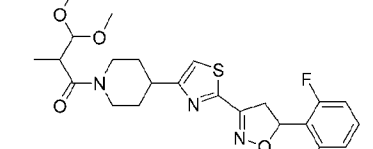
式(II-72)



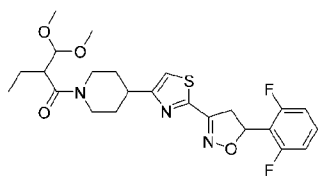
式(II-73)



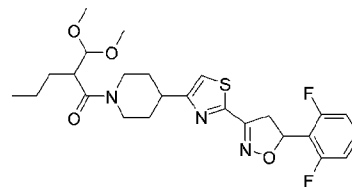
式(II-74)



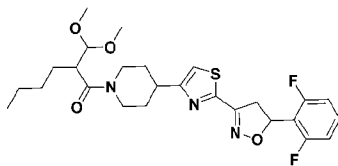
式(II-75)



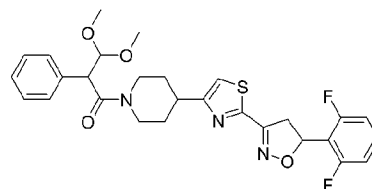
式(II-76)



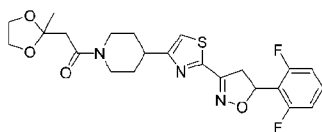
式(II-77)



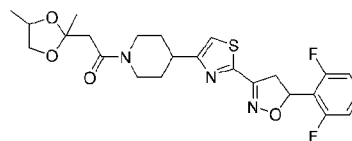
式(II-78)



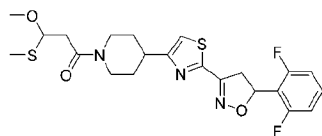
式(II-79)



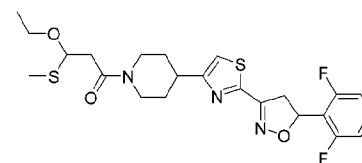
式(II-80)



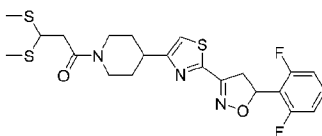
式(II-81)



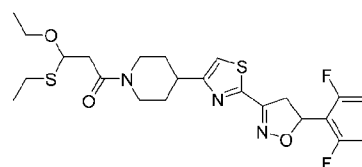
式(II-82)



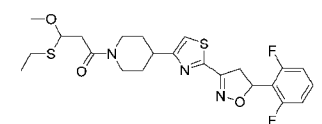
式(II-83)



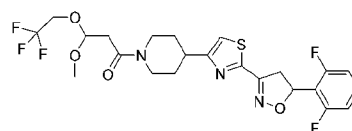
式(II-84)



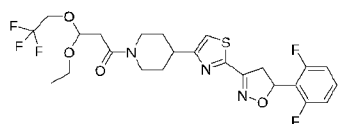
式(II-85)



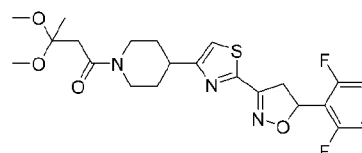
式(II-86)



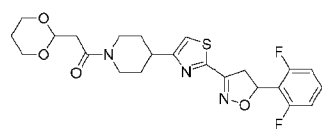
式(II-87)



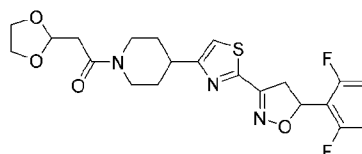
式(II-88)



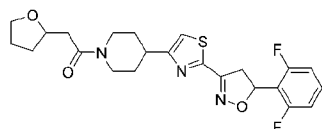
式(II-89)



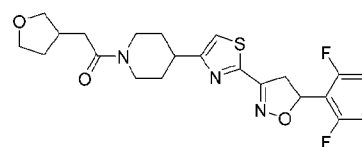
式(II-90)



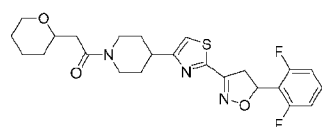
式(II-91)



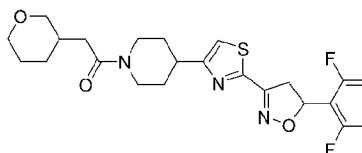
式(II-92)



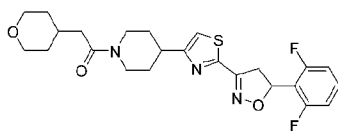
式(II-93)



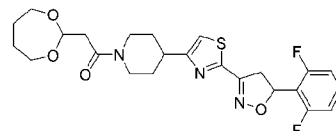
式(II-94)



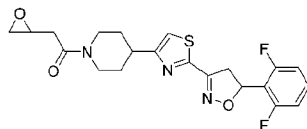
式(II-95)



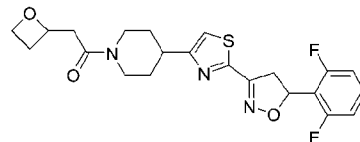
式(II-96)



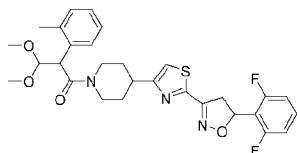
式(II-97)



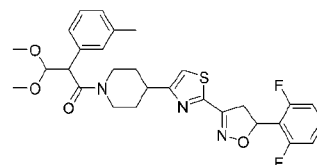
式(II-98)



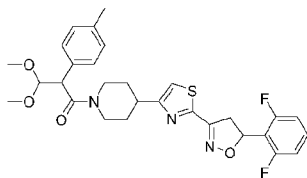
式(II-99)



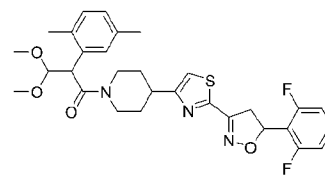
式(II-100)



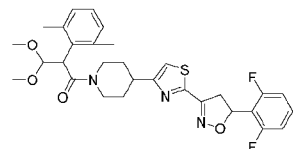
式(II-101)



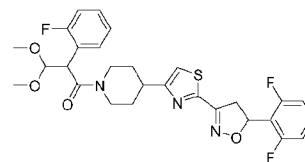
式(II-102)



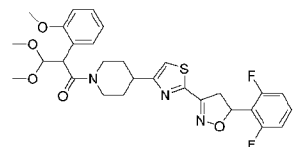
式(II-103)



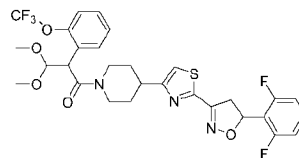
式(II-104)



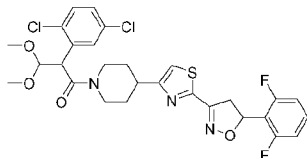
式(II-105)



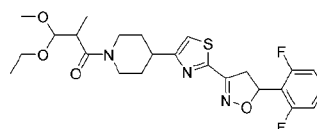
式(II-106)



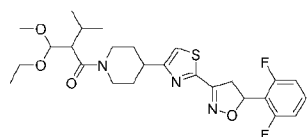
式(II-107)



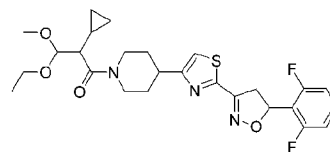
式(II-108)



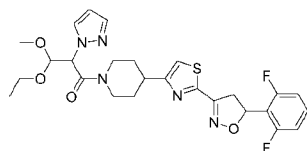
式(II-109)



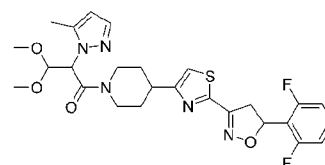
式(II-110)



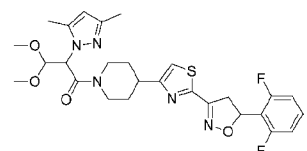
式(II-111)



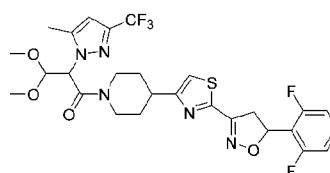
式(II-112)



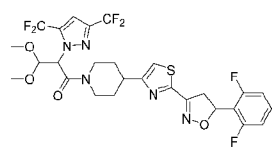
式(II-113)



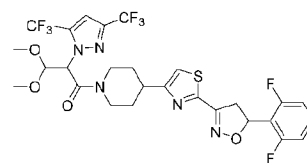
式(II-114)



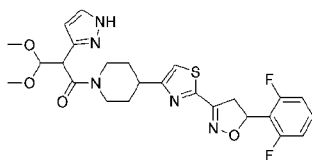
式(II-115)



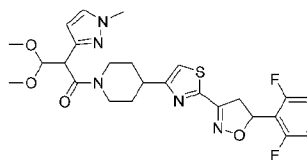
式(II-116)



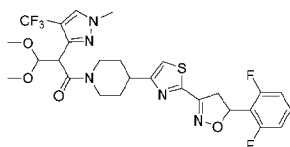
式(II-117)



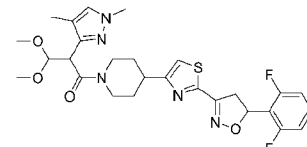
式(II-118)



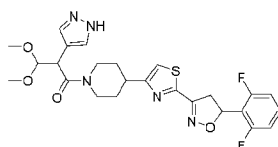
式(II-119)



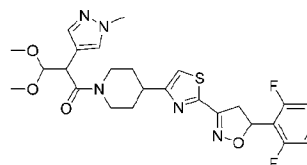
式(II-120)



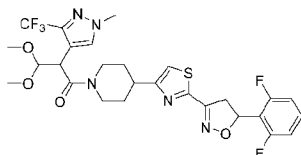
式(II-121)



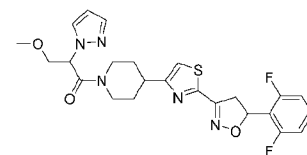
式(II-122)



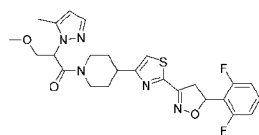
式(II-123)



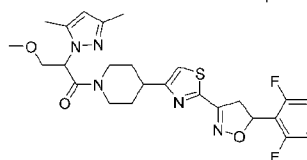
式(II-124)



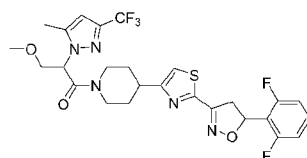
式(II-125)



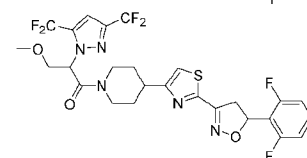
式(II-126)



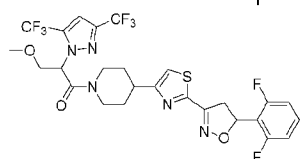
式(II-127)



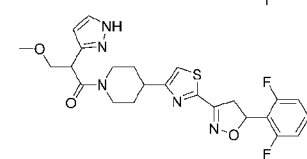
式(II-128)



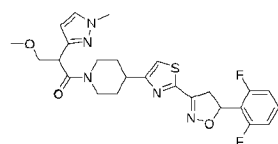
式(II-129)



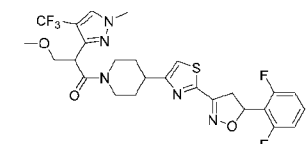
式(II-130)



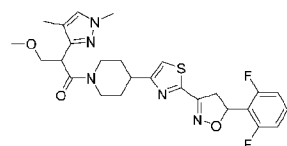
式(II-131)



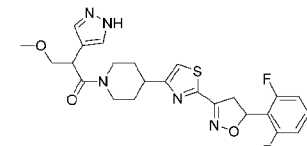
式(II-132)



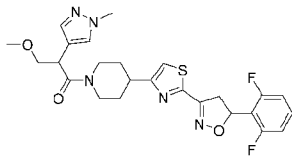
式(II-133)



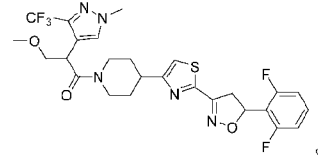
式(II-134)



式(II-135)



式(II-136)



本发明中对所述式(I)所示的化合物的立体结构没有特别限制,所述式(I)所示的化合物可以以不同的立体异构体或光学异构体或互变异构的形式存在,本发明包含所有立体异构体或光学异构体或互变异构及其各种比例的混合物。

本发明公开化合物的任何不对称原子(例如,碳等)均可以以外消旋或对映体富集的形式存在,例如(R)-、(S)-或(R,S)-构型形式存在。

本发明对制备所述含链状羧酸酰胺结构的化合物的方法没有特别的限制,本领域技术人员可以通过结构式的特征,结合有机合成领域内的已知方法制备获得,但是,为了更高收率地获得本发明所述的含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物,本发明提供如下第二方面所述的方法制备含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物;该方法包括:

在缩合反应条件下,将式(II)所示的化合物与式(III)所示的化合物进行接触反应,

且式(II)所示的化合物与式(III)所示的化合物中的取代基的定义与第一方面中所述的定义相同。

优选地,所述缩合反应在碱性试剂的存在且无水环境下进行。

优选情况下,所述碱性试剂为三乙胺、N,N-二异丙基乙胺、4-二甲氨基吡啶中的至少一种。

本发明的所述缩合反应在碱性条件下进行。

优选地,所述接触反应在溶剂存在下进行,所述溶剂优选选自二氯甲烷、四氢呋喃、N,N-二甲基甲酰胺、乙腈和丙酮中的至少一种。

优选地,所述接触反应的条件包括:反应温度为-5℃至60℃,反应时间为1~48h。

在本发明中,所述式(II)所示的化合物与式(III)所示的化合物可以来自商购,也可以根据结构式而采用现有技术的方法合成得到。本发明在实施例中示例性地提供了制备式(II)所示的化合物的方法,本领域技术人员不应理解为本发明的限制。

优选地,在本发明的第二方面中,式(II)所示的化合物与式(III)所示的化合物的用量摩尔比为1:(1~3);更优选为1:(1.1~2.2)。

在本发明的第二方面中,还可以对接触反应后获得的产物进行本领域内常规应用的后处理方法进行后处理以获得纯度更高的产物,例如,所述后处理操作方法包括:萃取、洗涤、旋转蒸发、柱层析、重结晶等,本发明对此没有特别的限制,只要能够获得本发明前述含链状羧酸酰胺结构的化合物即可。

如前所述,本发明的第三方面提供了第一方面中所述的含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物在防治植物卵菌病害中的应用。

优选地,所述植物卵菌病害选自黄瓜霜霉病、马铃薯晚疫病、辣椒疫霉病中的至少一种。

如前所述,本发明的第四方面提供了前述第一方面所述的含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物作为农用杀菌剂的应用。

如前所述,本发明的第五方面提供了一种杀菌剂,该杀菌剂由活性成分和辅料组成,所述活性成分包括前述第一方面所述的含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物中的至少一种。

优选地,所述活性成分的含量为1-99.9重量%;更优选所述活性成分的含量为5-95重量%。

优选地,所述杀菌剂的剂型选自乳油、悬浮剂、可湿性粉剂、粉剂、粒剂、水剂、毒饵、母液和母粉中的至少一种。

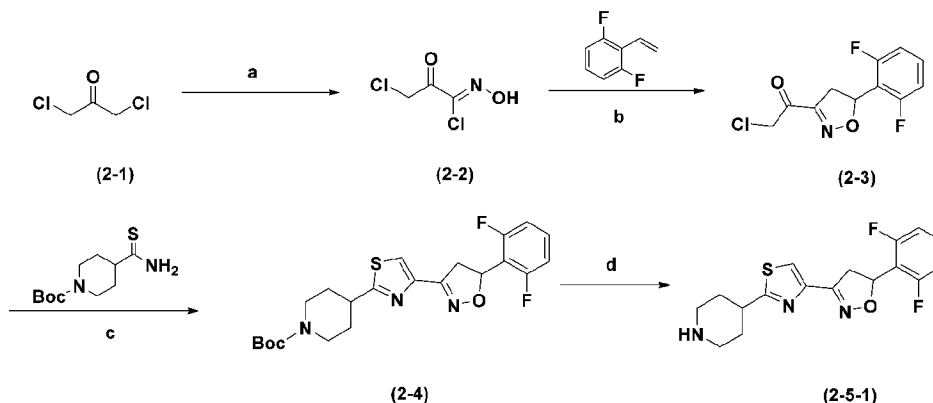
在本发明中，所述辅料可以为本领域内常规使用的各种辅料，例如可以为表面活性剂、溶剂等。

以下将通过实例对本发明进行详细描述。

以下实例中，在没有特别说明的情况下，使用的各种原料均来自商购，纯度为化学纯。

以下室温均表示 $25 \pm 1^\circ\text{C}$ 。

实施例 1



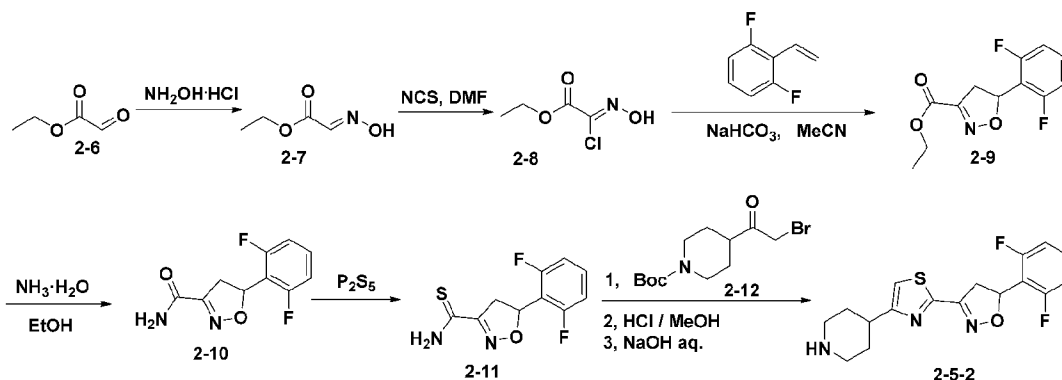
式 (2-2) 的合成: 25°C 下, 取式 (2-1) 所示化合物 (790.12 mmol) 置于 1 L 两颈烧瓶中, 加入 400 mL 的 2 M 的盐酸乙醚溶液中, 向反应瓶中缓慢滴加亚硝酸特丁酯 (534.62 mmol), 反应 3 小时。反应完毕将反应混合物减压浓缩成半固体, 用 1-氯丁烷洗涤, 抽滤得到白色晶状固体, 将滤液浓缩, 重复以上过程 2 次, 合并滤出的固体, 共计 81.10 g。直接用于下一步反应。

式 (2-3) 的合成: 向一个 500 mL 的梨型瓶中, 依次加入磁子, 式 (2-2) 所示化合物 (193.48 mmol), 250 mL 乙腈, 碳酸氢钠 (1.14 mol), 开启搅拌, 用恒压滴液漏斗缓慢滴加 2,6-二氟苯乙烯 (193.51 mmol)。反应 30 分钟, TLC 监测反应完全。将体系抽滤, 滤饼用乙腈洗涤三次, 合并滤液, 减压浓缩, 得到浅黄色粘稠液体。放置一夜后有固体析出, 抽滤, 将滤饼用 $V_{\text{石油醚}}:V_{\text{乙酸乙酯}} = 10:1$ 的溶液洗涤, 减压除去溶剂, 得到浅黄色固体, 滤液再次浓缩, 有固体析出, 重复上步操作两次, 合并所得固体, 得式 (2-3) 所示化合物 54.39 g, 质谱结果显示分子离子峰 259.30。核磁氢谱数据如下: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.47–7.25 (m, 1H), 6.88 (t, $J = 8.0$ Hz, 2H), 6.20–6.08 (m, 1H), 4.67 (s, 2H), 3.60–3.52 (m, 1H), 3.33 (dd, $J = 17.2, 8.0$ Hz, 1H)。

式 (2-4) 的合成: 向 250 mL 的梨型瓶中, 依次加入磁子, 式 (2-3) 所示化合物 (38.51 mmol), 100 mL 无水甲醇, 搅拌下加入 4-氨基硫代羰基四氢吡啶-1(2H)-甲酸叔丁酯 (38.02 mmol), 升温至回流, 约 4 小时反应完毕。减压浓缩除去大部分甲醇, 加入 100 mL 水, 用乙酸乙酯进行萃取, 分液, 有机相用无水硫酸钠干燥, 过滤, 滤液浓缩, 经硅胶柱层析纯化得式 (2-4) 所示化合物, 收率为 89%。核磁氢谱数据如下: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.71 (s, 1H), 7.29–7.25 (m, 1H), 6.96 (t, $J = 8.0$ Hz, 2H), 6.03 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.21 (s, 2H), 3.77 (dd, $J = 17.6, 12.0$ Hz, 1H), 3.60 (dd, $J = 17.6, 9.2$ Hz, 1H), 3.19 (tt, $J = 12.0, 4.0$ Hz, 1H), 2.86 (t, $J = 10.4$ Hz, 2H), 2.09 (d, $J = 12.8$ Hz, 2H), 1.70 (qd, $J = 12.8, 4.8$ Hz, 2H), 1.39 (s, 9H)。

式 (2-5-1) 的合成: 向式 (2-4) 所示化合物 (40.0 mmol) 中加入 80 mL 甲醇, 使其完全溶, 再加入 45 mL 盐酸/甲醇 (4 M) 溶液中, 升温至 50°C , 反应 4h, 反应完毕, 减压浓缩除去溶剂, 此时产物以盐酸盐的形式存在, 加入 2M 氢氧化钠溶液中和, 使体系呈碱性, 用乙酸乙酯多次萃取, 有机相干燥, 浓缩得黄褐色油状粗品, 硅胶柱层析得到浅棕色固体, 收率为 95%。核磁氢谱数据如下: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.39 (s, 1H), 8.01 (s, 1H), 7.48–7.39 (m, 1H), 7.20 (t, $J = 8.4$ Hz, 2H), 5.98 (dd, $J = 12.0, 9.2$ Hz, 1H), 3.87 (dd, $J = 17.6, 12.0$ Hz, 1H), 3.61–3.49 (m, 1H), 3.41–3.37 (m, 3H), 3.02 (t, $J = 12.0$ Hz, 2H), 2.19 (d, $J = 14.0$ Hz, 2H), 1.88 (q, $J = 12.4$ Hz, 2H)。

实施例 2



式(2-7)的合成: 将乙醛酸乙酯(50%的甲苯溶液, 369 mmol)和盐酸羟胺 (369 mmol)溶于 $\text{CH}_3\text{CN}:\text{H}_2\text{O}(9:1, 300 \text{ mL})$ 中, 在室温下搅拌 5 分钟, 然后滴加 Et_3N (51.7 mL, 369 mmol)。反应在室温下进行 1 小时, 然后减压浓缩。将残渣溶于 H_2O (50 mL)和 Et_2O (300 mL)中。有机层用饱和 NH_4Cl (50 mL)洗涤, 用 Na_2SO_4 干燥, 过滤, 浓缩。得无色晶状物收率为 97%。

式(2-8)的合成: 在 5°C 条件下, 将(2)-(羟基亚胺)乙酸乙酯(123.2 mmol)加入到 DMF 溶液中。反应混合物在室温下搅拌 12 小时, 加入水 (200 mL), 用乙酸乙酯($2\times 150 \text{ mL}$)萃取。分离有机层, 用无水硫酸钠干燥, 减压浓缩得到粗产物, 收率为 74%。

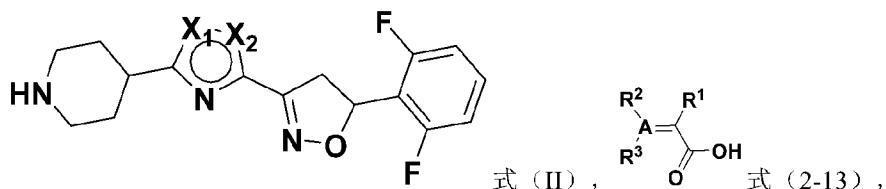
式(2-9)的合成: 向 500 mL 的梨型瓶中, 依次加入磁子, 式(2-8)所示化合物 (1.52 g), 250 mL 乙腈, 碳酸氢钠 (5.04 g), 开启搅拌, 用恒压滴液漏斗缓慢滴加 2,6-二氟苯乙烯 (1.4 g)。反应 30 分钟, TLC 监测反应完全。将体系抽滤, 滤饼用乙腈洗涤三次, 合并滤液, 减压浓缩, 得到浅黄色粘稠液体。放置一夜后有固体析出, 抽滤, 将滤饼用 $V_{\text{石油醚}}:V_{\text{乙酸乙酯}} = 10:1$ 的溶液洗涤, 减压除去溶剂, 得到浅黄色固体, 滤液再次浓缩, 有固体析出, 重复上步操作两次, 合并所得固体, 得式(2-9)所示化合物。

式(2-10)的合成: 将式(2-9)所示化合物置于封管中, 用乙醇溶解, 加入一水合氨(5 eq.)。室温反应 24 小时, 反应完毕, 有固体析出, 抽滤, 将滤饼用 $V_{\text{石油醚}}:V_{\text{乙酸乙酯}} = 10:1$ 的溶液洗涤, 收集滤饼, 干燥得白色固体。

式(2-11)的合成: 将式(2-10)所示化合物(1.8 g)溶于无水四氢呋喃中, 加入五硫化二磷(3.55g), 50°C 反应 6 小时。然后加入乙酸乙酯和 1N 盐酸, 将得到的悬浮液过滤。用水和乙酸乙酯洗涤残渣, 得到式(2-11)所示化合物。

式(2-5-2)的合成: 将式 2-11 所示化合物(1.69 g), 溶于甲醇中, 加入式(2-12)所示化合物 (2.14 g), 回流 6 小时。反应完毕冷至室温, 加入浓盐酸 3 mL, TLC 监测至反应完全。向体系中加入 2M 氢氧化钠溶液, 将体系调 pH 至 10, 用二氯甲烷萃取, 无水硫酸钠干燥, 浓缩, 得黄褐色油状物式(2-5-2)。

实施例 3: 制备式 (I) 所示的化合物



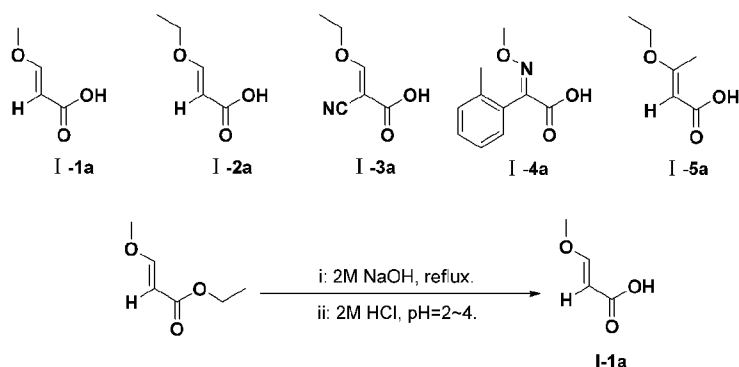
本实施例用于说明式 (I-1) ~式 (I-236)所示目标化合物的合成方法。

具体地, 以式 (I-1) 所示化合物的制备为例:

室温条件下,向 100 mL 的茄形瓶中,加入反-3-甲氧基丙烯酸(1.4 mmol, 1.4 eq.),用 20 mL 二氯甲烷溶解,依次加入 EDCI (2.1 mmol, 2.1 eq.), HOBt (2.10 mmol, 2.1 eq.), TEA (0.42 mL, 3.0 mmol, 3.0 eq.), 搅拌活化 60 min, 再向体系中加入式(2-5-1)所示化合物(1.0 mmol, 1.0 eq.)。继续反应 6 h, 反应完毕加水, 二氯甲烷萃取 2 次, 有机相干燥, 浓缩拌样, 柱层析纯化(V 石油醚:V 乙酸乙酯=2:1), 得到目标化合物式(I-1)。白色固体, 收率 78%。

实施例 4

酸中间体 I-1a~I-5a 的合成路线和方法

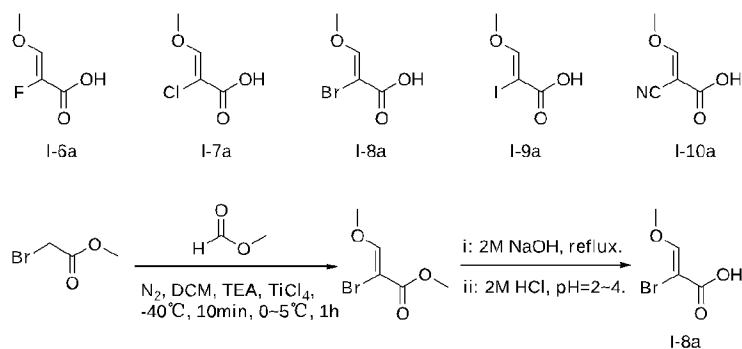


针对部分酸对应酯的片段, 直接进行酯水解即可得到相关酸中间体。

以式(I-1a)所示化合物的合成方法为例: 取 50 mL 茄形瓶, 加入反-3-甲氧基丙烯酸甲酯(10.0 mmol, 1 eq.), 再加入 10 mL 氢氧化钠溶液(20.0 mmol, 2.0 eq.), 反应温度升至 80℃, 反应过夜, TLC 监测水解完全, 停止加热。温度降至室温后, 使用 2 mol/L 盐酸调至酸性, 有白色固体析出, 抽滤, 少量水洗滤饼 2 次, 收集滤饼, 干燥得酸纯品, 白色固体, 收率 56.8%。

实施例 5

酸中间体 I-6a~I-10a 的合成路线和方法

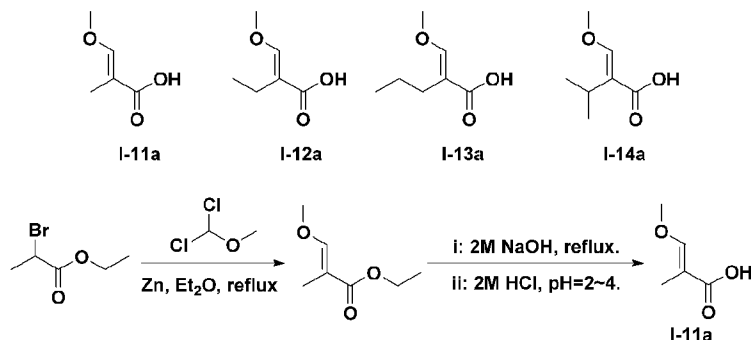


对丙烯酸 2 号位为吸电子取代基修饰的酸片段, 采用上述合成路线, 先得到相应酯, 再水解得到酸片段。

以化合物 I-8a 的制备为例: 取 100 mL 三颈烧瓶, N₂ 氛围下, 加入 20 mL 超干二氯甲烷, 称取溴乙酸甲酯(10.0 mmol, 1.0 eq.), 甲酸甲酯(30.0 mmol, 3.0 eq.) 溶于其中, 放入低温反应器中降温至 -40℃, 向体系中加入三乙胺(24.0 mmol, 2.4 eq.), 待温度重新降至 -40℃ 后, 向反应体系中缓慢滴加 TiCl₄(15 mL, 1mol/L 于 DCM 中, 15.0 mmol, 1.5 eq.), 滴加完毕后, 继续反应 10 min, 升温至 5℃ 继续反应 1 h, 反应完毕, 将反应混合物倒入冰水中, 二氯甲烷萃取两遍, 有机相干燥, 浓缩拌样, 柱层析纯化(V 石油醚:V 乙酸乙酯=20:1), 得黄色油状化合物, 收率 76.7%。水解酸化得相应酸 I-8a。

实施例 6

酸中间体 I-11a~I-14a 的合成路线和方法

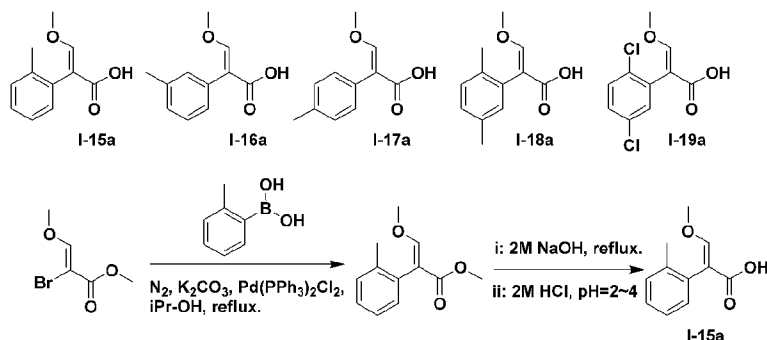


对丙烯酸 2 号位为甲基等给电子取代基修饰的酸片段，采用上述的合成路线，先得到相应酯，再水解得到酸片段。

以化合物 I-11a 的制备为例：准备 50 mL 茄形瓶，加入锌粉 (90.0 mmol, 3.0 eq.)，15 mL 乙醚，搅拌制得悬浊液，再向恒压滴液漏斗中加入二氯甲基甲醚 (30 mmol, 1.0 eq.)、2-溴丙酸乙酯 (60.0 mmol, 2.0 eq.)，15 mL 乙醚溶解进行稀释。控制温度使乙醚回流，将混合物缓慢滴加茄形瓶中，滴加完毕后，继续回流反应液 20 min，停止反应。硅胶抽滤除去锌粉，二氯甲烷洗涤干净，滤液使用 5v%醋酸-水溶液洗一次，水洗两次，饱和食盐水洗涤干燥，有机相拌样，硅胶柱层析 (V_{有机相}:V_{乙酸乙酯}=10:1)，得透明油状化合物，收率 57%。水解酸化得相应酸 I-11a。

实施例 7

酸中间体 I-15a~I-19a 的合成路线和方法，以酸片段化合物 I-15a 的合成路线和方法为例：

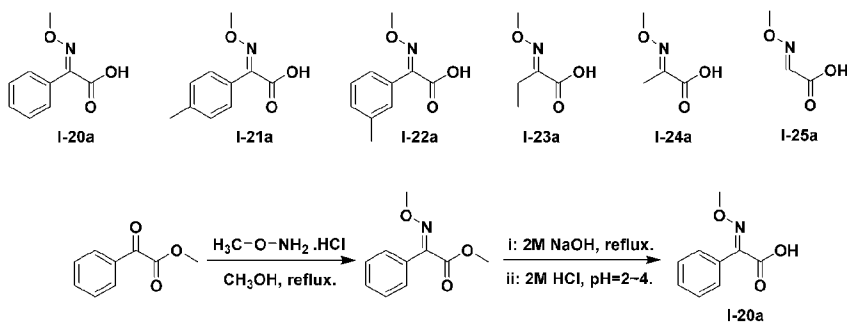


对丙烯酸 2 号位为取代苯环修饰的酸片段，采用上述的合成路线，先得溴代化合物，再与苯硼酸经 Suzuki 偶联得到相应酯，再水解得到酸片段。

以化合物 I-15a 的制备为例：取 100 mL 的三颈烧瓶，氮气氛围下，加入化合物甲基-(Z)-2-溴-3-甲氧基丙烯酸酯 (10.0 mmol, 1.0 eq.)、邻甲基苯硼酸 (30.0 mmol, 3.0 eq.)、无水碳酸钾 (50.0 mmol, 5.0 eq.)、双三苯基磷二氯化钯 (1.0 mmol, 0.1 eq.)，40 mL 异丙醇，升温至回流，反应过夜，TLC 监测反应完毕，加水，乙酸乙酯萃取两次，有机相干燥，浓缩拌样，柱层析纯化 (V_{有机相}:V_{乙酸乙酯}=20:1)，得淡黄色油状化合物，收率 92.1%，进而水解酸化得相应酸 I-15a。

实施例 8

酸中间体 I-20a~I-25a 的合成路线和方法，以酸片段化合物 I-20a 的合成路线和方法为例：



羧酸中间体含甲氧肟结构的引入, 采用上述的合成路线, 从取代乙酰甲酸甲酯出发, 与甲氧胺盐酸盐反应引入甲氧肟结构, 再水解得到酸片段。

以化合物 **I-20a** 的制备为例: 取 50 mL 茄形瓶, 加入苯乙酰基乙酸甲酯 (11.0 mmol, 1.0 eq.), 甲氧胺盐酸盐 (22.0 mmol, 2.0 eq.), 20 mL 甲醇, 体系升温至回流, 继续反应 8 h, 反应完毕加水, 乙酸乙酯萃取, 有机相干燥, 浓缩拌样, 柱层析纯化 ($V_{\text{石油醚}}:V_{\text{乙酸乙酯}}=20:1$), 得白色固体化合物, 收率 70.6%。进而水解酸化得相应酸 **I-20a**。

实施例 9

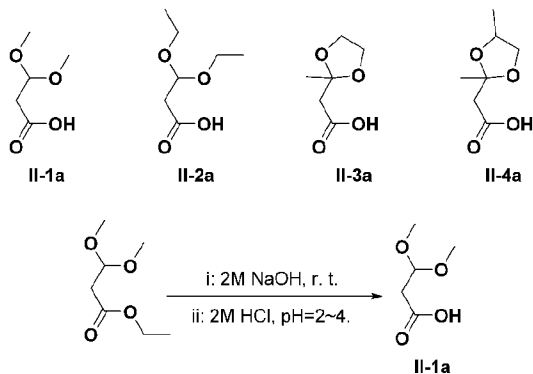
本实施例用于说明式 (II-1) ~ 式 (II-136) 所示目标化合物的合成方法。

具体地, 以式 (II-1) 所示化合物的制备为例:

室温条件下, 向 100 mL 的茄形瓶中, 加入羧酸 3,3-二甲氧基丙酸 (1.0 mmol, 1.0 eq.), 用 20 mL 二氯甲烷溶解, 依次加入 EDCI (1.5 mmol, 1.5 eq.), HOBt (1.5 mmol, 1.5 eq.), TEA (2.1 mmol, 2.14 eq.), 搅拌活化 60 min, 再向体系中加入前期得到的式 (2-5-1) 所示中间体 (0.71 mmol, 0.71 eq.)。继续反应 6h, 反应完毕加水, 二氯甲烷萃取, 有机相干燥, 浓缩拌样, 柱层析纯化 ($V_{\text{石油醚}}:V_{\text{乙酸乙酯}}=2:1$), 得到目标化合物 II-1。白色固体, 收率 68%。

实施例 10

酸中间体 II-1a~II-4a 的合成路线和方法, 以化合物 II-1a 的合成路线和方法为例:

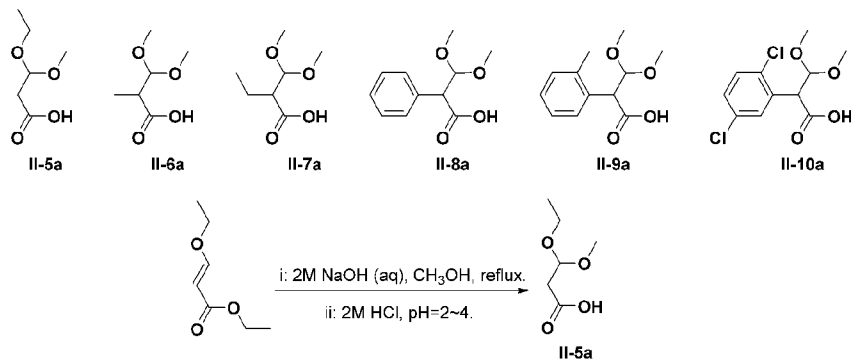


酸中间体 II-1a~II-4a 的合成路线和方法, 以化合物 II-1a 为例:

取 50 mL 茄形瓶, 加入乙基-3,3-二甲氧基丙酸酯 (10.0 mmol, 1 eq.), 再加入 2 mol/L 的氢氧化钠溶液 10 mL (20.0 mmol, 2.0 eq.), 加入 30 mL 甲醇, 使体系呈均相, 反应过夜, TLC 监测水解完全, 停止加热。温度降至室温后, 使用 2 mol/L 盐酸酸化, 乙酸乙酯萃取, 干燥浓缩得酸纯品。淡黄色油, 收率 85%。

实施例 11

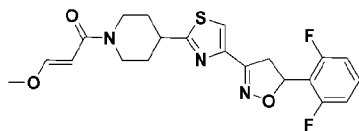
酸中间体 II-5a~II-10a 的合成路线和方法, 以酸片段化合物 II-5a 的合成路线和方法为例:



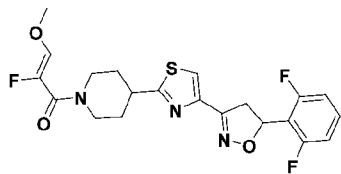
酸中间体 II-5a~II-10a 的合成路线和方法, 以化合物 II-5a 的制备为例:

50 mL 茄形瓶, 加入乙基-(E)-3-乙氧基丙烯酸酯(10.0 mmol, 1 eq.), 再加入配好的 2 mol/L 的氢氧化钠溶液 7.5 mL (15.0 mmol, 1.5 eq.), 加入 20 mL 甲醇, 温度升至 80°C, 反应过夜, TLC 监测水解完全, 停止加热。温度降至室温后, 使用 2 mol/L 盐酸调节 pH=3, 乙酸乙酯萃取, 有机相干燥, 浓缩得粗品酸。透明油状, 收率 84%。

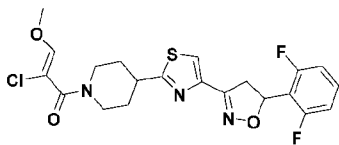
目标化合物的表征数据:



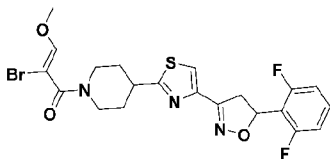
式 (I-1). 白色固体; m.p.= 134-136°C. ^1H NMR (600 MHz, $\text{DMSO}-d_6$) δ 8.02 (d, $J = 3.0$ Hz, 1H), 7.49 (t, $J = 7.8$ Hz, 1H), 7.44 (d, $J = 12.0$ Hz, 1H), 7.15 (t, $J = 9.0$ Hz, 2H), 6.00 (t, $J = 10.2$ Hz, 1H), 5.90 (d, $J = 12.0$ Hz, 1H), 4.46 (s, 1H), 4.16 (s, 1H), 3.89 (dd, $J = 16.8, 12.6$ Hz, 1H), 3.67 (s, 3H), 3.53 (dd, $J = 17.4, 8.6$ Hz, 1H), 3.37 (s, 1H), 3.15 (d, $J = 12.6$ Hz, 1H), 2.74 (d, $J = 12.6$ Hz, 1H), 2.08 (d, $J = 13.2$ Hz, 2H), 1.57 (s, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.79, 166.03, 162.69, 162.59, 160.13 (d, $J = 7.6$ Hz), 152.28, 145.14, 130.55 (t, $J = 10.5$ Hz), 117.70, 115.77 (t, $J = 16.1$ Hz), 111.98 - 111.73 (m), 94.83, 72.87 (t, $J = 3.3$ Hz), 57.85, 41.55, 40.71, 32.55. HRMS (MALDI) 计算值 $\text{C}_{21}\text{H}_{22}\text{F}_2\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 434.1344, 实测值 434.1342.



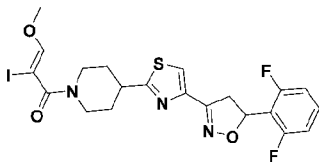
式(I-2). 白色固体; m.p.= 141-143°C. ^1H NMR (400 MHz, $\text{DMSO}-d_6$) δ 8.02 (s, 1H), 7.55 - 7.44 (m, 1H), 7.16 (t, $J = 8.4$ Hz, 2H), 6.83 (d, $J = 21.6$ Hz, 1H), 6.00 (dd, $J = 12.0, 8.8$ Hz, 1H), 4.16 (d, $J = 13.6$ Hz, 2H), 3.90 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.80 (s, 3H), 3.53 (dd, $J = 17.2, 8.6$ Hz, 1H), 3.44 - 3.35 (m, 1H), 3.07 (t, $J = 12.6$ Hz, 2H), 2.12 (dd, $J = 13.6, 3.6$ Hz, 2H), 1.71 - 1.57 (m, 2H). ^{13}C NMR (100 MHz, $\text{DMSO}-d_6$) δ 175.27, 162.39 (d, $J = 7.9$ Hz), 161.36, 161.15, 159.91 (d, $J = 7.8$ Hz), 152.58, 144.78, 141.29, 141.22, 140.18, 137.65, 131.83 (t, $J = 10.8$ Hz), 120.34, 116.09 (t, $J = 16.6$ Hz), 112.78 - 112.53 (m), 72.50 (d, $J = 3.0$ Hz), 61.85, 44.33, 41.61, 32.70. HRMS (MALDI) 计算值 $\text{C}_{21}\text{H}_{21}\text{F}_3\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 452.1250, 实测值 452.1250.



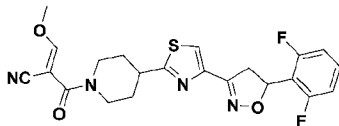
式(I-3). 白色固体; m.p.= 126-128°C. ^1H NMR (400 MHz, CDCl_3) δ 7.69 (s, 1H), 7.38 – 7.31 (m, 1H), 7.01 (s, 1H), 6.99 – 6.91 (m, 2H), 6.11 (dd, J = 12.0, 9.2 Hz, 1H), 4.36 (d, J = 13.6 Hz, 2H), 3.91 (s, 3H), 3.84 (dd, J = 17.2, 12.0 Hz, 1H), 3.67 (dd, J = 17.2, 9.2 Hz, 1H), 3.39 – 3.30 (m, 1H), 3.15 – 3.04 (m, 2H), 2.24 (dd, J = 13.6, 3.7 Hz, 2H), 1.95 – 1.82 (m, 2H). ^{13}C NMR (100 MHz, $\text{DMSO}-d_6$) δ 175.30, 164.12, 162.40 (d, J = 7.7 Hz), 159.92 (d, J = 7.8 Hz), 152.58, 151.83, 144.79, 131.86 (t, J = 11.0 Hz), 120.40, 116.11 (t, J = 16.5 Hz), 112.80 - 112.56 (m), 102.27, 72.51, 61.61, 44.85, 41.63, 32.50. HRMS (MALDI)计算值 $\text{C}_{21}\text{H}_{21}\text{ClF}_2\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 468.0955, 实测值 468.0953.



式(I-4). 白色固体; m.p.= 76-78°C. ^1H NMR (400 MHz, CDCl_3) δ 7.69 (s, 1H), 7.39 – 7.32 (m, 1H), 7.04 (s, 1H), 6.99 – 6.92 (m, 2H), 6.11 (dd, J = 12.0, 9.2 Hz, 1H), 4.37 (d, J = 13.6 Hz, 2H), 3.91 (s, 3H), 3.84 (dd, J = 17.2, 12.0 Hz, 1H), 3.67 (dd, J = 17.2, 9.2 Hz, 1H), 3.39 – 3.30 (m, 1H), 3.14 – 3.02 (m, 2H), 2.24 (dd, J = 13.6, 3.6 Hz, 2H), 1.94 – 1.83 (m, 2H). ^{13}C NMR (150 MHz, CDCl_3) δ 174.47, 164.93, 162.18, 160.52, 152.25, 145.16, 130.55, 117.74, 115.73 (t, J = 15.6 Hz), 111.92, 111.77, 91.57, 72.85, 61.39, 45.06, 41.53, 40.46, 32.27. HRMS (MALDI)计算值 $\text{C}_{21}\text{H}_{21}\text{BrF}_2\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 514.0431, 实测值 514.0434.

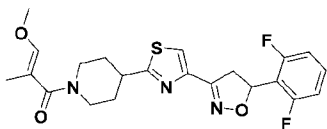


式(I-5). 浅黄色固体; m.p.= 76-78°C. ^1H NMR (400 MHz, CDCl_3) δ 7.69 (s, 1H), 7.38 – 7.30 (m, 1H), 6.95 (t, J = 8.0 Hz, 2H), 6.76 (s, 1H), 6.11 (dd, J = 12.0, 9.2 Hz, 1H), 4.36 (d, J = 13.6 Hz, 2H), 3.90 (s, 3H), 3.84 (dd, J = 17.2, 12.0 Hz, 1H), 3.66 (dd, J = 17.2, 9.2 Hz, 1H), 3.40 – 3.30 (m, 1H), 3.07 (t, J = 12.0 Hz, 2H), 2.27 – 2.18 (m, 2H), 1.94 – 1.81 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.52, 165.90, 162.61 (d, J = 7.5 Hz), 160.11 (d, J = 7.7 Hz), 155.16, 152.23, 145.17, 130.59 (t, J = 10.6 Hz), 117.82, 115.74 (t, J = 16.2 Hz), 112.00-111.75 (m), 72.87 (t, J = 2.8 Hz), 63.68, 60.96, 45.22, 41.55 (d, J = 2.3 Hz), 40.43, 32.13. HRMS (MALDI)计算值 $\text{C}_{21}\text{H}_{22}\text{F}_2\text{IN}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 560.0311, 实测值 560.0308.

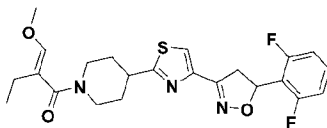


式(I-6). 白色固体; m.p.= 87-89°C. ^1H NMR (400 MHz, CDCl_3) δ 7.75 (s, 1H), 7.69 (s, 1H), 7.35 – 7.28 (m, 1H), 6.92 (t, J = 8.0 Hz, 2H), 6.08 (dd, J = 12.0, 9.2 Hz, 1H), 4.84 (d, J = 13.6 Hz, 1H), 3.85 – 3.76 (m, 4H), 3.73 (d, J = 12.8 Hz, 1H), 3.63 (dd, J = 17.2, 9.2 Hz, 1H), 3.54 (t, J = 12.0 Hz, 1H), 3.48 – 3.35 (m, 2H), 2.31 (d, J = 13.6 Hz, 2H), 2.09 – 1.94 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 172.92, 167.29, 162.62 (d, J = 7.6 Hz), 160.12 (d, J = 7.6 Hz), 155.65, 152.13, 145.38, 130.62 (t, J = 10.7 Hz), 117.95, 117.92, 115.73 (t, J = 16.2 Hz), 112.02 - 111.77 (m), 72.94 (t, J = 2.9

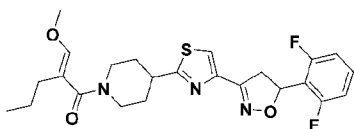
Hz), 69.71, 56.09, 52.16, 45.68, 41.55, 39.18, 32.73, 31.59. HRMS (MALDI)计算值 $C_{22}H_{21}F_2N_4O_3S$ $[M+H]^+$ 459.1297, 实测值 459.1302.



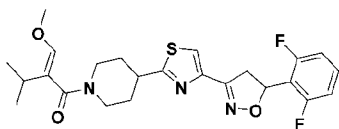
式(I-7). 黄色油状物. ^1H NMR (400 MHz, $CDCl_3$) δ 7.68 (s, 1H), 7.39 – 7.30 (m, 1H), 6.95 (t, $J = 8.0$ Hz, 2H), 6.46 – 6.41 (m, 1H), 6.11 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.34 (d, $J = 13.6$ Hz, 2H), 3.84 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.74 (s, 3H), 3.66 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.38 – 3.29 (m, 1H), 3.10 – 2.98 (m, 2H), 2.22 (dd, $J = 13.6, 3.6$ Hz, 2H), 1.88 – 1.74 (m, 5H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.75, 171.37, 162.63 (d, $J = 7.0$ Hz), 160.13 (d, $J = 7.0$ Hz), 152.24, 150.31, 145.18, 130.56 (t, $J = 10.0$ Hz), 117.71, 115.77 (t, $J = 16.0$ Hz), 111.98 – 111.74 (m), 109.47, 72.86 (t, $J = 3.0$ Hz), 60.33, 44.67, 41.55, 40.77, 32.59, 11.83. HRMS (MALDI)计算值 $C_{22}H_{24}F_2N_3O_3S$ $[M+H]^+$ 448.1501, 实测值 448.1502.



式(I-8). 黄色油状物. ^1H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, $J = 0.8$ Hz, 1H), 7.39 – 7.31 (m, 1H), 6.95 (t, $J = 8.0$ Hz, 2H), 6.28 (s, 1H), 6.11 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.42 (d, $J = 13.6$ Hz, 2H), 3.84 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.72 (d, $J = 0.8$ Hz, 3H), 3.66 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.40 – 3.28 (m, 1H), 3.05 (t, $J = 12.0$ Hz, 2H), 2.35 (q, $J = 7.6$ Hz, 2H), 2.27 – 2.19 (m, 2H), 1.87 – 1.72 (m, 2H), 1.08 – 1.01 (m, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.77, 170.77, 162.64 (d, $J = 7.0$ Hz), 160.14 (d, $J = 8.0$ Hz), 152.21, 148.54, 145.17, 130.56 (t, $J = 10.0$ Hz), 117.71, 117.69, 116.00, 115.78 (t, $J = 16.0$ Hz), 111.99 – 111.74 (m), 72.89 (t, $J = 3.0$ Hz), 60.27, 41.56, 40.76, 32.64, 19.64, 12.87. HRMS (MALDI)计算值 $C_{23}H_{26}F_2N_3O_3S$ $[M+H]^+$ 462.1657, 实测值 462.1660.

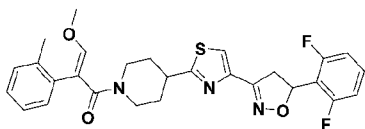


式(I-9). 黄色油状物. ^1H NMR (400 MHz, $CDCl_3$) δ 7.65 (s, 1H), 7.35 – 7.25 (m, 1H), 6.92 (t, $J = 8.0$ Hz, 2H), 6.28 (s, 1H), 6.08 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.38 (d, $J = 13.6$ Hz, 2H), 3.81 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.68 (s, 3H), 3.63 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.35 – 3.25 (m, 1H), 3.01 (s, 2H), 2.27 (dd, $J = 8.8, 6.4$ Hz, 2H), 2.23 – 2.15 (m, 2H), 1.82 – 1.69 (m, 2H), 1.47 – 1.37 (m, 2H), 0.92 (t, $J = 7.2$ Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.78, 170.93, 162.63 (d, $J = 8.0$ Hz), 160.13 (d, $J = 8.0$ Hz), 152.23, 149.03, 145.18, 130.56 (t, $J = 11.0$ Hz), 117.73, 115.77 (t, $J = 16.0$ Hz), 114.70, 111 – 111.74 (m), 72.87 (t, $J = 3.0$ Hz), 60.25, 44.70, 41.54, 40.78, 32.62, 28.38, 21.64, 14.10. HRMS (MALDI)计算值 $C_{24}H_{28}F_2N_3O_3S$ $[M+H]^+$ 476.1814, 实测值 476.1816.

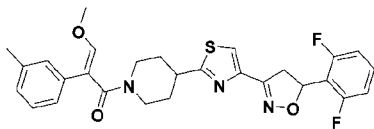


式(I-10). 白色固体; m.p.= 58-60°C. ^1H NMR (400 MHz, $CDCl_3$) δ 7.65 (s, 1H), 7.31 (tt, $J = 8.4, 6.4$ Hz, 1H), 6.96 – 6.88 (m, 2H), 6.11 – 6.03 (m, 2H), 4.44 (d, $J = 13.2$ Hz, 2H), 3.86 – 3.76 (m, 1H), 3.66 (s, 3H), 3.65 – 3.59 (m, 1H), 3.30 (tt, $J = 11.2, 3.6$ Hz, 1H), 3.01 (t, $J = 12.8$ Hz, 2H), 2.86 (p, $J = 7.2$ Hz, 1H), 2.23 – 2.15 (m, 2H), 1.81 – 1.67 (m, 2H),

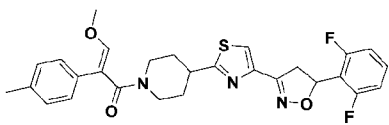
1.15 (s, 3H), 1.14 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 173.73, 168.89, 161.60 (d, $J = 7.3$ Hz), 159.10 (d, $J = 7.5$ Hz), 151.20, 145.62, 144.14, 129.53 (t, $J = 10.6$ Hz), 118.39, 116.72, 114.73 (t, $J = 16.1$ Hz), 110.95 - 110.70 (m), 71.85, 59.23, 43.50, 40.53, 39.75, 31.61, 25.77, 20.20. HRMS (MALDI)计算值 $\text{C}_{24}\text{H}_{27}\text{F}_2\text{N}_3\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$: 498.1633, 实测值 498.1632.



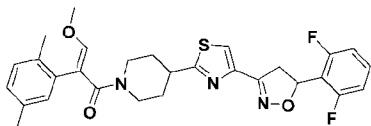
式(I-11). 白色固体; m.p.= 69-71°C. ^1H NMR (400 MHz, CDCl_3) δ 7.62 (s, 1H), 7.29 (d, $J = 7.6$ Hz, 1H), 7.25 (d, $J = 4.8$ Hz, 1H), 7.26 - 7.20 (m, 3H), 7.00 (s, 1H), 6.91 (t, $J = 8.0$ Hz, 2H), 6.06 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.12 (s, 2H), 3.79 (s, 4H), 3.60 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.26 - 3.14 (m, 1H), 2.86 - 2.74 (m, 2H), 2.27 (s, 3H), 1.95 (d, $J = 13.2$ Hz, 2H), 1.45 (s, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.89, 162.63 (d, $J = 8.0$ Hz), 160.13 (d, $J = 8.0$ Hz), 154.80, 152.26, 145.07, 136.52, 133.80, 130.56, 130.55 (t, $J = 10.0$ Hz), 130.15, 127.55, 125.74, 117.63, 115.78 (t, $J = 16.0$ Hz), 114.85, 111.99 - 111.74 (m), 72.84 (t, $J = 3.0$ Hz), 61.19, 41.55, 40.52, 32.11, 20.13. HRMS (MALDI)计算值 $\text{C}_{28}\text{H}_{28}\text{F}_2\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 524.1814, 实测值 524.1819.



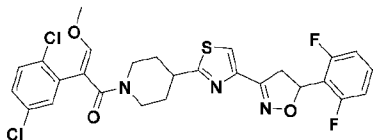
式(I-12). 白色固体; m.p.= 71-73°C. ^1H NMR (400 MHz, CDCl_3) δ 7.63 (s, 1H), 7.36 - 7.24 (m, 3H), 7.22 (dd, $J = 8.8, 7.3$ Hz, 1H), 7.03 (d, $J = 7.2$ Hz, 1H), 6.91 (t, $J = 8.0$ Hz, 2H), 6.64 (s, 1H), 6.06 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.26 (s, 2H), 3.82 (s, 3H), 3.80 - 3.74 (m, 1H), 3.61 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.28 - 3.15 (m, 1H), 2.96 - 2.84 (m, 2H), 2.34 (s, 3H), 2.05 (s, 2H), 1.61 (s, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.83, 162.64 (d, $J = 8.0$ Hz), 160.14 (d, $J = 8.0$ Hz), 152.25, 150.58, 145.14, 137.86, 133.69, 130.56 (t, $J = 10.0$ Hz), 128.49, 128.30, 127.71, 125.09, 117.66, 115.79 (t, $J = 16.0$ Hz), 115.22, 111.99 - 111.75 (m), 72.85, 61.39, 41.58, 40.58, 32.34, 21.60. HRMS (MALDI)计算值 $\text{C}_{28}\text{H}_{28}\text{F}_2\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 524.1814, 实测值 524.1819.



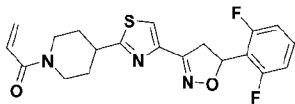
式(I-13). 白色固体; m.p.= 81-83°C. ^1H NMR (600 MHz, $\text{DMSO}-d_6$) δ 8.01 (s, 1H), 7.50 (p, $J = 7.2$ Hz, 1H), 7.31 (d, $J = 7.8$ Hz, 2H), 7.21 - 7.01 (m, 4H), 6.61 (s, 1H), 6.00 (dd, $J = 12.0, 8.4$ Hz, 1H), 4.11 (s, 1H), 3.89 (dd, $J = 17.4, 12.0$ Hz, 1H), 3.78 (s, 3H), 3.52 (dd, $J = 17.4, 8.5$ Hz, 1H), 3.38 (s, 2H), 2.94 (t, $J = 12.6$ Hz, 2H), 2.27 (s, 3H), 2.07 - 1.95 (m, 2H), 1.51 (s, 2H). ^{13}C NMR (150 MHz, $\text{DMSO}-d_6$) δ 174.82, 162.43 (d, $J = 8.0$ Hz), 160.15 (d, $J = 7.8$ Hz), 152.05, 150.38, 144.88, 137.69, 133.45, 130.22 (t, $J = 10.0$ Hz), 128.29, 128.08, 127.59, 124.42, 117.37, 115.69 (t, $J = 16.0$ Hz), 115.22, 111.98 - 111.74 (m), 72.87 (t, $J = 3.0$ Hz), 61.28, 41.58, 40.56, 32.31, 21.22. HRMS (MALDI)计算值 $\text{C}_{28}\text{H}_{28}\text{F}_2\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 524.1814, 实测值 524.1816.



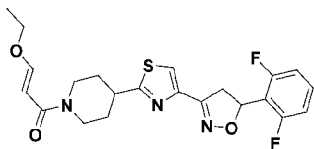
式(I-14). 白色固体; m.p.= 79-81°C. ^1H NMR (400 MHz, CDCl_3) δ 7.61 (s, 1H), 7.34 – 7.27 (m, 1H), 7.09 (d, J = 7.6 Hz, 1H), 7.05 (s, 1H), 6.98 (dd, J = 7.6, 1.6 Hz, 1H), 6.96 (s, 1H), 6.91 (t, J = 8.0 Hz, 2H), 6.05 (dd, J = 12.0, 9.2 Hz, 1H), 4.14 (s, 2H), 3.82 – 3.71 (m, 4H), 3.60 (dd, J = 17.2, 9.2 Hz, 1H), 3.19 – 3.09 (m, 1H), 2.84 – 2.75 (m, 2H), 2.30 (s, 3H), 2.22 (s, 3H), 2.00 – 1.87 (m, 2H), 1.45 (s, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.98, 169.86, 162.64 (d, J = 8.0 Hz), 160.14 (d, J = 6.0 Hz), 154.61, 152.27, 145.07, 135.05, 133.53, 133.33, 130.47, 128.44, 117.61, 115.79 (t, J = 16.3 Hz), 114.80, 111.99, 111.75, 72.85, 61.15, 41.55, 40.57, 32.15, 20.98, 19.67. HRMS (MALDI)计算值 $\text{C}_{29}\text{H}_{30}\text{F}_2\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 538.1970, 实测值 538.1976.



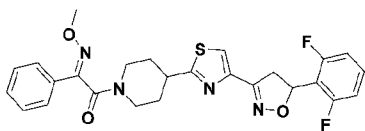
式(I-15). 白色固体; m.p.= 94-96°C. ^1H NMR (400 MHz, CDCl_3) δ 7.57 (s, 1H), 7.36 (d, J = 2.4 Hz, 1H), 7.25 – 7.18 (m, 2H), 7.12 (dd, J = 8.8, 2.5 Hz, 1H), 6.89 (s, 1H), 6.84 (t, J = 8.4 Hz, 2H), 6.00 (dd, J = 12.0, 9.2 Hz, 1H), 4.15 (s, 2H), 3.76 (s, 3H), 3.75 – 3.68 (m, 1H), 3.55 (dd, J = 17.2, 9.2 Hz, 1H), 3.22 – 3.14 (m, 1H), 2.90 – 2.79 (m, 2H), 1.99 (d, J = 11.2 Hz, 2H), 1.53 (d, J = 12.8 Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.77, 168.22, 162.63 (d, J = 8.0 Hz), 160.13 (d, J = 8.0 Hz), 155.83, 152.25, 145.11, 134.77, 132.41, 131.81, 131.75, 130.85, 130.56 (t, J = 10.0 Hz), 128.70, 117.71, 115.78 (t, J = 16.0 Hz), 111.99, 111.94 – 111.69 (m), 72.86 (t, J = 2.0 Hz), 61.62, 41.57, 40.54, 32.16. HRMS (MALDI)计算值 $\text{C}_{27}\text{H}_{24}\text{Cl}_2\text{F}_2\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 578.0878, 实测值 578.0881.



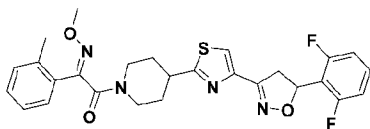
式(I-16). 白色固体; m.p.= 119-121°C. ^1H NMR (400 MHz, CDCl_3) δ 7.64 (s, 1H), 7.34 – 7.25 (m, 1H), 6.95 – 6.87 (m, 2H), 6.59 (dd, J = 16.8, 10.4 Hz, 1H), 6.28 (dd, J = 16.8, 2.0 Hz, 1H), 6.06 (dd, J = 12.0, 9.2 Hz, 1H), 5.70 (dd, J = 10.4, 2.0 Hz, 1H), 4.70 (s, 1H), 4.18 – 3.98 (m, 1H), 3.86 – 3.73 (m, 1H), 3.62 (dd, J = 17.2, 9.2 Hz, 1H), 3.38 – 3.29 (m, 1H), 3.23 (s, 1H), 2.87 (s, 1H), 2.20 (d, J = 12.0 Hz, 2H), 1.85 – 1.73 (m, 2H). ^{13}C NMR (100 MHz, $\text{DMSO}-d_6$) δ 175.41, 164.74, 162.38 (d, J = 7.9 Hz), 159.90 (d, J = 7.8 Hz), 152.58, 144.75, 131.85 (t, J = 10.8 Hz), 128.93, 127.64, 120.36, 116.09 (t, J = 16.5 Hz), 112.79 – 112.55 (m), 72.52, 72.49, 72.46, 45.21, 41.61, 40.02, 33.20, 32.33. HRMS (MALDI)计算值 $\text{C}_{20}\text{H}_{20}\text{F}_2\text{N}_3\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ 404.1239, 实测值 404.1241.



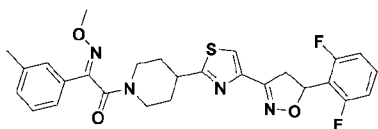
式(I-17). 白色固体; m.p.= 78-80°C. ^1H NMR (400 MHz, CDCl_3) δ 7.65 (d, J = 2.8 Hz, 1H), 7.59 (d, J = 11.6 Hz, 1H), 7.36 – 7.26 (m, 1H), 6.91 (t, J = 8.4 Hz, 2H), 6.07 (dd, J = 12.0, 9.2 Hz, 1H), 5.68 (d, J = 12.0 Hz, 1H), 4.36 (s, 2H), 3.95 (q, J = 7.2 Hz, 2H), 3.80 (dd, J = 17.2, 12.0 Hz, 1H), 3.63 (dd, J = 17.2, 9.2 Hz, 1H), 3.40 – 3.25 (m, 1H), 3.17 – 2.76 (m, 2H), 2.18 (dd, J = 13.6, 3.6 Hz, 2H), 1.85 – 1.70 (m, 2H), 1.34 (t, J = 7.2 Hz, 2H), 1.26 (t, J = 7.2 Hz, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.82, 166.24, 162.63 (d, J = 7.5 Hz), 162.01, 160.13 (d, J = 7.5 Hz), 152.25, 145.10, 130.54 (t, J = 10.6 Hz), 117.71, 117.67, 115.77 (t, J = 16.2 Hz), 112.02 – 111.68 (m), 95.38, 72.87 (t, J = 2.9 Hz), 67.51, 41.55, 40.71, 14.75. HRMS (MALDI)计算值 $\text{C}_{22}\text{H}_{24}\text{F}_2\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 448.1501, 实测值 448.1504.



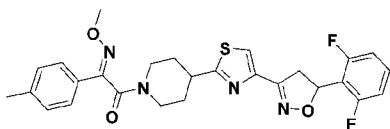
式(I-18). 白色固体; m.p.= 77-79°C. ^1H NMR (400 MHz, CDCl_3) δ 7.69 – 7.60 (m, 3H), 7.41 – 7.38 (m, 3H), 7.35 – 7.25 (m, 1H), 6.98 – 6.87 (m, 2H), 6.13 – 6.01 (m, 1H), 4.77 (dd, J = 35.2, 13.6 Hz, 1H), 4.02 (d, J = 1.6 Hz, 3H), 3.86 – 3.77 (m, 1H), 3.76 – 3.66 (m, 1H), 3.61 (dd, J = 17.6, 8.8 Hz, 1H), 3.38 – 3.28 (m, 1H), 3.32 – 2.93 (m, 2H), 2.35 – 2.07 (m, 2H), 1.99 – 1.54 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.48, 163.25, 162.63 (d, J = 7.4 Hz), 160.14 (d, J = 7.6 Hz), 152.59, 152.25, 145.24, 130.74, 130.58 (t, J = 10.0 Hz), 130.34, 128.88, 128.85, 126.21, 126.18, 117.77, 115.76 (t, J = 16.2 Hz), 111.87 (d, J = 24.7 Hz), 111.87 (d, J = 14.0 Hz), 72.89, 62.87, 46.07, 41.53, 40.54, 40.26, 32.95, 31.93, 29.69. HRMS (MALDI)计算值 $\text{C}_{26}\text{H}_{25}\text{F}_2\text{N}_4\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 511.1610, 实测值 511.1610.



式(I-19). 白色固体; m.p.= 74-76°C. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.36 – 7.17 (m, 5H), 6.92 (t, J = 8.0 Hz, 2H), 6.08 (dd, J = 12.0, 9.2 Hz, 1H), 4.67 (d, J = 13.6 Hz, 1H), 4.51 – 4.43 (m, 1H), 3.94 (s, 3H), 3.80 (dd, J = 17.2, 12.0 Hz, 1H), 3.63 (dd, J = 17.2, 9.2 Hz, 1H), 3.31 – 3.41 (m, 2H), 3.03 – 2.91 (m, 1H), 2.33 (s, 3H), 2.29 – 2.18 (m, 2H), 1.93 – 1.80 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.50, 163.76, 162.65 (d, J = 8.0 Hz), 160.15 (d, J = 8.0 Hz), 152.26, 151.50, 145.22, 136.49, 131.04, 130.59 (t, J = 10.0 Hz), 130.27, 129.38, 127.29, 125.55, 117.80, 115.78 (t, J = 16.0 Hz), 112.01 – 111.76 (m), 72.91 (t, J = 3.0 Hz), 62.74, 46.77, 41.91, 41.55, 40.54, 32.82, 31.85, 20.21. HRMS (MALDI)计算值 $\text{C}_{27}\text{H}_{27}\text{F}_2\text{N}_4\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 525.1766, 实测值 525.1773.

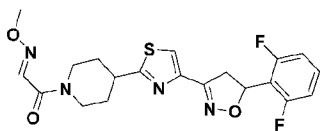


式(I-20). 白色固体; m.p.= 81-83°C. ^1H NMR (400 MHz, CDCl_3) δ 7.69 (d, J = 11.6 Hz, 1H), 7.55 – 7.40 (m, 2H), 7.38 – 7.28 (m, 2H), 7.26 (s, 1H), 6.99 – 6.91 (m, 2H), 6.15 – 6.06 (m, 1H), 4.81 (dd, J = 39.6, 13.6 Hz, 1H), 4.05 (d, J = 1.6 Hz, 3H), 3.84 (dd, J = 17.2, 10.8 Hz, 1H), 3.79 – 3.71 (m, 1H), 3.65 (dt, J = 17.6, 9.6 Hz, 1H), 3.37 (dt, J = 12.0, 5.6 Hz, 1H), 3.33 – 2.97 (m, 2H), 2.40 (s, 3H), 2.32 (t, J = 15.6 Hz, 1H), 2.17 (dd, J = 27.6, 13.2 Hz, 1H), 2.00 – 1.58 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.54, 163.34, 162.63 (d, J = 7.3 Hz), 160.13 (d, J = 7.4 Hz), 152.80, 152.24, 145.23, 138.63, 131.22, 130.59 (t, J = 10.0 Hz), 128.78, 128.75, 126.62, 123.45, 117.77, 115.75 (t, J = 16.1 Hz), 112.00 – 111.75 (m), 72.89, 62.65, 46.11, 41.52, 40.58, 40.26, 32.97, 31.97, 21.43, 21.41. HRMS (MALDI)计算值 $\text{C}_{27}\text{H}_{27}\text{F}_2\text{N}_4\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 525.1766, 实测值 525.1771.

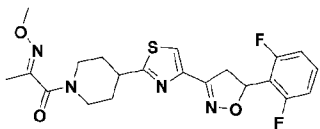


式(I-21). 白色固体; m.p.= 85-87°C. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (d, J = 11.2 Hz, 1H), 7.52 (dd, J = 13.2, 8.0 Hz, 2H), 7.31 (q, J = 7.2 Hz, 1H), 7.19 (d, J = 8.0 Hz, 2H), 6.96 – 6.87 (m, 2H), 6.12 – 6.03 (m, 1H), 4.76 (dd, J = 32.0, 13.6 Hz, 1H), 4.00 (d, J = 2.0 Hz, 3H), 3.86 – 3.76 (m, 1H), 3.76 – 3.67 (m, 1H), 3.67 – 3.56 (m, 1H), 3.39 – 3.29 (m,

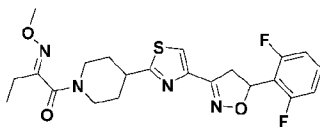
1H), 3.28 – 2.94 (m, 2H), 2.36 (d, $J = 3.6$ Hz, 3H), 2.28 (t, $J = 16.8$ Hz, 1H), 2.13 (dd, $J = 23.2, 13.6$ Hz, 1H), 1.99 – 1.52 (m, 2H). ^{13}C NMR (150 MHz, DMSO- d_6) δ 175.14, 162.31, 161.92 (d, $J = 7.5$ Hz), 160.27 (d, $J = 7.7$ Hz), 152.83, 152.53, 144.78, 144.69, 140.76, 131.80 (t, $J = 10.6$ Hz), 130.08, 130.04, 128.12, 126.26, 120.38, 116.03 (t, $J = 16.6$ Hz), 112.69, 112.54, 72.46, 62.74, 45.70, 41.55, 40.19, 39.78, 33.03, 32.11, 21.34. HRMS (MALDI) 计算值 $\text{C}_{27}\text{H}_{27}\text{F}_2\text{N}_4\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 525.1766, 实测值 525.1775.



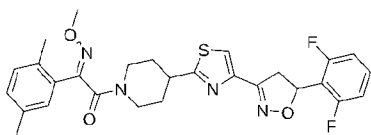
式(I-22). 白色固体; m.p.= 123-125°C. ^1H NMR (400 MHz, CDCl_3) δ 7.71 (s, 1H), 7.67 (s, 1H), 7.34 – 7.28 (m, 1H), 6.96 – 6.88 (m, 2H), 6.08 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.67 (d, $J = 14.4$ Hz, 1H), 4.35 (d, $J = 14.0$ Hz, 1H), 3.98 (s, 2H), 3.94 (s, 1H), 3.81 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.63 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.42 – 3.33 (m, 1H), 3.33 – 3.19 (m, 1H), 2.98 – 2.89 (m, 1H), 2.23 (d, $J = 13.6$ Hz, 2H), 1.92 – 1.77 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.35, 162.62 (d, $J = 7.6$ Hz), 160.94, 160.12 (d, $J = 7.5$ Hz), 152.23, 145.19, 142.36, 130.60 (t, $J = 10.6$ Hz), 117.81, 115.75 (t, $J = 16.1$ Hz), 112.00 – 111.76 (m), 72.89, 62.76, 46.13, 41.98, 41.55, 40.39, 32.83, 31.90. HRMS (MALDI) 计算值 $\text{C}_{20}\text{H}_{21}\text{F}_2\text{N}_4\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$: 435.1297, 实测值 435.1301.



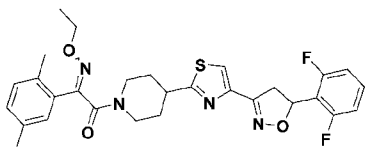
式(I-23). 白色固体; m.p.= 142-144°C. ^1H NMR (400 MHz, CDCl_3) δ 7.70 (s, 1H), 7.38 – 7.31 (m, 1H), 6.96 (t, $J = 8.0$ Hz, 2H), 6.12 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.69 (d, $J = 13.2$ Hz, 1H), 4.24 (d, $J = 13.6$ Hz, 1H), 3.97 (s, 3H), 3.85 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.67 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.40 (tt, $J = 11.2, 4.0$ Hz, 1H), 3.32 – 3.22 (m, 1H), 3.01 – 2.91 (m, 1H), 2.25 (d, $J = 13.2$ Hz, 2H), 2.08 (s, 3H), 1.95 – 1.82 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.48, 164.89, 162.62 (d, $J = 8.0$ Hz), 160.12 (d, $J = 7.0$ Hz), 152.24, 151.21, 145.18, 130.57 (t, $J = 10.0$ Hz), 117.75, 115.75 (t, $J = 16.0$ Hz), 111.99 – 111.74 (m), 72.87 (t, $J = 3.0$ Hz), 62.23, 46.67, 41.76, 41.54 (t, $J = 2.0$ Hz), 40.54, 32.84, 31.88, 12.96. HRMS (MALDI) 计算值 $\text{C}_{21}\text{H}_{23}\text{F}_2\text{N}_4\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 449.1453, 实测值 449.1454.



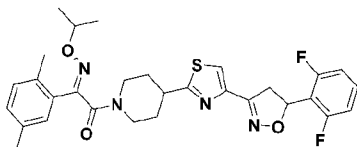
式(I-24). 白色固体; m.p.= 58-60°C. ^1H NMR (400 MHz, CDCl_3) δ 7.69 (s, 1H), 7.40 – 7.30 (m, 1H), 6.96 (t, $J = 8.0$ Hz, 2H), 6.11 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.71 (d, $J = 13.6$ Hz, 1H), 4.20 (d, $J = 13.6$ Hz, 1H), 3.94 (s, 3H), 3.84 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.67 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.43 – 3.34 (m, 1H), 3.32 – 3.22 (m, 1H), 3.02 – 2.92 (m, 1H), 2.61 (q, $J = 7.6$ Hz, 2H), 2.25 (d, $J = 13.6$ Hz, 2H), 1.95 – 1.79 (m, 2H), 1.13 (t, $J = 7.6$ Hz, 3H). ^{13}C NMR (100 MHz, DMSO- d_6) δ 175.16, 163.62, 162.38 (d, $J = 8.0$ Hz), 159.90 (d, $J = 8.0$ Hz), 156.47, 152.55, 144.79, 131.85 (t, $J = 11.0$ Hz), 120.44, 116.08 (t, $J = 16.0$ Hz), 112.79 – 112.54 (m), 72.50 (t, $J = 3.0$ Hz), 62.18, 46.31, 41.61, 41.13, 39.86, 32.98, 32.18, 20.25, 10.06. HRMS (MALDI) 计算值 $\text{C}_{22}\text{H}_{25}\text{F}_2\text{N}_4\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 463.1610, 实测值 463.1611.



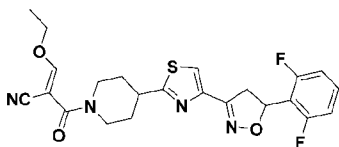
式(I-25). 白色固体; m.p.= 72-74°C. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.36 – 7.26 (m, 1H), 7.20 (s, 1H), 7.13 (d, J = 8.0 Hz, 1H), 7.08 (dd, J = 8.0, 1.6 Hz, 1H), 6.91 (t, J = 8.4 Hz, 2H), 6.07 (dd, J = 12.0, 9.2 Hz, 1H), 4.73 (s, 1H), 4.01 (s, 3H), 3.78 (dt, J = 16.8, 10.4 Hz, 2H), 3.62 (dd, J = 17.2, 9.2 Hz, 1H), 3.32 (t, J = 11.2 Hz, 1H), 3.19 (s, 1H), 2.98 (s, 1H), 2.50 (s, 3H), 2.30 (s, 3H), 2.29 – 2.11 (m, 2H), 1.84 (s, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 162.64 (d, J = 7.6 Hz), 160.14 (d, J = 7.6 Hz), 153.59, 152.18, 145.18, 135.50, 134.30, 131.82, 130.59 (t, J = 10.6 Hz), 130.29, 129.48, 129.35, 117.74, 115.76 (t, J = 16.2 Hz), 112.00 – 111.75 (m), 72.91 (t, J = 3.0 Hz), 62.71, 41.56, 41.54, 40.52, 31.93, 21.75, 20.94. HRMS (MALDI) 计算值 $\text{C}_{28}\text{H}_{29}\text{F}_2\text{N}_4\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 539.1923, 实测值 539.1925.



式(I-26). 白色固体; m.p.= 70-72°C. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.34 – 7.28 (m, 1H), 7.19 (s, 1H), 7.13 (d, J = 8.0 Hz, 1H), 7.07 (dd, J = 8.0, 1.6 Hz, 1H), 6.92 (t, J = 8.0 Hz, 2H), 6.07 (dd, J = 12.0, 9.2 Hz, 1H), 4.74 (d, J = 44.0 Hz, 1H), 4.26 (q, J = 7.2 Hz, 2H), 3.79 (dd, J = 17.2, 12.0 Hz, 2H), 3.62 (dd, J = 17.0, 9.2 Hz, 1H), 3.38 – 3.28 (m, 1H), 3.23 – 2.86 (m, 2H), 2.50 (s, 3H), 2.30 (s, 3H), 2.29 – 2.22 (m, 1H), 2.14 (s, 1H), 1.88 – 1.76 (m, 2H), 1.34 (t, J = 7.2 Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 162.64 (d, J = 7.5 Hz), 160.14 (d, J = 7.5 Hz), 153.17, 152.25, 145.23, 135.47, 134.26, 131.81, 130.58 (t, J = 10.7 Hz), 130.17, 129.75, 129.29, 117.70, 115.77 (t, J = 16.2 Hz), 112.01 – 111.76 (m), 72.90 (t, J = 3.0 Hz), 70.45, 41.55, 40.66, 21.87, 20.96, 14.85. HRMS (MALDI) 计算值 $\text{C}_{29}\text{H}_{31}\text{F}_2\text{N}_4\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 553.2079, 实测值 553.2083.

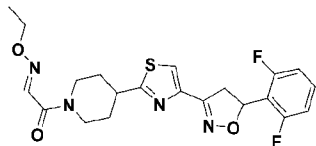


式(I-27). 白色固体; m.p.= 69-71°C. ^1H NMR (400 MHz, CDCl_3) δ 7.67 (s, 1H), 7.34 – 7.28 (m, 1H), 7.17 (s, 1H), 7.13 (d, J = 8.0 Hz, 1H), 7.10 – 7.04 (m, 1H), 6.91 (t, J = 8.4 Hz, 2H), 6.11 – 6.02 (m, 1H), 4.82 (s, 1H), 4.53 – 4.42 (m, 1H), 3.79 (dd, J = 17.2, 11.2 Hz, 2H), 3.62 (dd, J = 17.2, 9.2 Hz, 1H), 3.32 (d, J = 12.0 Hz, 1H), 3.20 – 2.84 (m, 2H), 2.51 (s, 3H), 2.30 (s, 4H), 2.16 (d, J = 12.8 Hz, 1H), 1.91 – 1.77 (m, 2H), 1.33 (s, 3H), 1.31 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 162.64 (d, J = 7.5 Hz), 160.14 (d, J = 7.5 Hz), 152.27, 145.22, 135.43, 134.24, 131.80, 130.59 (t, J = 10.6 Hz), 130.03, 130.00, 129.25, 117.68, 115.77 (t, J = 16.3 Hz), 112.00 – 111.75 (m), 76.52, 72.89, 41.57, 40.81, 22.05, 21.72, 20.97. HRMS (MALDI) 计算值 $\text{C}_{30}\text{H}_{33}\text{F}_2\text{N}_4\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 567.2236, 实测值 567.2240.

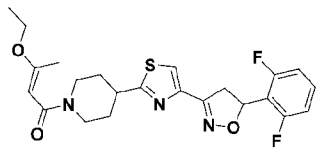


式(I-28). 白色固体; m.p.= 106-108°C. ^1H NMR (400 MHz, CDCl_3) δ 7.74 (s, 1H), 7.69 (s, 1H), 7.35 – 7.28 (m, 1H), 6.92 (t, J = 8.4 Hz, 2H), 6.08 (dd, J = 12.0, 9.2 Hz, 1H), 4.84 (d, J = 13.6 Hz, 1H), 4.24 (q, J = 7.2 Hz, 2H), 3.85 – 3.69 (m, 2H), 3.63 (dd, J = 17.2, 9.2 Hz, 1H), 3.54 (t, J = 12.0 Hz, 1H), 3.43 (d, J = 25.6 Hz, 2H), 2.30 (d, J = 13.6 Hz, 2H),

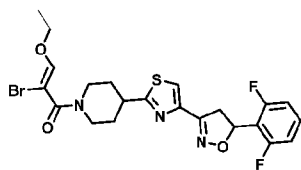
2.07 – 1.95 (m, 2H), 1.31 (t, $J = 7.2$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 172.95, 166.82, 162.61 (d, $J = 8.0$ Hz), 160.11 (d, $J = 8.0$ Hz), 155.60, 152.18, 145.40, 130.62 (t, $J = 10.0$ Hz), 117.95, 117.92, 115.72 (t, $J = 16.0$ Hz), 112.01 – 111.76 (m), 72.92 (t, $J = 3.0$ Hz), 70.05, 60.99, 56.05, 45.65, 41.54, 39.21, 32.73, 31.61, 14.45. HRMS (MALDI) 计算值 $\text{C}_{23}\text{H}_{22}\text{F}_2\text{N}_4\text{NaO}_3\text{S} [\text{M}+\text{Na}]^+$: 495.1273, 实测值 495.1270.



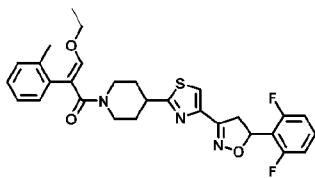
式(I-29). 黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.70 (s, 1H), 7.66 (s, 1H), 7.31 (dt, $J = 12.8, 6.0$ Hz, 1H), 6.92 (t, $J = 8.0$ Hz, 2H), 6.08 (t, $J = 10.4$ Hz, 1H), 4.68 (d, $J = 14.0$ Hz, 1H), 4.37 (d, $J = 14.0$ Hz, 1H), 4.31 – 4.20 (m, 2H), 3.81 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.63 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.32 (dt, $J = 33.6, 11.6$ Hz, 2H), 2.94 (t, $J = 12.4$ Hz, 1H), 2.22 (d, $J = 13.2$ Hz, 2H), 1.94 – 1.73 (m, 2H), 1.29 (t, $J = 6.8$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.32, 162.61 (d, $J = 7.6$ Hz), 161.18, 160.11 (d, $J = 7.6$ Hz), 152.24, 145.21, 142.10, 130.57 (t, $J = 10.6$ Hz), 117.75, 115.76 (t, $J = 16.1$ Hz), 111.99 – 111.74 (m), 72.86 (t, $J = 3.0$ Hz), 70.69, 46.14, 41.98, 41.54, 40.42, 32.84, 31.90, 14.55. HRMS (MALDI) 计算值 $\text{C}_{21}\text{H}_{23}\text{F}_2\text{N}_4\text{O}_3\text{S} [\text{M}+\text{H}]^+$ 449.1453, 实测值 449.1455.



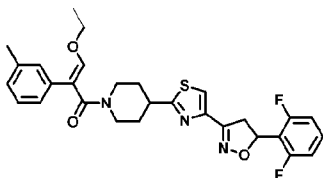
式(I-30). 白色固体; m.p. = 124-126°C. ^1H NMR (400 MHz, CDCl_3) δ 7.65 (d, $J = 3.6$ Hz, 1H), 7.36 – 7.26 (m, 1H), 6.92 (t, $J = 8.4$ Hz, 2H), 6.07 (dd, $J = 12.0, 9.2$ Hz, 1H), 5.17 (s, 1H), 4.39 (s, 2H), 3.89 – 3.76 (m, 3H), 3.67 – 3.55 (m, 1H), 3.36 – 3.27 (m, 1H), 3.00 (s, 2H), 2.29 – 2.16 (m, 5H), 1.88 – 1.71 (m, 2H), 1.34 (t, $J = 6.8$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.94, 167.50, 167.42, 162.64 (d, $J = 7.4$ Hz), 160.14 (d, $J = 7.3$ Hz), 152.26, 145.13, 130.54 (t, $J = 10.6$ Hz), 117.65, 115.79 (t, $J = 16.1$ Hz), 111.99 – 111.74 (m), 91.45, 72.87, 63.19, 41.57, 40.80, 32.64, 19.05, 14.37. HRMS (MALDI) 计算值 $\text{C}_{23}\text{H}_{26}\text{F}_2\text{N}_3\text{O}_3\text{S} [\text{M}+\text{H}]^+$ 462.1657, 实测值 462.1658.



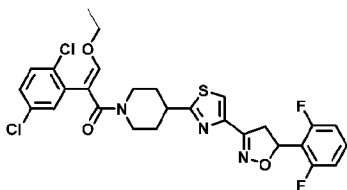
式(I-53). 白色固体; m.p. = 86-88°C. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.36 – 7.24 (m, 2H), 6.91 (t, $J = 8.0$ Hz, 2H), 6.07 (dd, $J = 12.0, 8.0$ Hz, 1H), 4.99 (dd, $J = 12.0, 8.0$ Hz, 1H), 4.62 (d, $J = 12.0$ Hz, 1H), 4.51 (dd, $J = 20.0, 8.0$ Hz, 1H), 3.99 (d, $J = 12.0$ Hz, 1H), 3.83 – 3.73 (m, 2H), 3.38 – 3.20 (m, 2H), 2.87 (ddd, $J = 13.2, 12.0, 4.0$ Hz, 1H), 2.19 (q, $J = 12.0, 8.4$ Hz, 2H), 2.02 – 1.68 (m, 2H), 1.17 (td, $J = 7.2, 1.6$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.29 (d, $J = 11.3$ Hz), 165.84 (d, $J = 20.7$ Hz), 162.63 (d, $J = 7.6$ Hz), 160.13 (d, $J = 7.6$ Hz), 152.28, 145.21 (d, $J = 2.4$ Hz), 130.56 (t, $J = 10.6$ Hz), 117.68 (d, $J = 8.7$ Hz), 115.78 (t, $J = 16.3$ Hz), 111.97 (d, $J = 5.9$ Hz), 111.77 (d, $J = 5.9$ Hz), 103.34 (d, $J = 38.4$ Hz), 72.87, 65.81 (d, $J = 12.4$ Hz), 64.21 (d, $J = 41.2$ Hz), 46.12 (d, $J = 32.9$ Hz), 42.59, 42.19 (d, $J = 38.0$ Hz), 41.58, 32.36, 31.65, 15.21. HRMS (MALDI) 计算值 $\text{C}_{22}\text{H}_{23}\text{BrF}_2\text{N}_3\text{O}_3\text{S} [\text{M}+\text{H}]^+$: 526.0606, 实测值 526.0604.



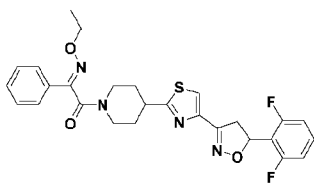
式 (I-59). 白色固体; m.p.=121~123°C. ^1H NMR (400 MHz, CDCl_3) δ 7.55 (s, 1H), 7.21–7.16 (m, 2H), 7.15–7.07 (m, 3H), 7.01 (s, 1H), 6.84 (t, J = 8.4 Hz, 2H), 5.99 (dd, J = 12.0, 9.2 Hz, 1H), 3.96 (m, 4H), 3.71 (dd, J = 17.2, 12 Hz, 1H), 3.53 (dd, J = 17.2, 9.2 Hz, 1H), 3.15–3.03 (m, 1H), 2.72 (t, J = 12.0 Hz, 2H), 2.20 (s, 3H), 1.86 (s, 2H), 1.38 (s, 2H), 1.23 (t, J = 7.1 Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.88, 170.07, 162.55 (d, J = 7.6 Hz), 160.05 (d, J = 7.5 Hz), 153.67, 152.17, 144.94, 136.42, 133.92, 130.79–130.27 (m), 130.06, 127.32, 125.60, 117.54, 114.22, 111.88 (d, J = 5.8 Hz), 111.68 (d, J = 5.6 Hz), 72.76 (d, J = 3.8 Hz), 69.83, 41.47, 40.44, 32.01, 20.14, 15.32. HRMS(MALDI)计算值 $\text{C}_{29}\text{H}_{29}\text{F}_2\text{N}_3\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$: 560.1790, 实测值 560.1790.



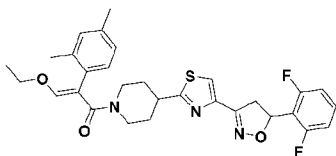
式 (I-60). 白色固体; m.p.=123~124°C. ^1H NMR (400 MHz, CDCl_3) δ 7.56 (d, J = 3.5 Hz, 1H), 7.25 (dd, J = 8.4, 6.4 Hz, 1H), 7.19 (s, 2H), 7.18–7.11 (m, 1H), 7.02 (s, 1H), 6.98 (t, J = 6.2 Hz, 1H), 6.85 (t, J = 8.0 Hz, 2H), 6.10–5.91 (m, 1H), 4.63 (d, J = 12.4 Hz, 1H), 3.94–3.82 (m, 1H), 3.73 (dd, J = 16.4, 4.0 Hz, 1H), 3.66 (s, 2H), 3.54 (ddd, J = 17.2, 9.2, 2.4 Hz, 1H), 3.18 (tdd, J = 14.8, 7.2, 3.6 Hz, 1H), 3.12–3.02 (m, 1H), 2.81–2.68 (m, 1H), 2.26 (s, 3H), 2.08 (d, J = 14.4 Hz, 1H), 1.96 (d, J = 10.4 Hz, 1H), 1.75–1.52 (m, 3H), 1.50–1.38 (m, 1H), 1.19 (t, J = 7.2 Hz, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.40, 174.16, 165.17, 164.81, 163.91 (d, J = 6.2 Hz), 160.00, 159.42, 145.68, 141.94, 134.78, 131.20, 130.08, 129.68, 128.59, 126.78, 125.40, 124.92 (d, J = 8.3 Hz), 124.07, 104.20, 61.51, 51.40, 44.95, 42.19–41.80 (m), 40.45, 38.61, 32.52, 31.68, 21.75, 14.37. HRMS(MALDI)计算值 $\text{C}_{29}\text{H}_{29}\text{F}_2\text{N}_3\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$: 560.1790, 实测值 560.1792.



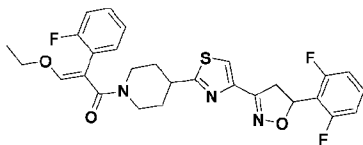
式 (I-63). 白色固体; m.p.=120~122°C. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.46 (d, J = 2.8 Hz, 1H), 7.38–7.27 (m, 2H), 7.26–7.16 (m, 1H), 7.07 (s, 1H), 6.94 (t, J = 8.4 Hz, 2H), 6.14–6.03 (m, 1H), 4.24 (d, J = 12.4 Hz, 1H), 4.15–4.06 (m, 2H), 3.81 (dd, J = 21.2, 8.8 Hz, 2H), 3.63 (dd, J = 17.6, 9.6 Hz, 1H), 3.23 (d, J = 11.6 Hz, 1H), 2.94 (t, J = 12.8 Hz, 2H), 1.63 (q, J = 12.4 Hz, 2H), 1.34 (t, J = 7.2 Hz, 3H), 1.26 (d, J = 16.8 Hz, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.86, 168.68, 162.68 (d, J = 7.5 Hz), 160.18 (d, J = 7.4 Hz), 154.94, 152.28, 145.12, 135.01, 132.40, 131.87, 130.86, 130.58 (t, J = 10.6 Hz), 128.60, 117.70, 112.02, 111.77, 111.25, 72.92, 70.44, 41.60, 40.56, 32.17, 15.42. HRMS(MALDI)计算值 $\text{C}_{28}\text{H}_{26}\text{Cl}_2\text{F}_2\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$: 592.1035, 实测值 592.1041.



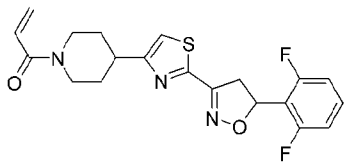
式 (I-64) . 白色固体; m.p.=74-75°C. ^1H NMR (400 MHz, CDCl_3) δ 7.68 – 7.60 (m, 3H), 7.40 – 7.36 (m, 3H), 7.30 (ddt, J = 8.4, 6.4, 2.0 Hz, 1H), 6.91 (td, J = 8.4, 2.8 Hz, 2H), 6.07 (ddd, J = 12.0, 9.2, 5.2 Hz, 1H), 4.78 (dd, J = 50.8, 13.6 Hz, 1H), 4.33 – 4.22 (m, 2H), 3.86 – 3.66 (m, 2H), 3.61 (dt, J = 17.2, 8.4 Hz, 1H), 3.39 – 3.27 (m, 1H), 3.10 (tdd, J = 14.4, 11.6, 2.8 Hz, 1H), 3.30 – 2.90 (m, 1H), 2.28 (dd, J = 23.6, 13.2 Hz, 1H), 2.12 (d, J = 10.4 Hz, 1H), 2.01 – 1.78 (m, 2H), 1.37 – 1.30 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.36 (d, J = 41.1 Hz), 163.51, 163.08, 160.14 (d, J = 7.5 Hz), 152.18, 151.96, 145.22 (d, J = 2.0 Hz), 130.99 (d, J = 7.6 Hz), 130.58 (t, J = 10.6 Hz), 130.20 (d, J = 1.6 Hz), 128.83 (d, J = 2.9 Hz), 126.15 (d, J = 2.7 Hz), 117.70 (d, J = 6.8 Hz), 115.77 (t, J = 16.2 Hz), 111.97 (d, J = 5.8 Hz), 111.78 (d, J = 5.6 Hz), 73.06 – 72.63 (m), 70.67, 46.11, 45.33, 41.54, 40.52 (dd, J = 38.6, 9.6 Hz), 32.97, 32.50 – 31.83 (m), 14.76 (d, J = 20.8 Hz). HRMS(MALDI)计算值 $\text{C}_{27}\text{H}_{26}\text{F}_2\text{N}_4\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$: 547.1586, 实测值 547.1583.



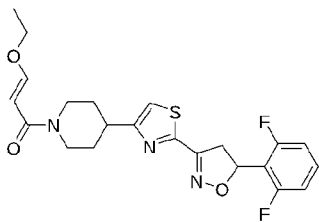
式 (I-78) . 白色固体; m.p.=78-80 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.71 – 7.55 (m, 1H), 7.34 – 7.20 (m, 3H), 7.12 (t, J = 6.8 Hz, 2H), 6.91 (t, J = 8.4 Hz, 2H), 6.06 (q, J = 10.4 Hz, 1H), 4.97 (dd, J = 8.0, 1.2 Hz, 1H), 4.65 (dd, J = 36.0, 13.6 Hz, 1H), 4.12 – 3.93 (m, 2H), 3.88 – 3.70 (m, 2H), 3.62 (dd, J = 19.6, 9.2 Hz, 1H), 3.21 (d, J = 11.2 Hz, 1H), 3.15 (s, 3H), 2.76 (t, J = 12.4 Hz, 1H), 2.43 – 2.27 (m, 3H), 2.09 (t, J = 20.0 Hz, 2H), 1.95 – 1.70 (m, 2H), 0.91 (t, J = 6.8 Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.84, 169.95 – 169.10 (m), 162.63 (d, J = 7.4 Hz), 160.13 (d, J = 7.7 Hz), 152.22, 145.02 (d, J = 14.6 Hz), 137.01, 132.23, 130.54 (t, J = 10.6 Hz), 129.79 (d, J = 6.1 Hz), 129.49 – 129.21 (m), 128.76 (d, J = 6.9 Hz), 128.62 (d, J = 7.2 Hz), 117.64 (d, J = 8.3 Hz), 115.86 (d, J = 16.2 Hz), 111.96 (d, J = 5.8 Hz), 111.77 (d, J = 5.7 Hz), 72.86, 64.66 (d, J = 8.4 Hz), 56.16 (d, J = 10.1 Hz), 45.43 (d, J = 8.2 Hz), 41.62 (d, J = 14.2 Hz), 40.47, 32.19 (t, J = 39.6 Hz), 21.12, 15.07. HRMS(MALDI)计算值 $\text{C}_{30}\text{H}_{31}\text{F}_2\text{N}_3\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$: 574.1946, 实测值 574.1947.



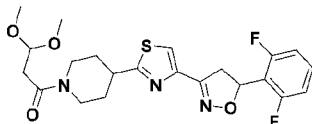
式 (I-81) . 白色固体; m.p.=82-84°C. ^1H NMR (400 MHz, CDCl_3) δ 7.63 (s, 1H), 7.48 (td, J = 7.2, 1.6 Hz, 1H), 7.34 – 7.27 (m, 1H), 7.25 – 7.21 (m, 1H), 7.17 – 7.10 (m, 1H), 7.05 (ddd, J = 10.4, 8.0, 1.2 Hz, 1H), 6.95 – 6.87 (m, 3H), 6.06 (dd, J = 12.0, 9.2 Hz, 1H), 4.21 (s, 1H), 4.12 (qd, J = 7.2, 1.6 Hz, 1H), 4.04 (q, J = 7.2 Hz, 2H), 3.78 (dd, J = 17.2, 12.0 Hz, 1H), 3.60 (dd, J = 17.2, 9.2 Hz, 1H), 3.26 – 3.12 (m, 1H), 2.89 (t, J = 12.4 Hz, 2H), 2.00 (s, 2H), 1.57 (s, 2H), 1.31 (td, J = 6.8, 2.8 Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.98, 169.39, 161.38 (dd, J = 251.5, 7.6 Hz), 160.49, 158.02, 153.00, 152.26, 145.04, 131.10 (d, J = 3.6 Hz), 130.56 (t, J = 10.6 Hz), 128.95 (d, J = 8.3 Hz), 124.01 (d, J = 3.3 Hz), 122.28 (d, J = 14.4 Hz), 117.70, 115.98 – 115.36 (m), 111.99, 111.74, 108.77, 72.86, 70.10, 41.54, 40.57, 32.11, 15.36. HRMS(MALDI)计算值 $\text{C}_{28}\text{H}_{26}\text{F}_3\text{N}_3\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$: 564.1539, 实测值 564.1534.



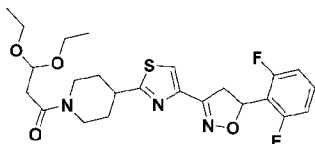
式 (I-134). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.36 – 7.28 (m, 1H), 7.00 (s, 1H), 6.96 – 6.89 (m, 2H), 6.61 (dd, J = 16.8, 10.6 Hz, 1H), 6.28 (dd, J = 16.8, 1.6 Hz, 1H), 6.13 (dd, J = 12.0, 9.2 Hz, 1H), 5.69 (dd, J = 10.6, 2.0 Hz, 1H), 4.81 – 4.69 (m, 1H), 4.15 – 4.04 (m, 1H), 3.87 (dd, J = 17.6, 12.0 Hz, 1H), 3.68 (dd, J = 17.4, 9.2 Hz, 1H), 3.28 – 3.13 (m, 1H), 3.07 (tt, J = 11.6, 3.6 Hz, 1H), 2.86 – 2.73 (m, 1H), 2.12 (d, J = 13.2 Hz, 2H), 1.75 – 1.64 (m, 2H). HRMS(MALDI)计算值 $\text{C}_{20}\text{H}_{20}\text{F}_2\text{N}_3\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$: 404.1239, 实测值 404.1242.



式 (I-135). 白色固体; m.p. = 81-83°C. ^1H NMR (400 MHz, CDCl_3) δ 7.58 (d, J = 11.6 Hz, 1H), 7.35 – 7.27 (m, 1H), 7.01 – 6.98 (m, 1H), 6.96 – 6.89 (m, 2H), 6.12 (dd, J = 12.0, 9.2 Hz, 1H), 5.70 (d, J = 11.6 Hz, 1H), 4.72 (d, J = 13.6 Hz, 1H), 3.97 – 3.82 (m, 3H), 3.72 – 3.64 (m, 2H), 3.26 – 3.12 (m, 1H), 3.07 – 3.01 (m, 1H), 2.83 – 2.69 (m, 1H), 2.12 – 2.07 (m, 2H), 1.72 – 1.65 (m, 2H), 1.33 (t, J = 7.2 Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 166.21, 162.54 (d, J = 7.6 Hz), 161.80, 161.20, 160.04 (d, J = 7.5 Hz), 156.72, 153.31, 130.75 (t, J = 10.6 Hz), 115.34 (t, J = 16.0 Hz), 114.32, 111.96 (d, J = 5.9 Hz), 111.77 (d, J = 5.2 Hz), 95.55, 73.94, 67.45, 46.44 – 44.90 (m), 40.56, 38.69, 32.15, 31.33, 27.06, 14.72. HRMS(MALDI)计算值 $\text{C}_{22}\text{H}_{24}\text{F}_2\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$: 448.1501, 实测值 448.1501.

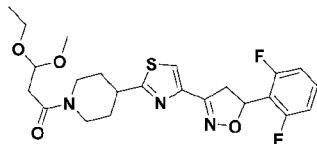


式(II-1). 白色固体; m.p. = 96-98°C. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.35 – 7.27 (m, 1H), 6.92 (t, J = 8.0 Hz, 2H), 6.07 (dd, J = 12.0, 9.2 Hz, 1H), 4.84 (t, J = 5.6 Hz, 1H), 4.69 (d, J = 13.6 Hz, 1H), 4.02 (d, J = 13.6 Hz, 1H), 3.80 (dd, J = 17.2, 12.0 Hz, 1H), 3.63 (dd, J = 17.2, 9.2 Hz, 1H), 3.42 (d, J = 2.4 Hz, 6H), 3.35 – 3.27 (m, 1H), 3.20 (t, J = 12.8 Hz, 1H), 2.79 (t, J = 12.8 Hz, 1H), 2.71 (t, J = 5.2 Hz, 2H), 2.18 (t, J = 13.6 Hz, 2H), 1.87 – 1.68 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.62, 167.84, 162.62 (d, J = 7.6 Hz), 160.12 (d, J = 7.5 Hz), 152.26, 145.18, 130.55 (t, J = 10.7 Hz), 117.66, 115.77 (t, J = 16.1 Hz), 111.98 – 111.73 (m), 103.33, 72.85 (t, J = 3.0 Hz), 54.82, 54.58, 45.76, 41.56 (d, J = 2.4 Hz), 41.44, 40.50, 37.75, 32.80, 32.09. HRMS (MALDI)计算值 $\text{C}_{22}\text{H}_{25}\text{F}_2\text{N}_3\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 488.1426, 实测值 488.1426.

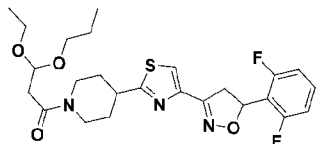


式(II-2). 黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.69 (s, 1H), 7.38 – 7.30 (m, 1H), 6.95 (t, J = 8.0 Hz, 2H), 6.10 (dd, J = 12.0, 9.2 Hz, 1H), 4.98 (t, J = 5.6 Hz, 1H), 4.73 (d, J = 13.6 Hz, 1H), 4.11 (d, J = 12.0 Hz, 1H), 3.89 – 3.72 (m, 3H), 3.70 – 3.57 (m, 3H), 3.39 – 3.29 (m, 1H), 3.23 (t, J = 12.8 Hz, 1H), 2.86 – 2.69 (m, 3H), 2.20 (s, 2H), 1.93 – 1.71

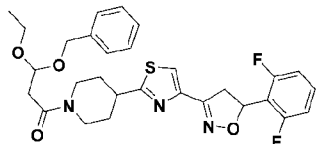
(m, 2H), 1.25 (t, $J = 7.2$ Hz, 6H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.67, 168.07, 162.62 (d, $J = 7.6$ Hz), 160.12 (d, $J = 7.7$ Hz), 152.29, 145.16, 130.55 (t, $J = 10.6$ Hz), 117.60, 115.78 (t, $J = 16.1$ Hz), 111.98 - 111.73 (m), 101.72, 72.85 (t, $J = 3.0$ Hz), 63.35, 63.15, 45.96, 41.57, 41.45, 40.57, 38.76, 32.81, 32.20, 15.40, 15.38. HRMS (MALDI) 计算值 $\text{C}_{24}\text{H}_{29}\text{F}_2\text{N}_3\text{NaO}_4\text{S} [\text{M}+\text{Na}]^+$ 516.1739, 实测值 516.1738.



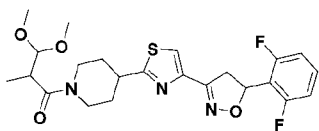
式(II-3). 黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.35 - 7.26 (m, 1H), 6.92 (t, $J = 8.0$ Hz, 2H), 6.07 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.93 - 4.87 (m, 1H), 4.73 - 4.63 (m, 1H), 4.09 - 4.01 (m, 1H), 3.80 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.76 - 3.68 (m, 1H), 3.67 - 3.54 (m, 2H), 3.42 (d, $J = 3.2$ Hz, 3H), 3.35 - 3.26 (m, 1H), 3.25 - 3.16 (m, 1H), 2.85 - 2.76 (m, 1H), 2.76 - 2.66 (m, 2H), 2.23 - 2.13 (m, 2H), 1.86 - 1.67 (m, 2H), 1.22 (t, $J = 7.2$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.66, 168.06, 162.63 (d, $J = 7.6$ Hz), 160.13 (d, $J = 7.6$ Hz), 152.27, 145.16, 130.54 (t, $J = 10.6$ Hz), 117.63, 115.77 (t, $J = 16.2$ Hz), 111.98 - 111.73 (m), 102.54, 72.86 (t, $J = 3.0$ Hz), 63.45, 54.52, 45.90, 41.56, 41.49, 40.52, 38.16, 32.80, 32.10, 15.35 (d, $J = 2.9$ Hz). HRMS (MALDI) 计算值 $\text{C}_{23}\text{H}_{28}\text{F}_2\text{N}_3\text{O}_4\text{S} [\text{M}+\text{H}]^+$: 480.1763, 实测值 480.1761.



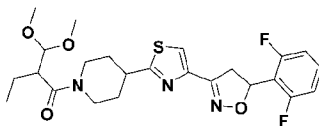
式(II-4). 黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.70 (s, 1H), 7.39 - 7.31 (m, 1H), 6.95 (t, $J = 8.0$ Hz, 2H), 6.11 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.98 (q, $J = 4.8$ Hz, 1H), 4.77 - 4.69 (m, 1H), 4.15 - 4.08 (m, 1H), 3.90 - 3.73 (m, 2H), 3.70 - 3.58 (m, 3H), 3.54 - 3.46 (m, 1H), 3.39 - 3.29 (m, 1H), 3.23 (t, $J = 12.8$ Hz, 1H), 2.86 - 2.70 (m, 3H), 2.20 (s, 2H), 1.84 (s, 2H), 1.64 (q, $J = 7.2$ Hz, 2H), 1.25 (t, $J = 7.2$ Hz, 3H), 0.99 - 0.92 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.66, 168.08, 162.60 (d, $J = 7.7$ Hz), 160.10 (d, $J = 7.5$ Hz), 152.27, 145.14, 130.54 (t, $J = 10.6$ Hz), 117.62, 115.76 (t, $J = 16.2$ Hz), 111.96 - 111.71 (m), 101.80 (d, $J = 7.1$ Hz), 72.82 (t, $J = 2.9$ Hz), 69.43 (d, $J = 16.3$ Hz), 63.15 (d, $J = 20.2$ Hz), 45.95 (d, $J = 6.2$ Hz), 41.55, 41.42 (d, $J = 4.0$ Hz), 40.55 (d, $J = 3.1$ Hz), 38.65, 32.80, 32.17, 23.09, 15.37 (d, $J = 2.9$ Hz), 10.63 (d, $J = 2.2$ Hz). HRMS (MALDI) 计算值 $\text{C}_{25}\text{H}_{31}\text{F}_2\text{N}_3\text{NaO}_4\text{S} [\text{M}+\text{Na}]^+$ 530.1896, 实测值 530.1899.



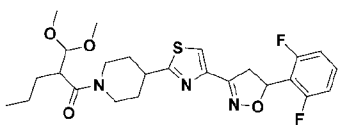
式(II-5). 黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.70 (s, 1H), 7.38 (t, $J = 4.8$ Hz, 4H), 7.35 - 7.32 (m, 2H), 6.96 (t, $J = 8.0$ Hz, 2H), 6.11 (dd, $J = 12.0, 9.2$ Hz, 1H), 5.15 (t, $J = 5.6$ Hz, 1H), 4.81 - 4.70 (m, 2H), 4.64 (dd, $J = 11.6, 4.8$ Hz, 1H), 4.08 (d, $J = 13.6$ Hz, 1H), 3.90 - 3.75 (m, 2H), 3.71 - 3.60 (m, 2H), 3.31 (d, $J = 4.4$ Hz, 1H), 3.19 (q, $J = 12.0$ Hz, 1H), 2.92 - 2.73 (m, 3H), 2.19 (d, $J = 13.6$ Hz, 2H), 1.89 - 1.68 (m, 2H), 1.27 (t, $J = 7.2$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.64, 167.91, 162.64 (d, $J = 7.6$ Hz), 160.14 (d, $J = 7.6$ Hz), 152.30, 145.18, 137.99, 130.55 (t, $J = 10.6$ Hz), 128.40, 127.83, 127.75, 127.69, 117.60, 115.80 (t, $J = 16.2$ Hz), 111.99 - 111.74 (m), 101.52, 72.86 (t, $J = 3.2$ Hz), 69.35, 63.09, 45.92, 41.58, 40.52, 38.70, 32.69, 32.00, 15.40, 15.38. HRMS (MALDI) 计算值 $\text{C}_{29}\text{H}_{31}\text{F}_2\text{N}_3\text{NaO}_4\text{S} [\text{M}+\text{Na}]^+$ 530.1896, 实测值 530.1897.



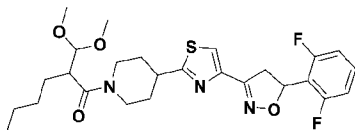
式(II-6). 白色固体; m.p.= 58-60°C. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.34 – 7.27 (m, 1H), 6.92 (t, J = 8.0 Hz, 2H), 6.07 (dd, J = 12.0, 9.2 Hz, 1H), 4.74 (d, J = 13.6 Hz, 1H), 4.51 (dd, J = 15.2, 8.0 Hz, 1H), 4.10 (dd, J = 25.2, 13.6 Hz, 1H), 3.81 (dd, J = 17.2, 12.0 Hz, 1H), 3.63 (dd, J = 17.2, 9.2 Hz, 1H), 3.42 (d, J = 6.8 Hz, 6H), 3.32 (s, 1H), 3.19 (dd, J = 22.8, 11.4 Hz, 1H), 3.05 (q, J = 7.2 Hz, 1H), 2.89 – 2.69 (m, 1H), 2.21 (dd, J = 27.9, 12.8 Hz, 2H), 1.92 – 1.65 (m, 2H), 1.16 (dd, J = 7.2, 3.2 Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 175.00, 172.25, 162.64 (d, J = 7.8 Hz), 160.14 (d, J = 7.5 Hz), 152.27, 145.15, 130.55 (t, J = 10.6 Hz), 117.63, 115.79 (t, J = 16.1 Hz), 111.99 - 111.74 (m), 107.72, 72.88, 56.80, 53.75, 45.82, 41.84, 41.59, 40.78, 39.44, 32.95, 32.38, 13.81. HRMS (MALDI)计算值 $\text{C}_{23}\text{H}_{27}\text{F}_2\text{N}_3\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 502.1583, 实测值 502.1583.



式(II-7). 黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.38 – 7.24 (m, 1H), 6.92 (t, J = 8.0 Hz, 2H), 6.07 (dd, J = 12.0, 9.2 Hz, 1H), 4.74 (dd, J = 32.8, 13.6 Hz, 1H), 4.48 (dd, J = 8.0, 5.6 Hz, 1H), 4.23 – 4.10 (m, 1H), 3.80 (dd, J = 17.2, 12.0 Hz, 1H), 3.63 (dd, J = 17.2, 9.2 Hz, 1H), 3.45 – 3.34 (m, 6H), 3.34 – 3.26 (m, 1H), 3.26 – 3.15 (m, 1H), 3.02 – 2.93 (m, 1H), 2.92 – 2.73 (m, 1H), 2.29 – 2.12 (m, 2H), 1.91 – 1.59 (m, 4H), 0.92 – 0.81 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 175.09, 171.50, 162.63 (d, J = 7.5 Hz), 160.13 (d, J = 7.6 Hz), 152.29, 145.17, 130.55 (t, J = 10.6 Hz), 117.61, 115.77 (t, J = 16.1 Hz), 111.98 - 111.73 (m), 107.37, 72.86 (t, J = 3.0 Hz), 56.82, 53.99, 46.89, 41.95, 41.56, 40.83, 40.51, 32.99, 32.47, 22.10, 11.63. HRMS (MALDI)计算值 $\text{C}_{23}\text{H}_{27}\text{F}_2\text{N}_3\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 516.1739, 实测值 516.1742.

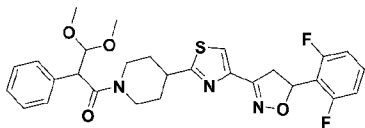


式(II-8). 黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (d, J = 3.6 Hz, 1H), 7.34 – 7.26 (m, 1H), 6.92 (t, J = 8.0 Hz, 2H), 6.07 (dd, J = 12.0, 9.2 Hz, 1H), 4.82 – 4.63 (m, 1H), 4.46 (dd, J = 8.4, 2.0 Hz, 1H), 4.16 (dd, J = 18.8, 14.4 Hz, 1H), 3.80 (dd, J = 16.8, 12.0 Hz, 1H), 3.63 (dd, J = 17.2, 9.2 Hz, 1H), 3.41 (d, J = 2.8 Hz, 3H), 3.37 (s, 1H), 3.34 – 3.25 (m, 1H), 3.25 – 3.15 (m, 1H), 3.09 – 3.00 (m, 1H), 2.93 – 2.70 (m, 1H), 2.28 – 2.13 (m, 2H), 1.94 (s, 2H), 1.80 – 1.69 (m, 2H), 1.58 – 1.47 (m, 1H), 1.43 – 1.33 (m, 1H), 1.33 – 1.17 (m, 2H), 0.98 – 0.88 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 175.10, 171.63, 162.63 (d, J = 7.5 Hz), 160.13 (d, J = 7.7 Hz), 152.29, 145.17, 130.54 (t, J = 10.6 Hz), 117.68, 115.78 (t, J = 16.2 Hz), 111.98 - 111.73 (m), 107.51, 77.39, 77.07, 76.75, 72.86, 56.86, 53.97, 46.03, 45.19, 41.96, 41.55, 40.84, 33.18, 31.07, 22.61, 20.42, 14.16. HRMS (MALDI)计算值 $\text{C}_{25}\text{H}_{31}\text{F}_2\text{N}_3\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 530.1896, 实测值 530.1899.

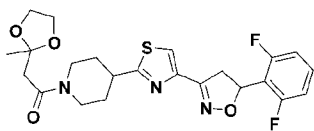


式(II-9). 黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (d, J = 4.0 Hz, 1H), 7.34 – 7.27 (m, 1H), 6.92 (t, J = 8.0 Hz,

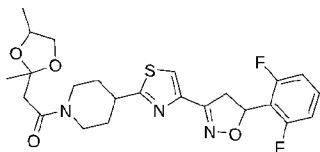
2H), 6.07 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.73 (dd, $J = 42.0, 13.2$ Hz, 1H), 4.46 (dd, $J = 8.0, 3.6$ Hz, 1H), 4.16 (t, $J = 16.7$ Hz, 1H), 3.80 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.63 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.47 (s, 1H), 3.44 – 3.39 (m, 3H), 3.37 (s, 1H), 3.35 – 3.27 (m, 1H), 3.26 – 3.15 (m, 1H), 3.06 – 2.99 (m, 1H), 2.93 – 2.72 (m, 1H), 2.18 (t, $J = 15.6$ Hz, 2H), 1.98 – 1.86 (m, 1H), 1.83 – 1.68 (m, 2H), 1.62 – 1.52 (m, 1H), 1.40 – 1.11 (m, 5H), 0.88 (t, $J = 7.2$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.72, 171.65, 162.63 (d, $J = 7.5$ Hz), 160.14 (d, $J = 7.7$ Hz), 152.28, 145.16, 130.54 (t, $J = 10.6$ Hz), 117.67, 115.78 (t, $J = 16.3$ Hz), 111.98 - 111.73 (m), 107.52, 72.87, 56.87, 53.95, 46.03, 45.36, 41.98, 41.56, 40.85, 33.01, 32.50, 29.41, 28.71, 22.83, 13.99. HRMS (MALDI)计算值 $\text{C}_{26}\text{H}_{33}\text{F}_2\text{N}_3\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 544.2052, 实测值 544.2055.



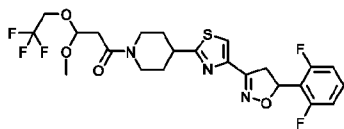
式(II-10). 白色固体; m.p.= 69-71°C. ^1H NMR (400 MHz, CDCl_3) δ 7.68 – 7.56 (m, 1H), 7.38 (d, $J = 5.6$ Hz, 2H), 7.36 – 7.26 (m, 4H), 6.91 (t, $J = 8.4$ Hz, 2H), 6.05 (q, $J = 11.2$ Hz, 1H), 4.98 (d, $J = 8.0$ Hz, 1H), 4.65 (dd, $J = 40.0, 13.6$ Hz, 1H), 4.11 – 3.96 (m, 2H), 3.85 – 3.68 (m, 1H), 3.67 – 3.55 (m, 1H), 3.54 – 3.48 (m, 3H), 3.25 – 3.16 (m, 2H), 3.14 (d, $J = 2.4$ Hz, 3H), 2.77 (s, 1H), 2.16 – 2.04 (m, 1H), 1.87 (d, $J = 12.8$ Hz, 1H), 1.82 – 0.77 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.72, 169.09, 162.63 (d, $J = 7.4$ Hz), 160.13 (d, $J = 7.4$ Hz), 152.19, 144.95, 135.33, 130.54 (t, $J = 10.7$ Hz), 128.84, 128.76, 127.50, 117.67, 117.59, 115.78 (t, $J = 16.0$ Hz), 111.99 - 111.74 (m), 107.42, 107.30, 72.86, 56.56, 55.50, 53.15, 45.43, 41.76, 41.55, 40.44, 32.22, 31.77. HRMS (MALDI)计算值 $\text{C}_{28}\text{H}_{29}\text{F}_2\text{N}_3\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 564.1739, 实测值 564.1738.



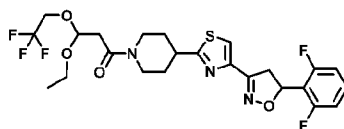
式(II-11). 白色固体; m.p.= 126-128°C. ^1H NMR (400 MHz, CDCl_3) δ 7.69 (s, 1H), 7.38 – 7.31 (m, 1H), 6.95 (t, $J = 8.4$ Hz, 2H), 6.11 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.77 (d, $J = 13.2$ Hz, 1H), 4.14 (dd, $J = 14.4, 7.4$ Hz, 1H), 4.05 – 3.94 (m, 4H), 3.84 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.66 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.39 – 3.29 (m, 1H), 3.24 (t, $J = 12.8$ Hz, 1H), 2.89 – 2.75 (m, 3H), 2.22 (s, 2H), 1.81 (dd, $J = 28.8, 13.6$ Hz, 2H), 1.52 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.79, 167.48, 162.61 (d, $J = 7.5$ Hz), 160.11 (d, $J = 7.5$ Hz), 152.26, 145.15, 130.56 (t, $J = 10.7$ Hz), 117.69, 115.76 (t, $J = 16.2$ Hz), 111.98 - 111.73 (m), 108.71, 72.85 (t, $J = 3.0$ Hz), 64.78, 64.74, 46.49, 43.10, 41.55, 41.41, 40.51, 32.82, 32.15, 24.66. HRMS (MALDI)计算值 $\text{C}_{23}\text{H}_{25}\text{F}_2\text{N}_3\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 500.1426, 实测值 500.1425.



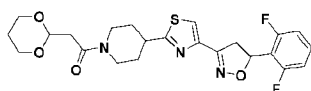
式(II-12). 黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.69 (s, 1H), 7.37 – 7.31 (m, 1H), 6.95 (t, $J = 8.0$ Hz, 2H), 6.10 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.76 (d, $J = 12.8$ Hz, 1H), 4.32 – 4.18 (m, 1H), 4.14 – 4.06 (m, 2H), 3.84 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.66 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.54 – 3.40 (m, 1H), 3.38 – 3.29 (m, 1H), 3.24 (s, 1H), 2.86 (s, 1H), 2.85 – 2.76 (m, 2H), 2.21 (s, 2H), 1.81 (dd, $J = 32.4, 12.7$ Hz, 2H), 1.52 (d, $J = 21.2$ Hz, 3H), 1.32 (d, $J = 6.0$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.79, 167.64, 162.61 (d, $J = 7.6$ Hz), 160.11 (d, $J = 7.5$ Hz), 152.27, 145.14, 130.56 (t, $J = 10.6$ Hz), 117.68, 115.76 (t, $J = 16.1$ Hz), 111.97 - 111.72 (m), 108.95, 72.84, 70.98, 46.49, 44.05, 43.30, 41.54, 41.39, 40.49, 32.77, 32.16, 24.83, 18.26. HRMS (MALDI)计算值 $\text{C}_{24}\text{H}_{27}\text{F}_2\text{N}_3\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 514.1583, 实测值 514.1580.



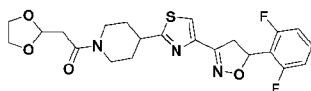
式(II-18). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.65 (s, 1H), 7.31 (tt, $J = 8.4, 6.6$ Hz, 1H), 6.92 (t, $J = 8.3$ Hz, 2H), 6.07 (dd, $J = 12.0, 9.2$ Hz, 1H), 5.07 (q, $J = 5.6$ Hz, 1H), 4.72 – 4.61 (m, 1H), 4.04 – 3.90 (m, 3H), 3.80 (dd, $J = 17.1, 12.0$ Hz, 1H), 3.63 (dd, $J = 17.1, 9.2$ Hz, 1H), 3.44 (d, $J = 2.8$ Hz, 3H), 3.31 (tt, $J = 11.4, 3.9$ Hz, 1H), 3.21 (t, $J = 11.9$ Hz, 1H), 2.86 – 2.68 (m, 3H), 2.24 – 2.12 (m, 2H), 1.87 – 1.66 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.53, 167.10 (d, $J = 2.5$ Hz), 162.67 (d, $J = 7.6$ Hz), 160.17 (d, $J = 7.5$ Hz), 152.31, 145.23 (d, $J = 3.6$ Hz), 130.61 (t, $J = 10.6$ Hz), 122.47 (q, $J = 278.2$ Hz), 117.77 (d, $J = 3.5$ Hz), 115.80 (t, $J = 16.3$ Hz), 112.00 (d, $J = 5.8$ Hz), 111.81 (d, $J = 5.9$ Hz), 102.94 (d, $J = 7.3$ Hz), 72.90, 64.75 – 63.33 (m), 54.71 (d, $J = 20.6$ Hz), 45.71 (d, $J = 3.0$ Hz), 41.57, 41.49 (d, $J = 3.8$ Hz), 40.47 (d, $J = 8.5$ Hz), 37.69 (d, $J = 20.2$ Hz), 32.73, 32.05. HRMS(MALDI)计算值 $\text{C}_{23}\text{H}_{24}\text{F}_5\text{N}_3\text{NaO}_4\text{S}[\text{M}+\text{Na}]^+$: 556.1300, 实测值 556.1301.



式(II-19). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.66 (s, 1H), 7.42 – 7.19 (m, 1H), 6.92 (t, $J = 8.2$ Hz, 2H), 6.07 (dd, $J = 11.9, 9.1$ Hz, 1H), 5.12 (q, $J = 5.2$ Hz, 1H), 4.68 (d, $J = 13.3$ Hz, 1H), 4.05 – 3.90 (m, 3H), 3.86 – 3.69 (m, 2H), 3.69 – 3.55 (m, 2H), 3.31 (tt, $J = 11.4, 3.9$ Hz, 1H), 3.21 (t, $J = 12.6$ Hz, 1H), 2.86 – 2.67 (m, 3H), 2.19 (t, $J = 13.7$ Hz, 2H), 1.88 – 1.64 (m, 2H), 1.27 – 1.20 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.53, 171.20, 167.21, 162.66 (d, $J = 7.6$ Hz), 160.16 (d, $J = 7.7$ Hz), 152.31, 145.22 (d, $J = 4.2$ Hz), 130.59 (t, $J = 10.6$ Hz), 123.87 (q, $J = 278.1$ Hz), 117.73 (d, $J = 6.2$ Hz), 115.81 (t, $J = 16.2$ Hz), 111.99 (d, $J = 5.7$ Hz), 111.80 (d, $J = 5.6$ Hz), 102.01 (d, $J = 9.7$ Hz), 72.90, 64.58 – 63.56 (m), 63.42 (d, $J = 17.7$ Hz), 45.80, 41.55 (d, $J = 7.6$ Hz), 40.51 (d, $J = 6.4$ Hz), 38.19 (d, $J = 6.6$ Hz), 32.73 (d, $J = 6.6$ Hz), 32.10, 15.16. HRMS(MALDI)计算值 $\text{C}_{24}\text{H}_{26}\text{F}_5\text{N}_3\text{NaO}_4\text{S}[\text{M}+\text{Na}]^+$: 570.1456, 实测值 570.1455.

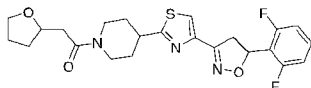


式(II-21). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.68 (s, 1H), 7.36 – 7.30 (m, 1H), 6.99 – 6.88 (m, 2H), 6.09 (dd, $J = 12.0, 9.2$ Hz, 1H), 5.07 (t, $J = 5.2$ Hz, 1H), 4.71 (d, $J = 13.4$ Hz, 1H), 4.15 – 4.09 (m, 2H), 4.05 (d, $J = 13.4$ Hz, 1H), 3.89 – 3.78 (m, 3H), 3.65 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.32 (tt, $J = 11.6, 3.6$ Hz, 1H), 3.25 – 3.16 (m, 1H), 2.85 – 2.76 (m, 1H), 2.73 (dd, $J = 5.2, 1.6$ Hz, 2H), 2.25 – 2.09 (m, 3H), 1.88 – 1.70 (m, 2H), 1.43 – 1.33 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.65, 167.33, 162.55 (d, $J = 7.6$ Hz), 160.05 (d, $J = 7.6$ Hz), 152.21, 145.07, 130.47 (t, $J = 10.6$ Hz), 117.60, 115.70 (t, $J = 16.2$ Hz), 111.88 (d, $J = 5.8$ Hz), 111.69 (d, $J = 5.8$ Hz), 99.82, 72.79 (t, $J = 2.9$ Hz), 66.93 (d, $J = 1.9$ Hz), 45.74, 41.48 (t, $J = 2.1$ Hz), 41.39, 40.45, 39.20, 32.71, 31.96, 25.50. HRMS(MALDI)计算值 $\text{C}_{23}\text{H}_{25}\text{F}_2\text{N}_3\text{NaO}_4\text{S}[\text{M}+\text{Na}]^+$: 500.1426, 实测值 500.1424.

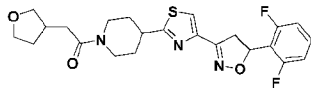


式(II-22). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.64 (s, 1H), 7.36 – 7.25 (m, 1H), 6.91 (t, $J = 8.4$ Hz, 2H), 6.07 (dd, $J = 12.0, 9.2$ Hz, 1H), 5.31 (t, $J = 4.8$ Hz, 1H), 4.71 (d, $J = 13.6$ Hz, 1H), 4.03 – 3.88 (m, 5H), 3.79 (dd, $J =$

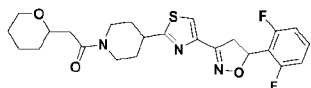
17.1, 12.0 Hz, 1H), 3.62 (dd, $J = 16.8, 9.2$ Hz, 1H), 3.34 – 3.24 (m, 1H), 3.24 – 3.16 (m, 1H), 2.85 – 2.74 (m, 3H), 2.18 (t, $J = 16.2$ Hz, 2H), 1.87 – 1.70 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.57, 167.24, 162.60 – 162.51 (m), 160.17 – 160.00 (m), 152.21, 145.11, 130.50, 117.65, 115.71, 111.91, 111.71, 101.82, 72.82, 64.94, 45.63, 41.50, 41.30, 40.45, 38.29, 32.71, 31.93. HRMS(MALDI)计算值 $\text{C}_{22}\text{H}_{23}\text{F}_2\text{N}_3\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$:486.1270, 实测值 486.1268.



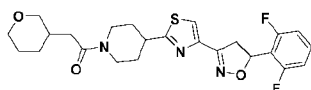
式 (II-23). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.65 (s, 1H), 7.35 – 7.26 (m, 1H), 6.91 (t, $J = 8.0$ Hz, 2H), 6.06 (t, $J = 10.4$ Hz, 1H), 4.68 (s, 1H), 4.26 (t, $J = 6.4$ Hz, 1H), 4.07 – 3.96 (m, 1H), 3.91 – 3.68 (m, 3H), 3.62 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.30 (t, $J = 11.6$ Hz, 1H), 3.19 (s, 1H), 2.83-2.72 (m, 1H), 2.55-2.44 (m, 1H), 2.24 – 2.02 (m, 4H), 1.90 (t, $J = 7.2$ Hz, 2H), 1.84 – 1.69 (m, 2H), 1.64 – 1.51 (m, 1H). HRMS(MALDI)计算值 $\text{C}_{23}\text{H}_{25}\text{F}_2\text{N}_3\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$:484.1477, 实测值 484.1476.



式 (II-24). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.64 (s, 1H), 7.33 – 7.27 (m, 1H), 6.95 – 6.87 (m, 2H), 6.06 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.66 (d, $J = 13.2$ Hz, 1H), 4.02 – 3.90 (m, 2H), 3.91 – 3.80 (m, 1H), 3.80 – 3.71 (m, 2H), 3.62 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.43 (t, $J = 6.8$ Hz, 1H), 3.29 (tt, $J = 11.2, 4.0$ Hz, 1H), 3.18 (t, $J = 12.8$ Hz, 1H), 2.79 (m, 1H), 2.71 (m, 1H), 2.52 – 2.39 (m, 2H), 2.25 – 2.11 (m, 3H), 1.82 – 1.69 (m, 2H), 1.56 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.45, 170.00, 162.56 (d, $J = 7.7$ Hz), 160.06 (d, $J = 7.5$ Hz), 152.16, 145.12, 130.50 (t, $J = 10.6$ Hz), 117.64, 115.69 (t, $J = 16.2$ Hz), 111.89 (d, $J = 5.9$ Hz), 111.70 (d, $J = 5.7$ Hz), 73.27, 72.80 (t, $J = 3.1$ Hz), 67.58, 45.14, 41.49, 41.32, 40.45, 37.02, 35.49, 32.72, 32.18, 32.05. HRMS(MALDI)计算值 $\text{C}_{23}\text{H}_{25}\text{F}_2\text{N}_3\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$:484.1477, 实测值 484.1475.

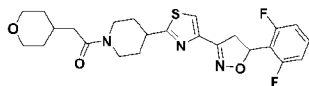


式 (II-25). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.64 (s, 1H), 7.33 – 7.26 (m, 1H), 6.94 – 6.87 (m, 2H), 6.06 (dd, $J = 11.6, 9.2$ Hz, 1H), 4.69 (t, $J = 14.8$ Hz, 1H), 4.08 – 3.99 (m, 1H), 3.96 – 3.91 (m, 1H), 3.84 – 3.74 (m, 2H), 3.61 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.51 – 3.40 (m, 1H), 3.34 – 3.21 (m, 1H), 3.23 – 3.11 (m, 1H), 2.84 – 2.71 (m, 1H), 2.73 – 2.61 (m, 1H), 2.39 – 2.28 (m, 1H), 2.21 – 2.10 (m, 2H), 1.85 – 1.67 (m, 4H), 1.59 – 1.45 (m, 3H), 1.37 – 1.26 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 174.88, 174.67, 169.46, 169.30, 162.58 (d, $J = 7.5$ Hz), 160.08 (d, $J = 7.6$ Hz), 152.21, 145.07 (d, $J = 5.0$ Hz), 130.48 (t, $J = 10.7$ Hz), 117.60, 115.72 (t, $J = 16.1$ Hz), 111.90 (d, $J = 6.0$ Hz), 111.71 (d, $J = 5.6$ Hz), 75.12 (d, $J = 12.7$ Hz), 72.81 (t, $J = 2.9$ Hz), 68.54, 45.74 (d, $J = 7.4$ Hz), 41.50, 40.53 (d, $J = 8.0$ Hz), 40.19 (d, $J = 13.7$ Hz), 32.82, 32.03 (d, $J = 9.9$ Hz), 25.78, 23.35. HRMS(MALDI)计算值 $\text{C}_{24}\text{H}_{27}\text{F}_2\text{N}_3\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$: 498.1633, 实测值 498.1634.

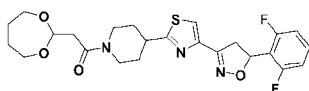


式 (II-26). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.68 (s, 1H), 7.39 – 7.30 (m, 1H), 6.94 (t, $J = 8.5$ Hz, 2H), 6.14 – 6.05 (m, 1H), 4.71 (d, $J = 13.0$ Hz, 1H), 3.99 (d, $J = 11.2$ Hz, 1H), 3.94 – 3.78 (m, 3H), 3.65 (dd, $J = 12.8, 9.6$ Hz, 1H), 3.53 – 3.41 (m, 1H), 3.40 – 3.27 (m, 1H), 3.23 (t, $J = 10.0$ Hz, 2H), 2.81 (t, $J = 12.4$ Hz, 1H), 2.33 (dd, $J = 14.8, 6.8$

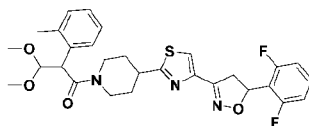
Hz, 1H), 2.29 – 2.13 (m, 3H), 2.01 (s, 1H), 1.98 – 1.90 (m, 1H), 1.85 – 1.70 (m, 2H), 1.69 – 1.61 (m, 2H), 1.39 – 1.28 (m, 1H). HRMS(MALDI)计算值 $C_{24}H_{27}F_2N_3NaO_3S [M+Na]^+$:498.1633, 实测值 498.1631.



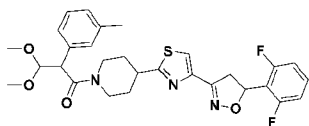
式 (II-27). 浅黄色油状物. ^1H NMR (400 MHz, $CDCl_3$) δ 7.63 (s, 1H), 7.33 – 7.26 (m, 1H), 6.96 – 6.80 (m, 2H), 6.05 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.67 (d, $J = 13.4$ Hz, 1H), 4.02 – 3.90 (m, 3H), 3.78 (dd, $J = 16.8, 12.0$ Hz, 1H), 3.61 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.46 – 3.37 (m, 2H), 3.29 (tt, $J = 11.6, 4.0$ Hz, 1H), 3.18 (t, $J = 12.8$ Hz, 1H), 2.77 (t, $J = 12.4$ Hz, 1H), 2.27 (d, $J = 7.2$ Hz, 2H), 2.24 – 2.12 (m, 2H), 2.11 – 2.03 (m, 1H), 1.81 – 1.70 (m, 2H), 1.70 – 1.64 (m, 2H), 1.38-1.26 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.49, 169.93, 162.54 (d, $J = 7.5$ Hz), 160.04 (d, $J = 7.6$ Hz), 152.12, 145.10, 130.49 (t, $J = 10.6$ Hz), 117.65, 115.66 (t, $J = 16.2$ Hz), 111.88 (d, $J = 5.9$ Hz), 111.69 (d, $J = 5.7$ Hz), 72.81 (t, $J = 3.1$ Hz), 67.80, 45.38, 41.46, 41.31, 40.45, 39.91, 33.06, 32.82, 32.60, 32.08. HRMS(MALDI)计算值 $C_{24}H_{27}F_2N_3NaO_3S [M+Na]^+$:498.1633, 实测值 498.1627.



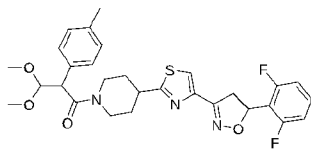
式 (II-28). 浅黄色油状物. ^1H NMR (400 MHz, $CDCl_3$) δ 7.66 – 7.63 (m, 1H), 7.33 – 7.26 (m, 1H), 6.94 – 6.86 (m, 2H), 6.09 – 6.02 (m, 1H), 5.18 – 5.13 (m, 1H), 4.68 (d, $J = 13.4$ Hz, 1H), 4.01 (d, $J = 13.6$ Hz, 1H), 3.94 – 3.86 (m, 2H), 3.84 – 3.74 (m, 1H), 3.72 – 3.63 (m, 2H), 3.63 – 3.57 (m, 1H), 3.34 – 3.24 (m, 1H), 3.18 (t, $J = 12.8$ Hz, 1H), 2.77 (t, $J = 12.8$ Hz, 1H), 2.72 – 2.66 (m, 2H), 2.14 (t, $J = 14.8$ Hz, 2H), 1.80 – 1.70 (m, 6H). HRMS(MALDI)计算值 $C_{24}H_{27}F_2N_3NaO_4S [M+Na]^+$:514.1583, 实测值 514.1581.



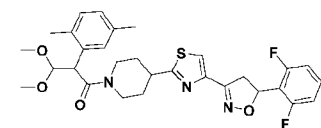
式 (II-31). 白色固体; m.p.=75–77 °C. ^1H NMR (400 MHz, $CDCl_3$) δ 7.62 (s, 1H), 7.50 – 7.41 (m, 1H), 7.34 – 7.26 (m, 1H), 7.20 – 7.12 (m, 3H), 6.91 (t, $J = 8.4$ Hz, 2H), 6.11 – 6.00 (m, 1H), 4.91 (d, $J = 7.6$ Hz, 1H), 4.76 – 4.53 (m, 1H), 4.28 – 4.17 (m, 1H), 3.91 – 3.68 (m, 2H), 3.67 – 3.56 (m, 1H), 3.54 (s, 3H), 3.27 – 3.13 (m, 1H), 3.09 (s, 3H), 2.95 – 2.83 (m, 1H), 2.82 – 2.69 (m, 1H), 2.43 (s, 3H), 2.15 – 1.95 (m, 2H), 1.57 – 1.45 (m, 1H), 0.73 – 0.58 (m, 1H). HRMS(MALDI)计算值 $C_{29}H_{31}F_2N_3NaO_4S [M+Na]^+$:578.1896, 实测值 578.1894.



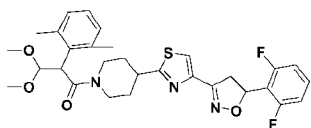
式 (II-32). 白色固体; m.p.=89–91 °C. ^1H NMR (400 MHz, $CDCl_3$) δ 7.62 (s, 1H), 7.34 – 7.27 (m, 1H), 7.23 – 7.14 (m, 3H), 7.07 (t, $J = 6.8$ Hz, 1H), 6.91 (td, $J = 8.0, 3.2$ Hz, 2H), 6.05 (dd, $J = 11.2$ Hz, $J = 20.8$ Hz, 1H), 4.98 (d, $J = 8.0$ Hz, 1H), 4.72 – 4.57 (m, 1H), 4.03 – 3.96 (m, 1H), 3.80 – 3.72 (m, 1H), 3.66 – 3.56 (m, 1H), 3.51 (s, 3H), 3.26 – 3.18 (m, 1H), 3.15 (s, 3H), 2.99 (t, $J = 11.6$ Hz, 1H), 2.81 – 2.72 (m, 1H), 2.33 (s, 3H), 2.16 – 2.06 (m, 1H), 1.93 – 1.80 (m, 1H), 1.81 – 1.73 (m, 1H), 1.58 – 1.48 (m, 1H), 0.93 – 0.81 (m, 1H). HRMS(MALDI)计算值 $C_{29}H_{31}F_2N_3NaO_4S [M+Na]^+$:578.1896, 实测值 578.1895.



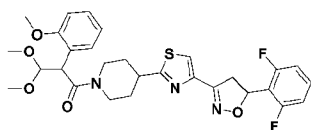
式(II-33). 浅黄色固体; m.p.=90~92 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.67 – 7.56 (m, 1H), 7.33 – 7.26 (m, 3H), 7.13 (d, J = 7.6 Hz, 2H), 6.91 (t, J = 8.0 Hz, 2H), 6.05 (dd, J = 20.4 Hz, J = 10.0 Hz, 1H), 4.96 (dd, J = 8.0, 2.0 Hz, 1H), 4.73 – 4.55 (m, 1H), 4.05 – 3.96 (m, 1H), 3.85 – 3.69 (m, 1H), 3.66 – 3.54 (m, 1H), 3.51 (d, J = 2.0 Hz, 3H), 3.27 – 3.17 (m, 1H), 3.15 (s, 3H), 2.97 (t, J = 12.4 Hz, 1H), 2.76 (t, J = 12.4 Hz, 1H), 2.35 – 2.27 (m, 3H), 2.16 – 2.02 (m, 2H), 1.91 – 1.78 (m, 1H), 1.59 – 1.46 (m, 1H), 0.96 – 0.81 (m, 1H). HRMS(MALDI) 计算值 $\text{C}_{29}\text{H}_{31}\text{F}_2\text{N}_3\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$: 578.1896, 实测值 578.1897.



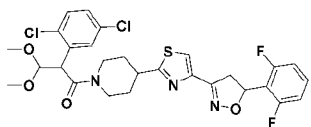
式(II-34). 白色固体; m.p.=93~95 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.66 – 7.56 (m, 1H), 7.34 – 7.26 (m, 2H), 7.06 (d, J = 7.6 Hz, 1H), 6.99 – 6.86 (m, 3H), 6.10 – 6.01 (m, 1H), 4.90 (d, J = 8.0 Hz, 1H), 4.76 – 4.56 (m, 1H), 4.22 – 4.09 (m, 1H), 3.90 – 3.60 (m, 3H), 3.54 (d, J = 6.4 Hz, 3H), 3.26 – 3.14 (m, 1H), 3.10 (d, J = 4.8 Hz, 3H), 2.93 – 2.68 (m, 1H), 2.38 (d, J = 3.2 Hz, 3H), 2.28 (d, J = 4.0 Hz, 3H), 2.16 – 2.05 (m, 1H), 1.92 – 1.72 (m, 2H), 1.56 – 1.44 (m, 1H), 0.68 – 0.56 (m, 1H). HRMS(MALDI) 计算值 $\text{C}_{30}\text{H}_{33}\text{F}_2\text{N}_3\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$: 592.2052, 实测值 592.2044.



式(II-35). 白色固体; m.p.=90~92 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.66 – 7.56 (m, 1H), 7.37 – 7.28 (m, 2H), 7.00 – 6.95 (m, 2H), 6.94 – 6.87 (m, 2H), 6.10 – 6.00 (m, 1H), 4.92 – 4.86 (m, 1H), 4.74 – 4.54 (m, 1H), 4.23 – 4.13 (m, 1H), 3.91 – 3.68 (m, 2H), 3.67 – 3.56 (m, 1H), 3.53 (d, J = 2.8 Hz, 3H), 3.23 – 3.12 (m, 1H), 3.10 (s, 3H), 2.94 – 2.68 (m, 1H), 2.39 (d, J = 2.8 Hz, 3H), 2.30 – 2.24 (m, 3H), 2.19 – 1.96 (m, 2H), 1.91 – 1.72 (m, 1H), 1.57 – 1.44 (m, 1H), 0.75 – 0.63 (m, 1H). HRMS(MALDI) 计算值 $\text{C}_{30}\text{H}_{33}\text{F}_2\text{N}_3\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$: 592.2052, 实测值 592.2044.

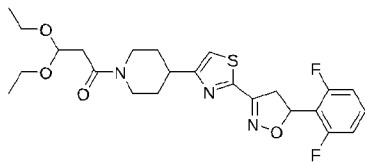


式(II-37). 白色固体; m.p.=98~100 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.67 – 7.56 (m, 1H), 7.53 – 7.46 (m, 1H), 7.34 – 7.27 (m, 1H), 7.25 – 7.20 (m, 1H), 6.98 – 6.87 (m, 4H), 6.10 – 6.00 (m, 1H), 5.13 – 5.04 (m, 1H), 4.72 – 4.52 (m, 2H), 4.21 (t, J = 15.6 Hz, 1H), 3.86 (s, 3H), 3.82 – 3.70 (m, 1H), 3.67 – 3.53 (m, 1H), 3.50 (s, 3H), 3.28 – 3.19 (m, 1H), 3.15 (s, 3H), 3.02 – 2.93 (m, 1H), 2.80 – 2.68 (m, 1H), 2.15 – 2.07 (m, 1H), 1.91 – 1.72 (m, 1H), 1.52 – 1.40 (m, 1H), 0.88 – 0.76 (m, 1H). HRMS(MALDI) 计算值 $\text{C}_{29}\text{H}_{31}\text{F}_2\text{N}_3\text{NaO}_5\text{S}$ $[\text{M}+\text{Na}]^+$: 594.1845, 实测值 594.1843.

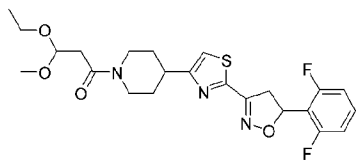


式(II-39). 白色固体; m.p.=113~115 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.71 – 7.62 (m, 2H), 7.33 – 7.28 (m, 2H),

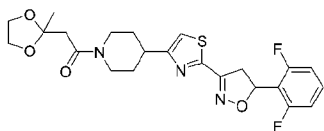
7.21 – 7.16 (m, 1H), 6.95 – 6.87 (m, 2H), 6.12 – 6.02 (m, 1H), 5.00 (dd, $J = 8.0, 2.8$ Hz, 1H), 4.72 – 4.58 (m, 2H), 4.27 – 4.10 (m, 1H), 3.88 – 3.55 (m, 2H), 3.51 (d, $J = 4.0$ Hz, 3H), 3.39 – 3.24 (m, 1H), 3.21 (s, 3H), 3.16 – 3.08 (m, 1H), 2.88 – 2.75 (m, 1H), 2.20 – 2.09 (m, 2H), 1.97 – 1.72 (m, 1H), 1.64 – 1.05 (m, 1H). HRMS(MALDI)计算值 $C_{28}H_{27}Cl_2F_2N_3NaO_4S[M+Na]^+$: 632.0960, 实测值 632.0963.



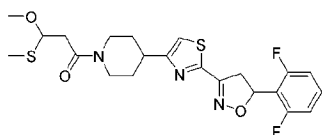
式 (II-70) .浅黄色油状物. ^1H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.28 (m, 1H), 6.98 (s, 1H), 6.92 (t, $J = 8.4$ Hz, 2H), 6.12 (t, $J = 10.8$ Hz, 1H), 4.97 – 4.92 (m, 1H), 4.72 (d, $J = 13.6$ Hz, 1H), 4.06 (d, $J = 13.6$ Hz, 1H), 3.90 – 3.80 (m, 1H), 3.77 – 3.65 (m, 3H), 3.61 – 3.53 (m, 2H), 3.15 (t, $J = 12.8$ Hz, 1H), 3.02 (t, $J = 12.4$ Hz, 1H), 2.79 – 2.65 (m, 3H), 2.12 – 2.02 (m, 2H), 1.77 – 1.58 (m, 2H), 1.26 – 1.16 (m, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.97, 162.51 (d, $J = 7.6$ Hz), 161.10, 160.00 (d, $J = 7.6$ Hz), 156.72, 153.29, 130.74 (t, $J = 10.6$ Hz), 115.30 (t, $J = 16.2$ Hz), 114.27, 111.94 (d, $J = 5.9$ Hz), 111.74 (d, $J = 5.5$ Hz), 101.67, 73.89 (t, $J = 3.0$ Hz), 63.17 (d, $J = 17.2$ Hz), 46.24, 41.76, 40.50 (d, $J = 2.3$ Hz), 38.71, 38.50, 32.14 (d, $J = 4.1$ Hz), 31.30 (d, $J = 4.7$ Hz), 15.31 (d, $J = 2.6$ Hz). HRMS(MALDI)计算值 $C_{24}H_{30}F_2N_3O_4S[M+H]^+$: 494.1920, 实测值 494.1923.



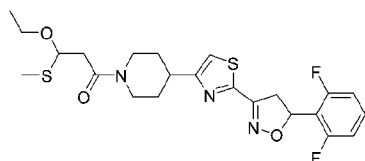
式 (II-71) .浅黄色油状物. ^1H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.28 (m, 1H), 6.98 (s, 1H), 6.92 (t, $J = 8.4$ Hz, 2H), 6.12 (t, $J = 10.8$ Hz, 1H), 4.90 (s, 1H), 4.72 (d, $J = 13.2$ Hz, 1H), 4.03 (d, $J = 13.6$ Hz, 1H), 3.90 – 3.81 (m, 1H), 3.76 – 3.55 (m, 3H), 3.41 (s, 3H), 3.16 (t, $J = 12.8$ Hz, 1H), 3.01 (t, $J = 12.0$ Hz, 1H), 2.71 (s, 3H), 2.14 – 2.02 (m, 2H), 1.76 – 1.58 (m, 2H), 1.26 – 1.18 (m, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.85, 162.52 (d, $J = 7.5$ Hz), 161.08, 160.02 (d, $J = 7.4$ Hz), 156.74, 153.30, 130.75 (t, $J = 10.6$ Hz), 115.32 (t, $J = 16.2$ Hz), 114.30, 111.95 (d, $J = 5.8$ Hz), 111.76 (d, $J = 5.7$ Hz), 102.49, 73.90 (d, $J = 2.9$ Hz), 63.28 (d, $J = 15.2$ Hz), 54.59 (d, $J = 24.3$ Hz), 46.15 (d, $J = 2.2$ Hz), 41.77 (d, $J = 1.9$ Hz), 40.53, 38.49 (d, $J = 2.9$ Hz), 38.22 (d, $J = 17.6$ Hz), 32.18 (d, $J = 3.8$ Hz), 31.34 – 31.19 (m), 15.30 (d, $J = 3.1$ Hz). HRMS(MALDI)计算值 $C_{23}H_{28}F_2N_3O_4S[M+H]^+$: 480.1763, 实测值 480.1760.



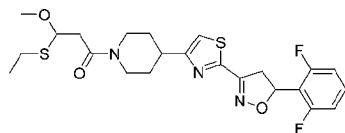
式 (II-79) .浅黄色油状物. ^1H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.28 (m, 1H), 7.00 (s, 1H), 6.96 – 6.89 (m, 2H), 6.13 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.77 (d, $J = 11.6$ Hz, 1H), 4.11 – 4.04 (m, 1H), 3.99 – 3.84 (m, 5H), 3.69 (dd, $J = 17.6, 9.2$ Hz, 1H), 3.23 – 3.12 (m, 1H), 3.05 (tt, $J = 12.0, 3.6$ Hz, 1H), 2.81 (s, 2H), 2.76 – 2.67 (m, 1H), 2.14 – 2.06 (m, 2H), 1.74 – 1.61 (m, 2H), 1.48 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.42, 162.51 (d, $J = 7.6$ Hz), 161.15, 160.01 (d, $J = 7.4$ Hz), 156.71, 153.29, 130.75 (t, $J = 10.7$ Hz), 115.30 (t, $J = 16.2$ Hz), 114.47 – 114.15 (m), 111.95 (d, $J = 5.8$ Hz), 111.75 (d, $J = 5.9$ Hz), 108.70, 73.91 (t, $J = 3.1$ Hz), 64.69 (d, $J = 4.7$ Hz), 46.87 – 46.49 (m), 43.00, 41.97 – 41.70 (m), 40.52 (d, $J = 2.5$ Hz), 38.52 – 38.26 (m), 32.30 – 31.91 (m), 31.40 – 31.02 (m), 30.17, 24.64. HRMS(MALDI)计算值 $C_{23}H_{26}F_2N_3O_4S[M+H]^+$: 478.1607, 实测值 478.1611.



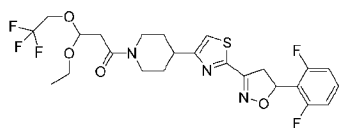
式(II-81). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.36 – 7.28 (m, 1H), 6.99 (s, 1H), 6.96 – 6.89 (m, 2H), 6.13 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.87 (d, $J = 7.2$ Hz, 1H), 4.73 (d, $J = 13.6$ Hz, 1H), 3.98 (d, $J = 13.2$ Hz, 1H), 3.87 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.68 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.42 (s, 3H), 3.18 (t, $J = 12.8$ Hz, 1H), 3.09 – 2.97 (m, 2H), 2.80 – 2.70 (m, 2H), 2.17 – 2.05 (m, 5H), 1.74 – 1.61 (m, 2H). HRMS(MALDI)计算值 $\text{C}_{22}\text{H}_{26}\text{F}_2\text{N}_3\text{O}_3\text{S}_2$ $[\text{M}+\text{H}]^+$: 482.1378, 实测值 482.1380.



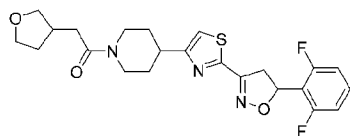
式(II-82). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.36 – 7.28 (m, 1H), 7.00 (s, 1H), 6.96 – 6.89 (m, 2H), 6.13 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.95 – 4.90 (m, 1H), 4.73 (d, $J = 13.2$ Hz, 1H), 3.98 (d, $J = 13.2$ Hz, 1H), 3.89 (dd, $J = 17.2, 12.0$ Hz, 1H), 3.69 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.42 (s, 3H), 3.18 (t, $J = 12.8$ Hz, 1H), 3.10 – 2.99 (m, 2H), 2.82 – 2.72 (m, 2H), 2.68 – 2.61 (m, 2H), 2.16 – 2.05 (m, 2H), 1.74 – 1.61 (m, 2H), 1.28 (t, $J = 7.6$ Hz, 3H). HRMS(MALDI)计算值 $\text{C}_{23}\text{H}_{28}\text{F}_2\text{N}_3\text{O}_3\text{S}_2$ $[\text{M}+\text{H}]^+$: 496.1535, 实测值 496.1530.



式(II-85). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.36 – 7.27 (m, 1H), 6.99 (s, 1H), 6.96 – 6.89 (m, 2H), 6.13 (dd, $J = 12.0, 9.2$ Hz, 1H), 4.97 – 4.92 (m, 1H), 4.78 – 4.68 (m, 1H), 4.05 – 3.96 (m, 1H), 3.91 – 3.78 (m, 2H), 3.68 (dd, $J = 17.2, 9.2$ Hz, 1H), 3.51 – 3.45 (m, 1H), 3.18 (t, $J = 12.8$ Hz, 1H), 3.09 – 2.99 (m, 2H), 2.81 – 2.69 (m, 2H), 2.13 – 2.06 (m, 5H), 1.75 – 1.62 (m, 2H), 1.20 (t, $J = 7.2$ Hz, 3H). HRMS(MALDI)计算值 $\text{C}_{23}\text{H}_{28}\text{F}_2\text{N}_3\text{O}_3\text{S}_2$ $[\text{M}+\text{H}]^+$: 496.1535, 实测值 496.1536.

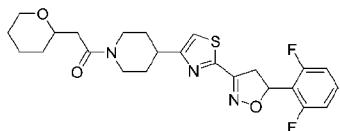


式(II-87). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.36 – 7.27 (m, 1H), 6.99 (s, 1H), 6.96 – 6.89 (m, 2H), 6.12 (dd, $J = 12.0, 9.2$ Hz, 1H), 5.14 – 5.09 (m, 1H), 4.71 (d, $J = 13.4$ Hz, 1H), 4.03 – 3.82 (m, 4H), 3.78 – 3.57 (m, 3H), 3.18 (t, $J = 12.8$ Hz, 1H), 3.09 – 3.00 (m, 1H), 2.78 – 2.68 (m, 3H), 2.14 – 2.05 (m, 2H), 1.74 – 1.62 (m, 2H), 1.24 – 1.19 (m, 3H). HRMS(MALDI)计算值 $\text{C}_{24}\text{H}_{27}\text{F}_5\text{N}_3\text{O}_4\text{S}$ $[\text{M}+\text{H}]^+$: 548.1637, 实测值 548.1642.

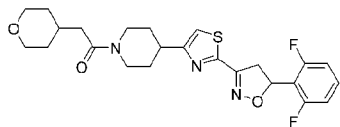


式(II-92). 浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.36 – 7.28 (m, 1H), 7.00 (s, 1H), 6.96 – 6.89 (m, 2H), 6.13 (dd, $J = 12.4, 9.2$ Hz, 1H), 4.72 (d, $J = 13.4$ Hz, 1H), 4.01 – 3.92 (m, 2H), 3.91 – 3.83 (m, 2H), 3.79 – 3.74 (m, 1H), 3.73

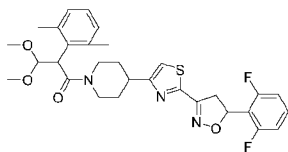
– 3.64 (m, 1H), 3.48 – 3.42 (m, 1H), 3.22 – 3.12 (m, 1H), 3.08 – 2.98 (m, 1H), 2.76 – 2.67 (m, 2H), 2.53 – 2.40 (m, 2H), 2.21 – 2.06 (m, 3H), 1.71 – 1.61 (m, 2H), 1.60 – 1.52 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 169.98, 162.53 (d, $J = 7.3$ Hz), 160.97, 160.03 (d, $J = 7.6$ Hz), 156.80, 153.28, 130.76 (t, $J = 10.7$ Hz), 115.24 (d, $J = 16.4$ Hz), 114.38, 111.96 (d, $J = 5.7$ Hz), 111.77 (d, $J = 5.5$ Hz), 73.93, 73.31, 67.61, 45.56, 41.72, 40.56, 38.52, 37.05, 35.56, 32.28, 32.21, 31.25. HRMS(MALDI)计算值 $\text{C}_{29}\text{H}_{31}\text{F}_2\text{N}_3\text{NaO}_5\text{S}$ $[\text{M}+\text{H}]^+$: 594.1845, 实测值 594.1843.



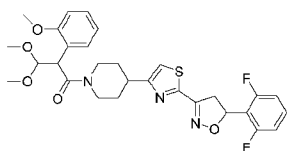
式(II-93).浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.37 – 7.29 (m, 1H), 6.99 (s, 1H), 6.97 – 6.89 (m, 2H), 6.17 – 6.08 (m, 1H), 4.78 – 4.69 (m, 1H), 4.04 (d, $J = 13.6$ Hz, 1H), 3.98 – 3.89 (m, 1H), 3.88 – 3.76 (m, 2H), 3.68 (dd, $J = 17.4$, 9.2 Hz, 1H), 3.50 – 3.42 (m, 1H), 3.21 – 3.09 (m, 1H), 3.08 – 2.98 (m, 1H), 2.79 – 2.63 (m, 2H), 2.39 – 2.31 (m, 1H), 2.14 – 2.03 (m, 2H), 1.86 – 1.60 (m, 4H), 1.58 – 1.46 (m, 3H), 1.37 – 1.27 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 169.22 (d, $J = 8.4$ Hz), 162.51 (d, $J = 7.5$ Hz), 161.16 (d, $J = 8.8$ Hz), 160.01 (d, $J = 7.5$ Hz), 156.69 (d, $J = 3.0$ Hz), 153.29, 130.73 (t, $J = 10.6$ Hz), 115.31 (t, $J = 16.2$ Hz), 114.29 (d, $J = 5.0$ Hz), 111.94 (d, $J = 5.8$ Hz), 111.74 (d, $J = 5.9$ Hz), 75.06 (d, $J = 5.9$ Hz), 73.90 (t, $J = 3.0$ Hz), 68.52 (d, $J = 1.8$ Hz), 46.04 (d, $J = 2.3$ Hz), 41.78 (d, $J = 2.0$ Hz), 40.53, 40.16 (d, $J = 13.0$ Hz), 38.52, 32.37 – 32.20 (m), 32.00 (d, $J = 8.4$ Hz), 31.24 (t, $J = 5.2$ Hz), 25.79, 23.33 (d, $J = 2.2$ Hz). HRMS(MALDI)计算值 $\text{C}_{24}\text{H}_{27}\text{F}_2\text{N}_3\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$: 498.1633, 实测值 498.1637.



式(II-95).浅黄色油状物. ^1H NMR (400 MHz, CDCl_3) δ 7.36 – 7.27 (m, 1H), 7.00 (s, 1H), 6.96 – 6.89 (m, 2H), 6.12 (dd, $J = 12.0$, 9.2 Hz, 1H), 4.73 (d, $J = 12.8$ Hz, 1H), 4.01 – 3.89 (m, 3H), 3.88 – 3.82 (m, 1H), 3.68 (dd, $J = 17.4$, 9.2 Hz, 1H), 3.42 (td, $J = 11.8$, 2.0 Hz, 2H), 3.22 – 3.11 (m, 1H), 3.04 (tt, $J = 11.6$, 3.6 Hz, 1H), 2.71 (t, $J = 10.6$ Hz, 1H), 2.28 (d, $J = 6.8$ Hz, 2H), 2.17 – 2.05 (m, 3H), 1.72 – 1.61 (m, 4H), 1.39 – 1.27 (m, 2H). HRMS(MALDI)计算值 $\text{C}_{24}\text{H}_{28}\text{F}_2\text{N}_3\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$: 476.1814, 实测值 476.1818.



式(II-103).白色固体; m.p. = 95 – 97 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.38 – 7.27 (m, 2H), 7.00 – 6.89 (m, 5H), 6.16 – 6.06 (m, 1H), 4.89 (dd, $J = 7.6$, 3.2 Hz, 1H), 4.77 – 4.63 (m, 1H), 4.19 (dd, $J = 17.2$, 8.0 Hz, 1H), 3.89 – 3.57 (m, 3H), 3.53 (d, $J = 3.2$ Hz, 3H), 3.09 (d, $J = 2.0$ Hz, 3H), 3.00 – 2.80 (m, 1H), 2.68 (t, $J = 13.2$ Hz, 1H), 2.39 (d, $J = 2.6$ Hz, 3H), 2.29 – 2.20 (m, 3H), 1.98 (d, $J = 13.6$ Hz, 1H), 1.81 – 1.65 (m, 2H), 1.46 – 1.35 (m, 1H), 0.70 – 0.59 (m, 1H). HRMS(MALDI)计算值 $\text{C}_{30}\text{H}_{34}\text{F}_2\text{N}_3\text{O}_4\text{S}$ $[\text{M}+\text{H}]^+$: 570.2233, 实测值 570.2238.

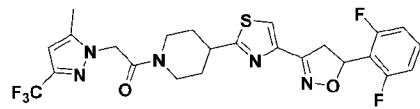


式(II-105).白色固体; m.p. = 97 – 99 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.54 – 7.47 (m, 1H), 7.36 – 7.28 (m, 1H), 7.24

– 7.17 (m, 1H), 6.99 – 6.86 (m, 4H), 6.74 (s, 1H), 6.16 – 6.07 (m, 1H), 5.12 – 5.06 (m, 1H), 4.74 – 4.59 (m, 2H), 4.22 (t, $J = 15.6$ Hz, 1H), 3.86 (s, 3H), 3.82 – 3.76 (m, 1H), 3.70 – 3.59 (m, 1H), 3.49 (d, $J = 1.8$ Hz, 3H), 3.15 (s, 3H), 3.13 – 3.07 (m, 1H), 3.02 – 2.86 (m, 1H), 2.71 – 2.63 (m, 1H), 2.02 – 1.93 (m, 1H), 1.84 – 1.75 (m, 1H), 1.42 – 1.30 (m, 1H), 0.79 – 0.65 (m, 1H). HRMS(MALDI)计算值 $C_{29}H_{32}F_2N_3O_5S$ $[M+H]^+$: 572.2025, 实测值 572.2029.

测试例 1：抑制黄瓜霜霉病的活体活性

测试和调查方法参照康卓、顾宝根编写的《农药生物活性测试标准操作规范》杀菌剂卷中的 SOP-SC-1098 黄瓜霜霉病盆栽法。测试结果见表 1、表 2、表 3，表中的“/”项表示未测试（下文中的情况均相同）。其中，对照药剂氟噻唑吡乙酮（OXA）的结构式如下：



氟噻唑吡乙酮（OXA）

对活性测试结果中各防治效果等级的说明：90%≤A≤100%；75%≤B<90%；60%≤C<75%；45%≤D<60%；0%≤E<45%。

目标化合物对黄瓜霜霉病室内活体杀菌活性筛选结果。

表 1：目标化合物对黄瓜霜霉病室内杀菌活体活性

编号	施药浓度(mg/L)/防治效果		
	20	5	1.25
I -1	A	A	A
I -2	A	B	B
I -3	A	A	A
I -4	A	A	B
I -5	B	B	C
I -6	B	/	/
I -7	A	B	/
I -8	A	A	A
I -9	A	A	A
I -10	A	A	A
I -11	C	/	/
I -12	B	D	/
I -13	A	B	/
I -14	A	A	A
I -15	C	C	/
I -16	B	C	D
I -17	A	A	A
I -18	D	/	/
I -19	A	A	A
I -20	D	/	/
I -21	D	/	/
I -22	A	A	A
I -23	B	B	D
I -24	A	B	C

I -25	A	B	C
I -26	C	D	D
I -28	A	B	/
I -29	A	A	A
I -30	A	B	B
II -1	A	A	A
II -2	A	A	A
II -3	A	A	A
II -4	A	A	A
II -5	A	D	/
II -6	C	D	/
II -7	B	D	/
II -8	A	C	D
II -9	A	B	D
II -10	D	/	/
II -11	A	C	D
II -12	A	D	/
II -18	A	A	A
II -19	A	A	A
II -21	A	B	D
II -22	A	D	/
II -28	C	C	/

为进一步探索化合物结构与活性之间的关系，本发明对黄瓜霜霉病室内活体杀菌活性测试初筛的最低浓度（1.25 mg/L）下防效超过 75%的部分化合物进行了降低浓度的杀菌活性复筛实验。实验结果如表 2 中所示。

表 2：目标化合物对黄瓜霜霉病室内杀菌活体活性复筛

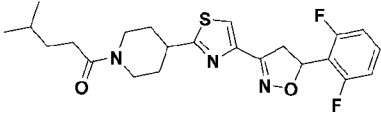
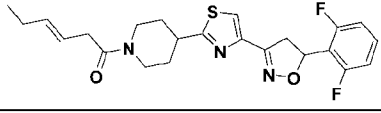
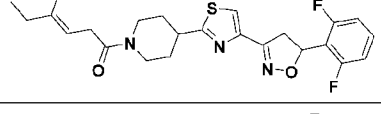
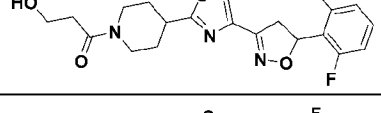
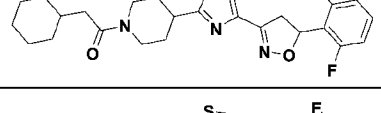
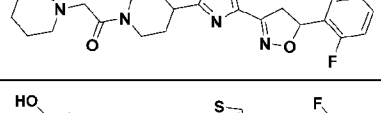
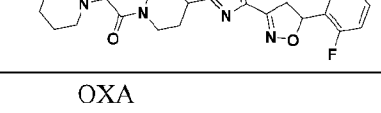
编号	施药浓度(mg/L)/防效				
	1.25	0.312	0.078	0.02	0.005
I -19	A	A	B	/	/
I -22	A	B	B	/	/
II -2	A	A	B	/	/
II -3	A	A	A	A	A
II -4	A	A	A	/	/
II -18	A	A	A	A	A
II -19	A	A	A	A	B
OXA	A	A	A	A	A
烯酰吗啉	A	A	B	C	/
氟霜唑	A	A	B	E	/

由上述活性结果可知，本发明的多个化合物对黄瓜霜霉病具有良好的防治效果，在 20 mg/L 至 1.25 mg/L 的三个施药浓度下，有多个化合物防效在 75%至 100%，与对照药剂氟噻唑吡乙酮相当，在活性复筛环节中，本发明的 4 个化合物（II -3、II -4、II -18、II -19）杀菌活性优异，在 0.078 mg/L 施药浓度下，具有 90%及以上的防效，与相同浓度下的氟噻唑吡乙酮药效相当，优于烯酰吗啉和氟霜唑的防效，最重要的是，本发明的化合物 II-3 和 II -18 在 0.005 mg/L 施药浓度下的防效与对照药剂 OXA 相当，具有进一步开发的價值。

与现有最接近化合物的比对:表 3 中的对比化合物(对比 1-对比 7)活性数据来源:Li, J. L. et al. *Pestic. Biochem.*

Phys. 2020, 169, 104673. DOI: doi.org/10.1016/j.pestbp.2020.104673。通过表 3 中的对比可以看出，本发明中多数化合物在 0.625 mg/L 浓度下对黄瓜霜霉病的防效要高于对比化合物。

表 3：对比化合物对黄瓜霜霉病室内杀菌活体活性结果

编号	结构式	施药浓度(mg/L)/防效		
		10	2.5	0.625
对比 1		B	B	E
对比 2		A	B	D
对比 3		A	C	E
对比 4		D	E	E
对比 5		A	D	E
对比 6		E	E	E
对比 7		E	E	E
OXA		A	A	A
II-3		A	A	A
II-18		A	A	A
II-19		A	A	A

注：防效等级：90%≤A≤100%；75%≤B<90%；60%≤C<75%；45%≤D<60%；0%≤E<45%

测试例 2：抑制卵菌病原菌丝生长的离体活性

采用微孔板法进行药剂室内生物活性的测定。辣椒疫霉、大豆疫霉、致病疫霉、烟草疫霉菌的培养：将靶标菌接种在 PDB 或 V8 汁液体培养基内摇培 72-96h，过滤后收集新鲜的菌丝，然后称取 0.1g 菌丝体，放入 50ml 的 PDB 液体培养基后，用组织捣碎机把菌丝体捣碎成小菌丝段，制成菌丝段悬浮液，置于 4℃下备用。

致病疫霉菌的培养：将致病疫霉接种于 V8 培养基平板后培养 12d，待其产生大量孢子囊后，加入无菌水并将平板转移到 4℃冰箱内放置 1h，然后再转移到室温内，诱导游动孢子释放。待游动孢子充分释放后，配置孢子浓度为 10⁵ 个/mL 的孢子悬浮液，置于 4℃下备用。

将供试药剂用 DMSO 配制成 2000 mg/L 的母液，然后用无菌水稀释成系列梯度浓度药液，置于 4℃下备用。

把孢子悬浮液（菌丝段悬浮液）和提前配制的系列梯度药液按 100μl+100μl 的量依次加入到每个微孔内，然后将 96 孔微孔板置于 25℃（致病疫霉 18℃）的培养箱内静置培养，3-4d（致病疫霉 7d）后用酶标仪检测各处理的 OD₅₉₅ 值。计算药剂对靶标菌的室内毒力。结果列于表 4 中。

抑制率%=(空白处理 OD₅₉₅-药剂处理 OD₅₉₅)/(空白处理 OD₅₉₅-参比 OD₅₉₅)*100

表 4：目标化合物 II-3、II-18 对卵菌病原菌菌丝生长的抑制活性

防治病菌类型	化合物编号	施药浓度 (mg/L) /抑制活性			
		5	0.5	0.05	0.005
辣椒疫霉	OXA	A	A	A	A
	II-3	A	A	A	A
	II-18	A	A	A	A
大豆疫霉	OXA	A	A	A	A
	II-3	A	A	A	B
	II-18	A	A	A	A
致病疫霉	OXA	A	A	A	A
	II-3	A	A	A	B
	II-18	A	A	A	A
烟草疫霉	OXA	A	A	A	A
	II-3	A	A	A	A
	II-18	A	A	A	B

注：抑制活性等级：90%≤A≤100%；75%≤B<90%；60%≤C<75%；

从表 4 的结果可知，化合物 II-3 和 II-18 对卵菌病原菌菌丝生长有良好抑制活性，在 5、0.5、0.05 mg/L 施药浓度下，对辣椒疫霉、大豆疫霉、致病疫霉、烟草腐霉的抑制活性均与对照药剂 OXA 相当。

测试例 3：防治黄瓜霜霉病的田间药效试验

本试验按照《农药田间药效施药准则(一)杀菌剂防治黄瓜霜霉病》（GB/T 17980.26-2000）实施。试验地点为江苏南京湖熟蔬菜基地，以黄瓜霜霉病为靶标，以氟啶唑吡乙酮和银法利为对照药剂，试验作物为黄瓜，品种为“绿芯”。 小组排列采用随机区组排列,每个小区约 8m²，每处理 3 次重复。采用整株茎叶喷雾，试验于黄瓜霜霉病发生初期进行，连续施药 2 次，第 1 次施药后 5 天进行第 2 次施药。调查方法是在每处理小区中每排黄瓜作一个调查点，调查所有黄瓜苗所有叶片的霜霉病发生程度，并计算病情指数和防效，结果见表 5 中。

表 5. 目标化合物 II-3 对黄瓜霜霉病的田间防治效果

药剂处理	剂量 (mg/L)	第 1 次药后防效		第 2 次药后防效	
		平均病指	防效 (%)	平均病指	防效 (%)
OXA	50	5.36	36.02	8.59	74.87
II-3	50	2.80	66.63	6.93	79.72
银法利	50	5.28	36.95	19.64	42.53
	100	5.14	38.64	11.13	67.43
空白对照	—	8.38		34.18	

测试结果表明，化合物 II-3 防治黄瓜霜霉病效果良好，能有效保护新叶片并能有效抑制已发病叶片上的病斑蔓延。田间防治黄瓜霜霉病时剂量为 50 mg/L，间隔 5~7 天连续施药 2~3 次能有效控制霜霉病的发生。在 50 mg/L 试验剂量下，防效优于对照药剂 OXA 和银法利。

测试例 4：防治马铃薯晚疫病的田间药效试验

本试验按照《农药田间药效施药准则(一)杀菌剂防治马铃薯晚疫病》（GB/T 17980.34-2000）实施。试验地点为陕西岐山，以马铃薯晚疫病为靶标，以市售增威赢绿（10%氟啶唑吡乙酮可分散油悬浮剂）为对照药剂，试验作物为马铃薯。小组排列采用随机区组排列，每处理 3 次重复。采用整株茎叶喷雾，试验于马铃薯晚疫病发生

初期进行，连续施药 2 次，第 1 次施药后 7 天进行第 2 次施药。调查方法是每小区对角线五点取样，每点选二株，每株调查中上部叶片约 20 张。记录调查的总叶数、病叶数和病级数，并计算病情指数和防效，结果见表 6 中。

表 6：目标化合物 II-3 对马铃薯晚疫病的田间防治效果

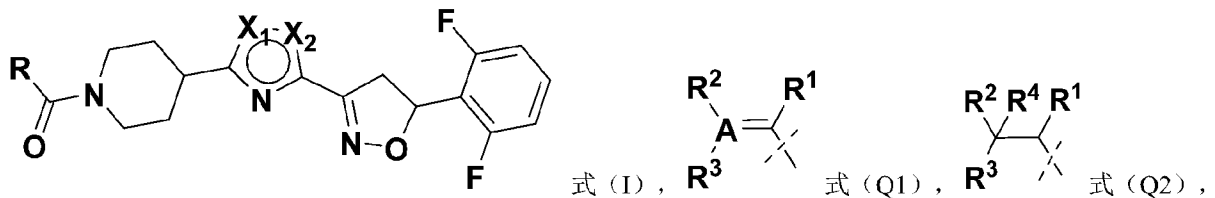
药剂处理	有效成分用量 (g.a.i./ha)	每亩制剂用量 (毫升/亩)	药前病基	第 1 次药后 7 天防效		第 2 次药后 7 天防效	
				平均病指	防效 (%)	平均病指	防效 (%)
5wt%的 II-3 乳油	22.5	30	0.02	0.07	76.81	0.68	75.87
	30.0	40	0.03	0.05	87.72	0.62	84.34
增威赢绿	22.5	15	0.03	0.10	75.34	1.12	71.29
	30.0	20	0.03	0.07	84.36	0.82	80.47
空白对照			0.04	0.43		4.13	

结果表明 5wt%的 II-3 乳油防治马铃薯晚疫病效果良好，能有效保护新叶片并能有效抑制已发病叶片上的病斑蔓延。田间防治马铃薯晚疫病时剂量为 30~40 毫升/亩，间隔 5~7 天连续施药 2~3 次能有效控制马铃薯晚疫病的发生，防效优于剂量为 15~20 毫升/亩下的市售增威赢绿的防效。即相同的有效成分用量下，5wt%的 II-3 乳油的防效优于增威赢绿。

以上详细描述了本发明的优选实施方式，但是，本发明并不限于此。在本发明的技术构思范围内，可以对本发明的技术方案进行多种简单变型，包括各个技术特征以任何其它的合适方式进行组合，这些简单变型和组合同样应当视为本发明所公开的内容，均属于本发明的保护范围。

权利要求书

1、一种含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物，该化合物具有式 (I) 所示的结构，



其中，在式 (I) 中， X_1 和 X_2 中的一者为 S，另一者为 CH；R 为式 (Q1) 所示的结构或式 (Q2) 所示的结构；

在式 (Q1) 中， R^1 、 R^2 、 R^3 各自独立地选自 H、 C_1 - C_{12} 的烷基、 C_1 - C_{12} 的烷氧基、 C_3 - C_{12} 的环烷基、 C_1 - C_{12} 的烷硫基、由至少一个卤素取代的 C_1 - C_{12} 的烷氧基、由苯基取代的 C_1 - C_{12} 的烷氧基、卤素、苯基、由组合 A 中的至少一种基团取代的苯基、氰基、硝基、吡啶基、吡唑基、由组合 A 中的至少一种基团取代的吡唑基；或者， R^2 和 R^3 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子的 3-7 元饱和杂环基；A 为 N 或 CH；且当 A 为 N 时， R^2 和 R^3 中的一者不存在；

在式 (Q2) 中， R^1 、 R^2 、 R^3 、 R^4 各自独立地选自 H、 C_1 - C_{12} 的烷基、 C_1 - C_{12} 的烷氧基、 C_3 - C_{12} 的环烷基、 C_1 - C_{12} 的烷硫基、由至少一个卤素取代的 C_1 - C_{12} 的烷氧基、由苯基取代的 C_1 - C_{12} 的烷氧基、卤素、苯基、由组合 A 中的至少一种基团取代的苯基、氰基、硝基、吡啶基、吡唑基、由组合 A 中的至少一种基团取代的吡唑基，且 R^1 、 R^2 、 R^3 、 R^4 中的至少一者为 C_1 - C_{12} 的烷氧基或 C_1 - C_{12} 的烷硫基；或者， R^2 和 R^3 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子作为成环原子的 3-7 元饱和杂环基；

所述组合 A 由 C_1 - C_{12} 的烷基、卤素、由至少一个卤素取代的 C_1 - C_{12} 的烷基、 C_1 - C_{12} 的烷氧基组成。

2、根据权利要求 1 所述的化合物，其中，在式 (I) 中，

X_1 和 X_2 中的一者为 S，另一者为 CH；

R 为式 (Q1) 所示的结构；在式 (Q1) 中， R^1 、 R^2 、 R^3 各自独立地选自 H、 C_1 - C_{12} 的烷基、 C_1 - C_{12} 的烷氧基、 C_3 - C_{12} 的环烷基、 C_1 - C_{12} 的烷硫基、由至少一个卤素取代的 C_1 - C_{12} 的烷氧基、由苯基取代的 C_1 - C_{12} 的烷氧基、卤素、苯基、由组合 A 中的至少一种基团取代的苯基、氰基、硝基、吡啶基、吡唑基、由组合 A 中的至少一种基团取代的吡唑基；或者， R^2 和 R^3 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子作为成环原子的 3-7 元饱和杂环基；

A 为 N 或 CH；且当 A 为 N 时， R^2 和 R^3 中的一者不存在；

所述组合 A 由 C_1 - C_{12} 的烷基、卤素、由至少一个卤素取代的 C_1 - C_{12} 的烷基、 C_1 - C_{12} 的烷氧基组成；

优选地，在式 (I) 中，

X_1 和 X_2 中的一者为 S，另一者为 CH；

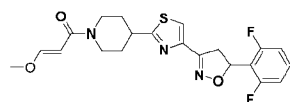
R 为式 (Q1) 所示的结构；在式 (Q1) 中， R^1 、 R^2 、 R^3 各自独立地选自 H、 C_1 - C_{10} 的烷基、 C_1 - C_{10} 的烷氧基、 C_3 - C_{10} 的环烷基、 C_1 - C_{10} 的烷硫基、由至少一个卤素取代的 C_1 - C_{10} 的烷氧基、由苯基取代的 C_1 - C_{10} 的烷氧基、卤素、苯基、由组合 A 中的至少一种基团取代的苯基、氰基、硝基、吡啶基、吡唑基、由组合 A 中的至少一种基团取代的吡唑基；或者， R^2 和 R^3 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子作为成环原子的 3-7 元饱和杂环基；

A 为 N 或 CH; 且当 A 为 N 时, R^2 和 R^3 中的一者不存在;

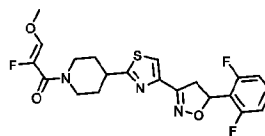
所述组合 A 由 C_1 - C_{10} 的烷基、卤素、由至少一个卤素取代的 C_1 - C_{10} 的烷基、 C_1 - C_{10} 的烷氧基组成。

3、根据权利要求 2 所述的化合物, 其中, 式 (I) 所示结构的化合物选自以下中的任意一种:

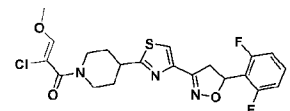
式(I-1)



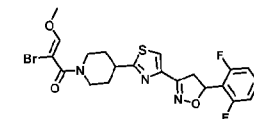
式(I-2)



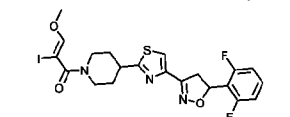
式(I-3)



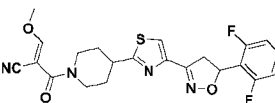
式(I-4)



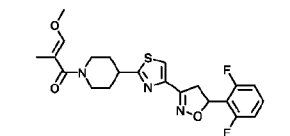
式(I-5)



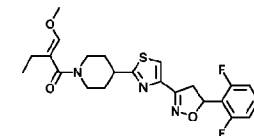
式(I-6)



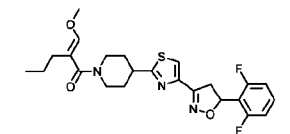
式(I-7)



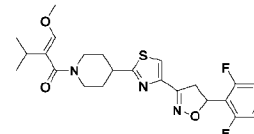
式(I-8)



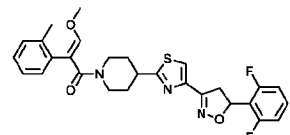
式(I-9)



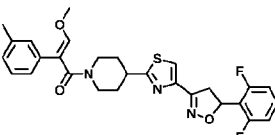
式(I-10)



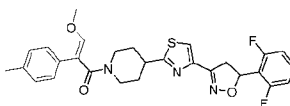
式(I-11)



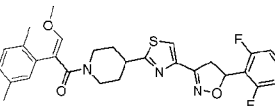
式(I-12)



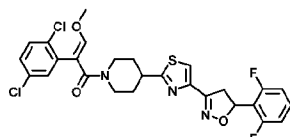
式(I-13)



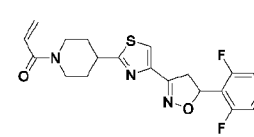
式(I-14)



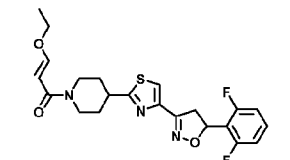
式(I-15)



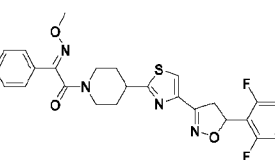
式(I-16)



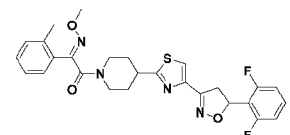
式(I-17)



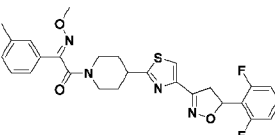
式(I-18)



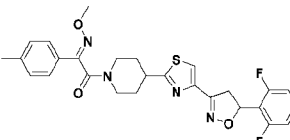
式(I-19)



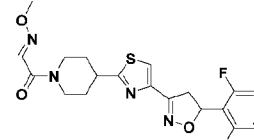
式(I-20)



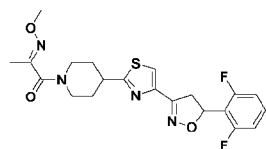
式(I-21)



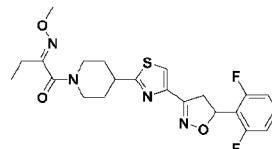
式(I-22)



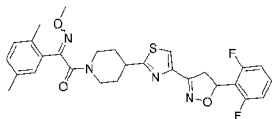
式(I-23)



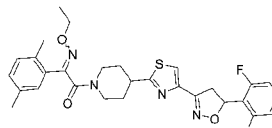
式(I-24)



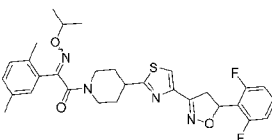
式(I-25)



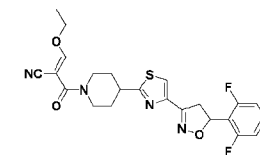
式(I-26)



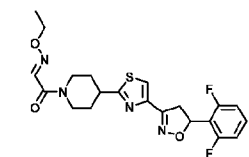
式(I-27)



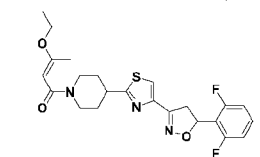
式(I-28)



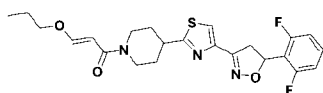
式(I-29)



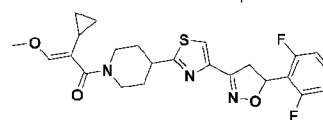
式(I-30)



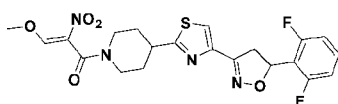
式(I-31)



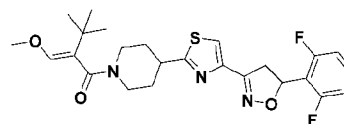
式(I-32)



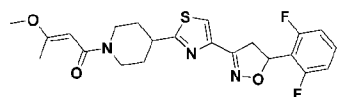
式(I-33)



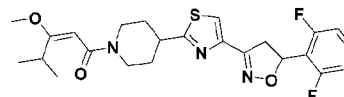
式(I-34)



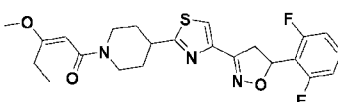
式(I-35)



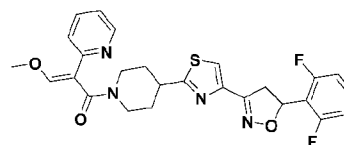
式(I-36)



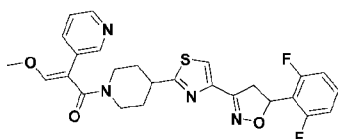
式(I-37)



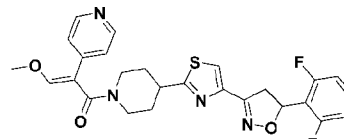
式(I-38)



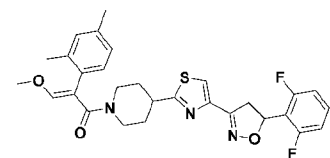
式(I-39)



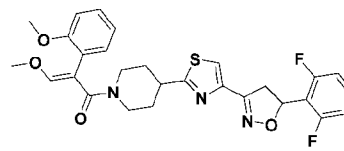
式(I-40)



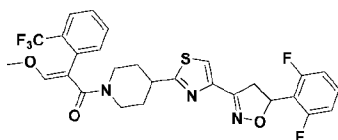
式(I-41)



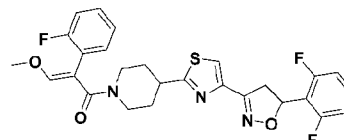
式(I-42)



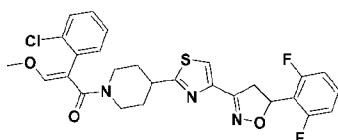
式(I-43)



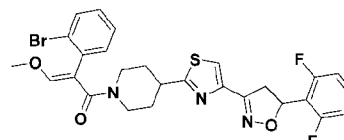
式(I-44)



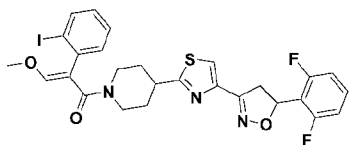
式(I-45)



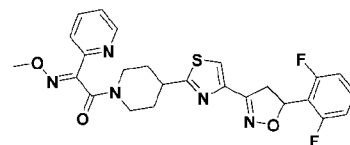
式(I-46)



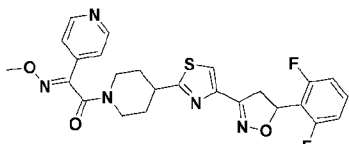
式(I-47)



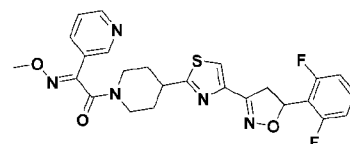
式(I-48)



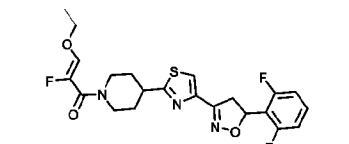
式(I-49)



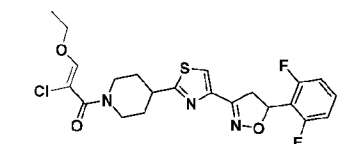
式(I-50)



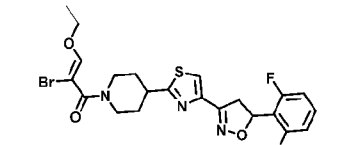
式(I-51)



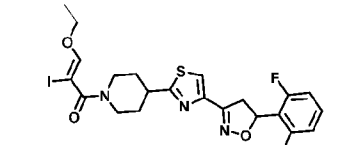
式(I-52)



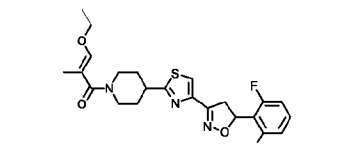
式(I-53)



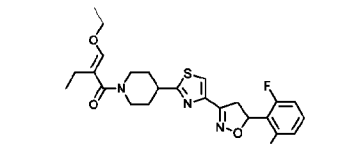
式(I-54)



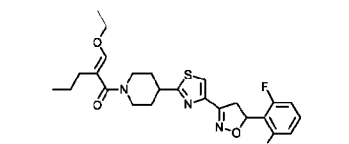
式(I-55)



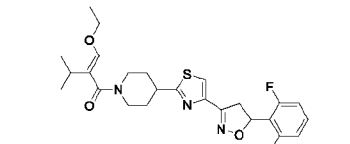
式(I-56)



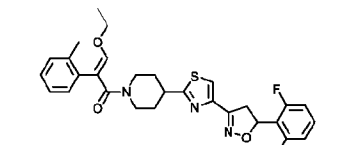
式(I-57)



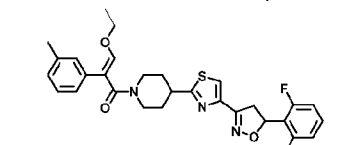
式(I-58)



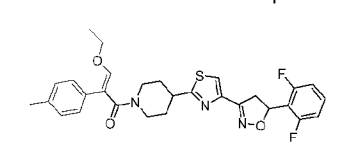
式(I-59)



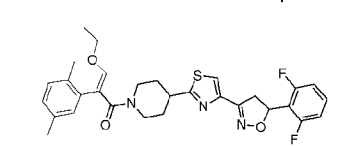
式(I-60)



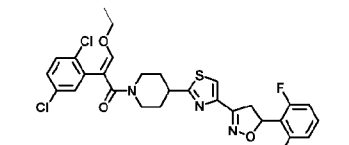
式(I-61)



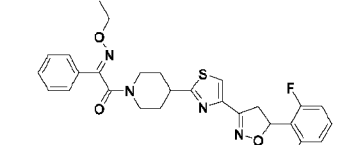
式(I-62)



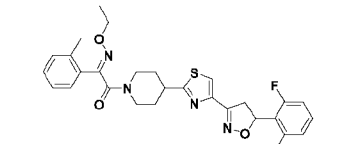
式(I-63)



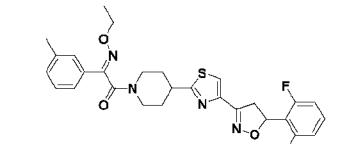
式(I-64)



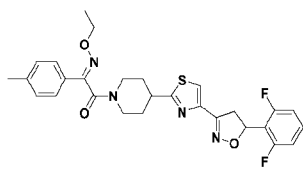
式(I-65)



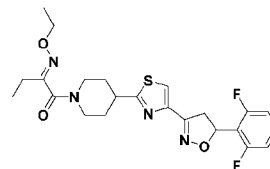
式(I-66)



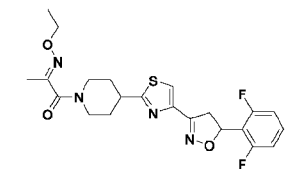
式(I-67)



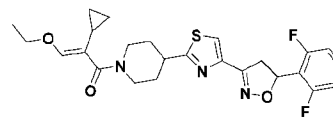
式(I-68)



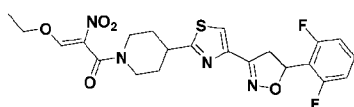
式(I-69)



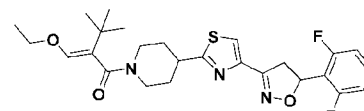
式(I-70)



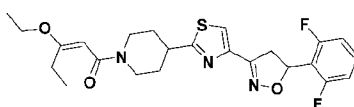
式(I-71)



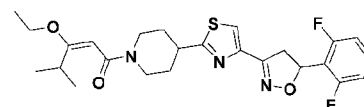
式(I-72)



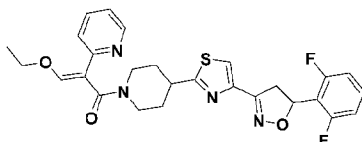
式(I-73)



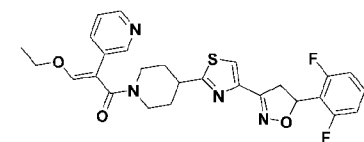
式(I-74)



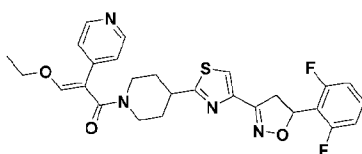
式(I-75)



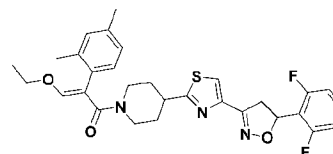
式(I-76)



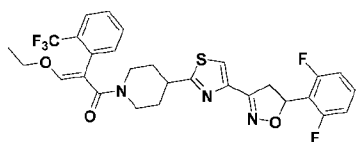
式(I-77)



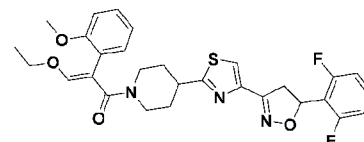
式(I-78)



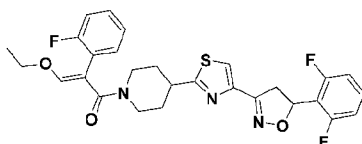
式(I-79)



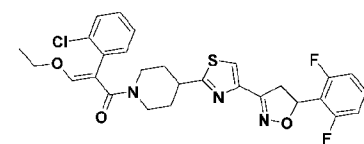
式(I-80)



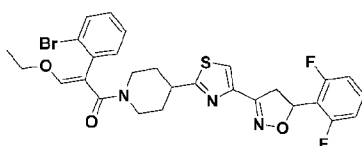
式(I-81)



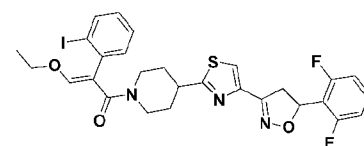
式(I-82)



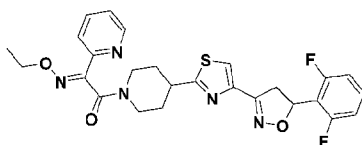
式(I-83)



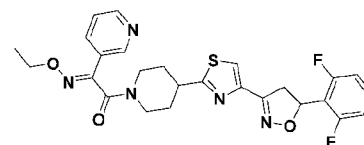
式(I-84)



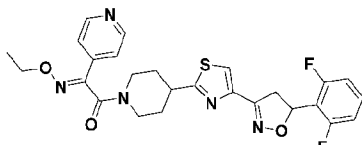
式(I-85)



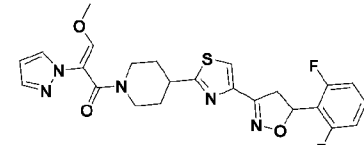
式(I-86)



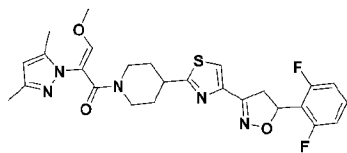
式(I-87)



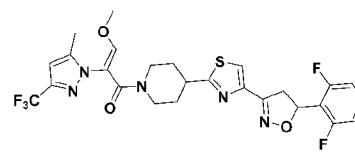
式(I-88)



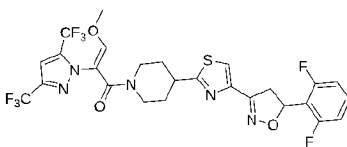
式(I-89)



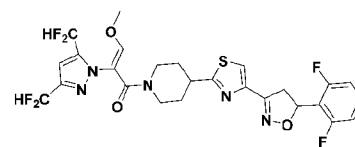
式(I-90)



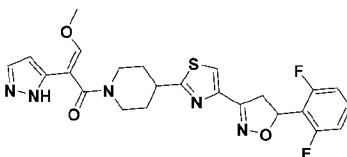
式(I-91)



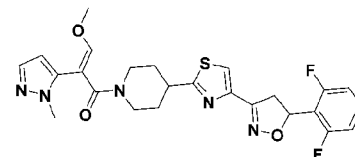
式(I-92)



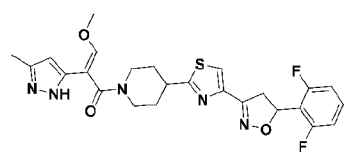
式(I-93)



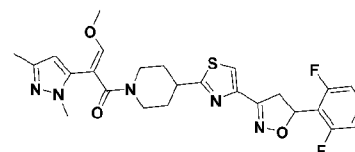
式(I-94)



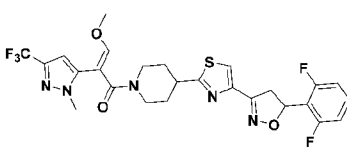
式(I-95)



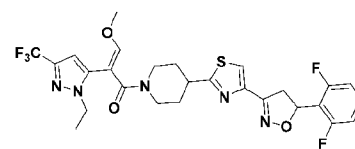
式(I-96)



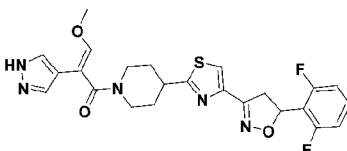
式(I-97)



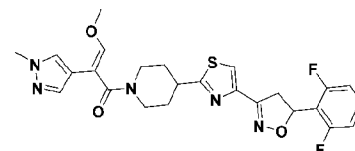
式(I-98)



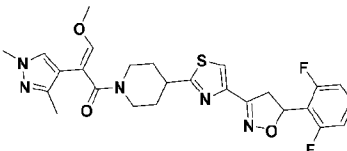
式(I-99)



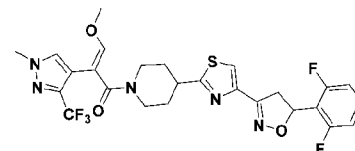
式(I-100)



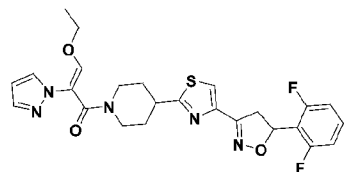
式(I-101)



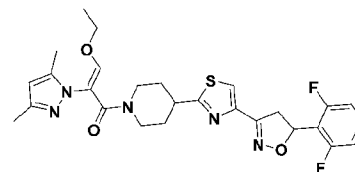
式(I-102)



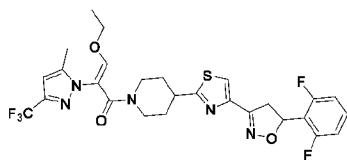
式(I-103)



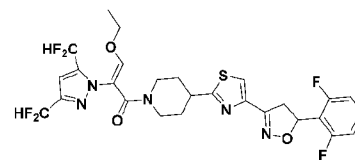
式(I-104)



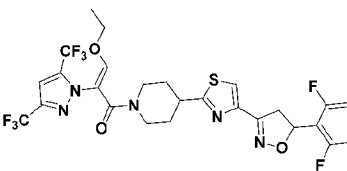
式(I-105)



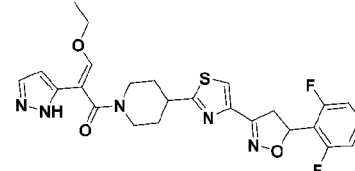
式(I-106)



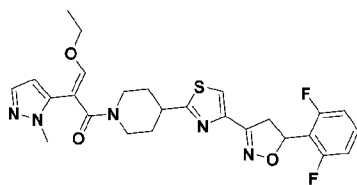
式(I-107)



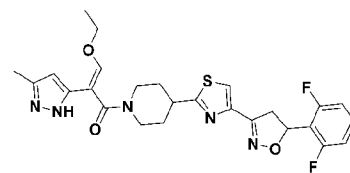
式(I-108)



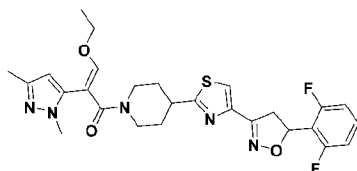
式(I-109)



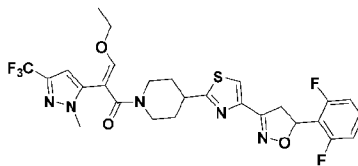
式(I-110)



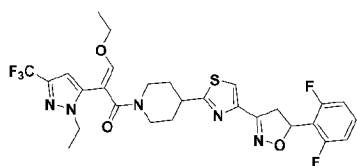
式(I-111)



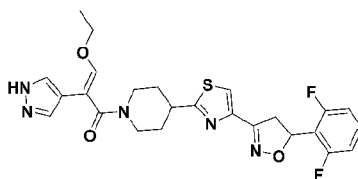
式(I-112)



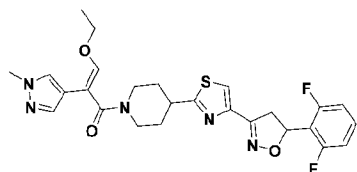
式(I-113)



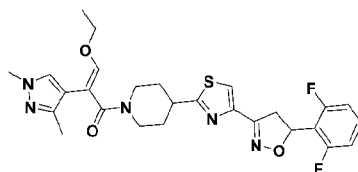
式(I-114)



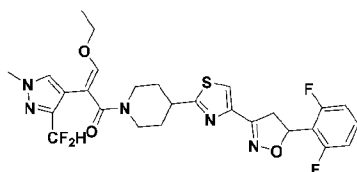
式(I-115)



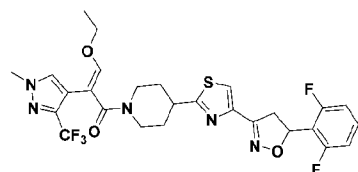
式(I-116)



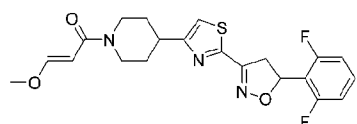
式(I-117)



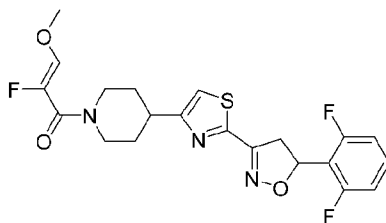
式(I-118)



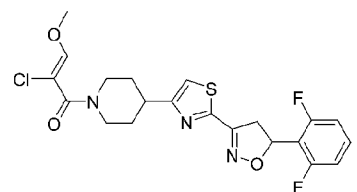
式(I-119)



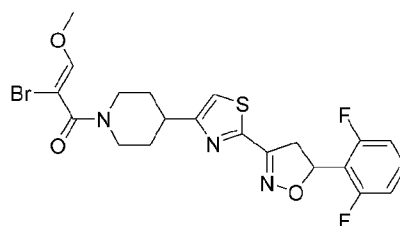
式(I-120)



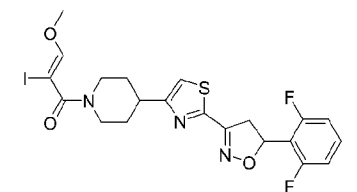
式(I-121)



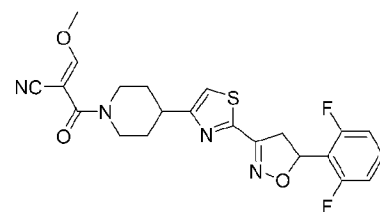
式(I-122)



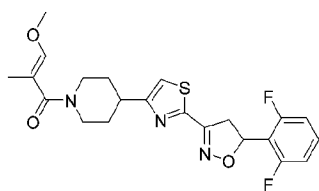
式(I-123)



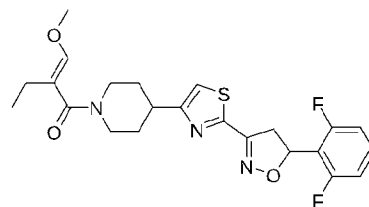
式(I-124)



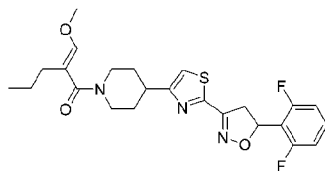
式(I-125)



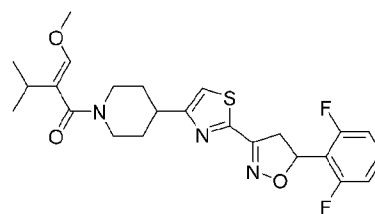
式(I-126)



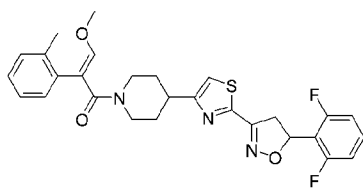
式(I-127)



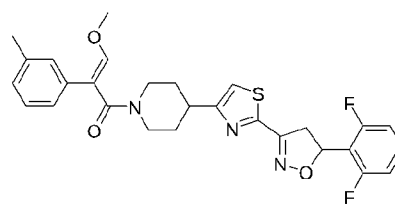
式(I-128)



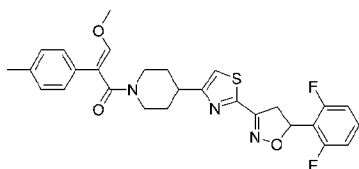
式(I-129)



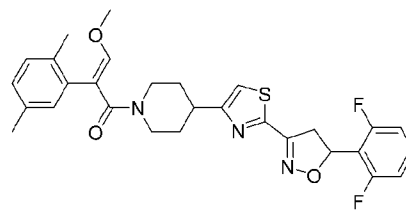
式(I-130)



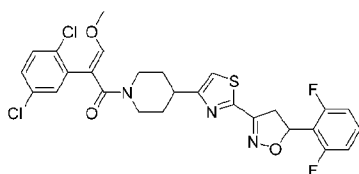
式(I-131)



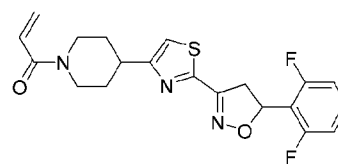
式(I-132)



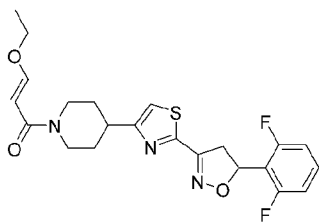
式(I-133)



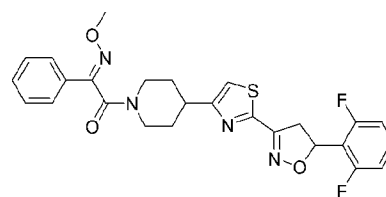
式(I-134)



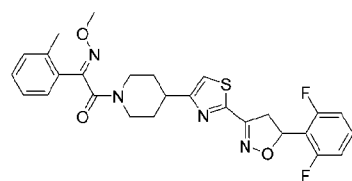
式(I-135)



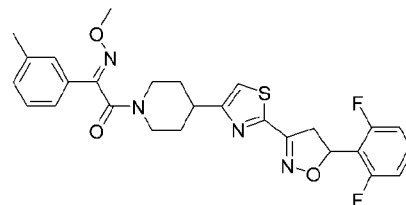
式(I-136)



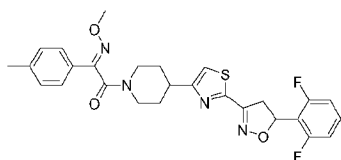
式(I-137)



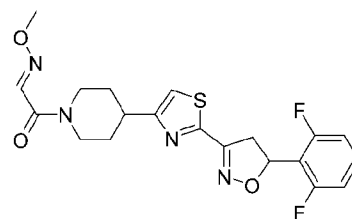
式(I-138)



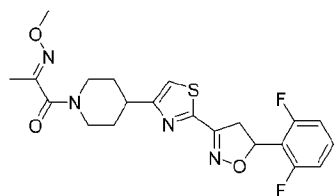
式(I-139)



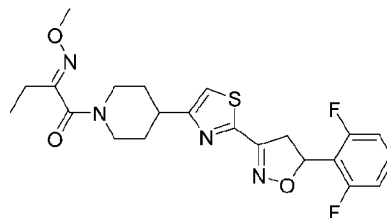
式(I-140)



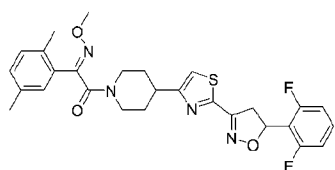
式(I-141)



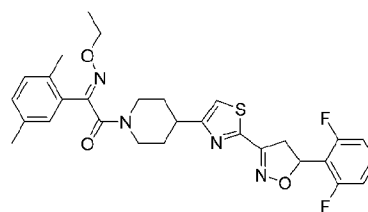
式(I-142)



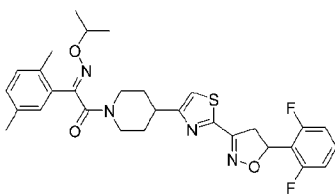
式(I-143)



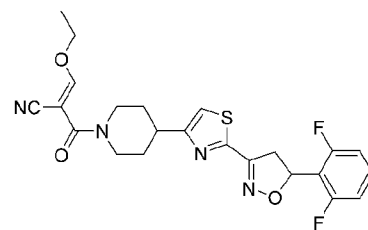
式(I-144)



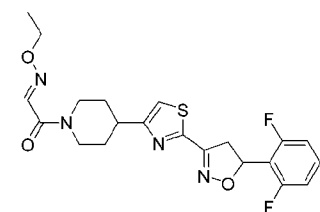
式(I-145)



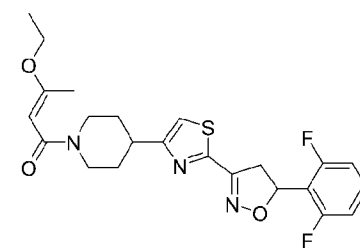
式(I-146)



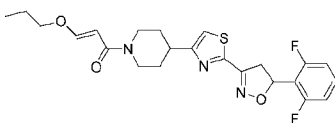
式(I-147)



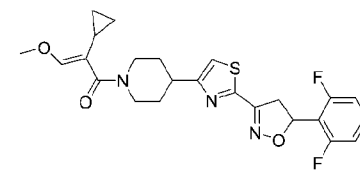
式(I-148)



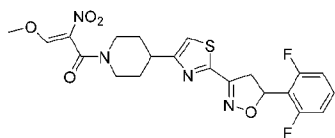
式(I-149)



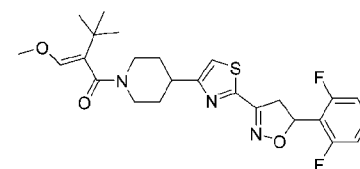
式(I-150)



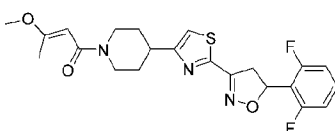
式(I-151)



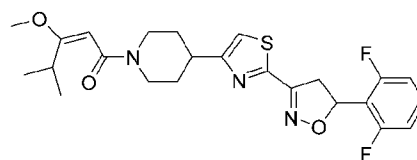
式(I-152)



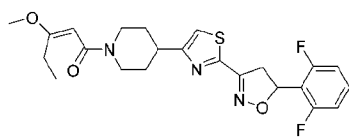
式(I-153)



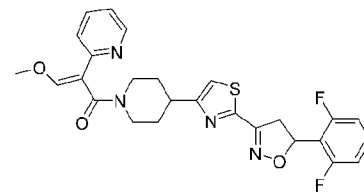
式(I-154)



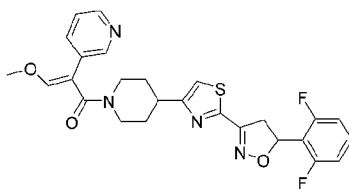
式(I-155)



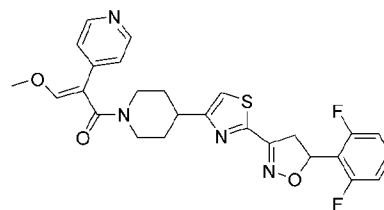
式(I-156)



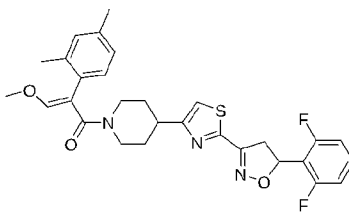
式(I-157)



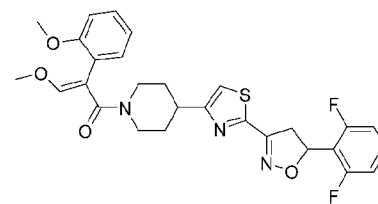
式(I-158)



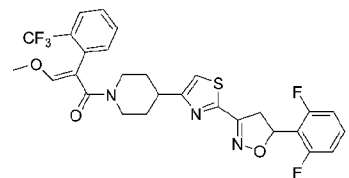
式(I-159)



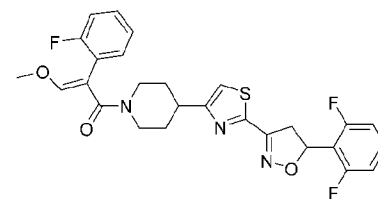
式(I-160)



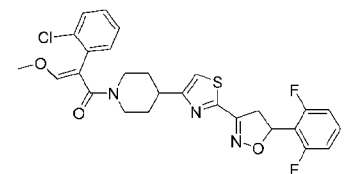
式(I-161)



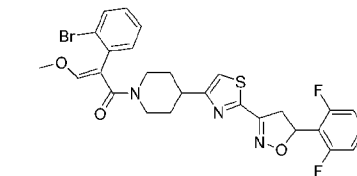
式(I-162)



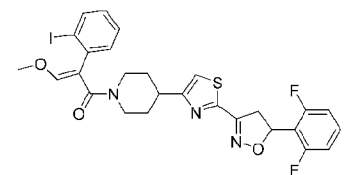
式(I-163)



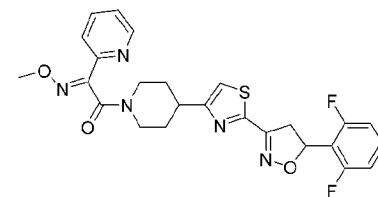
式(I-164)



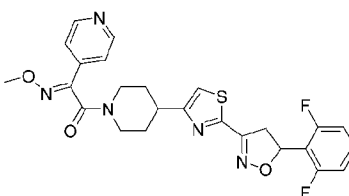
式(I-165)



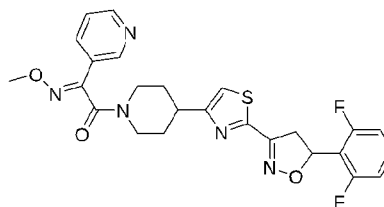
式(I-166)



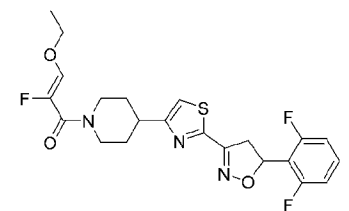
式(I-167)



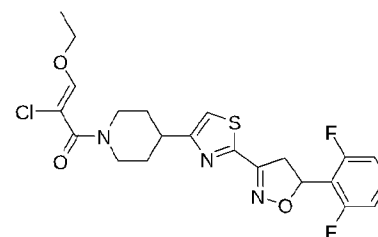
式(I-168)



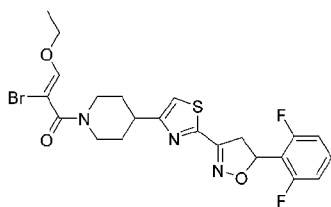
式(I-169)



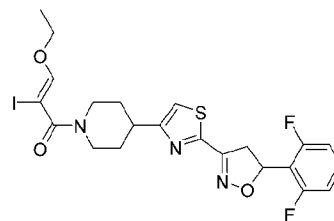
式(I-170)



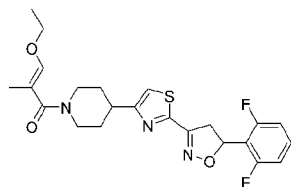
式(I-171)



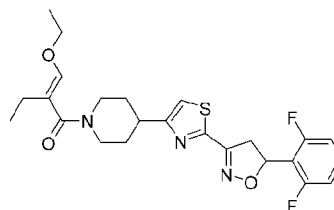
式(I-172)



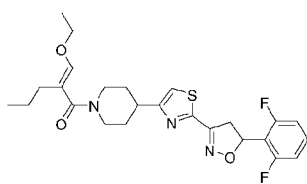
式(I-173)



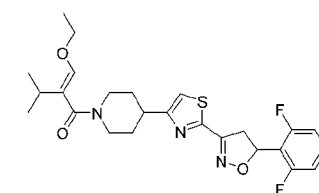
式(I-174)



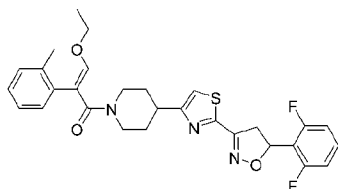
式(I-175)



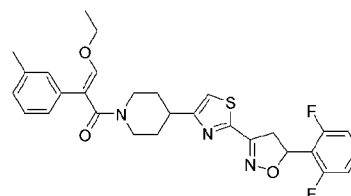
式(I-176)



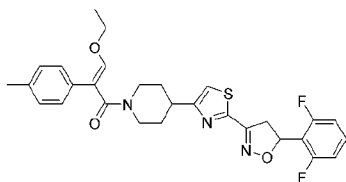
式(I-177)



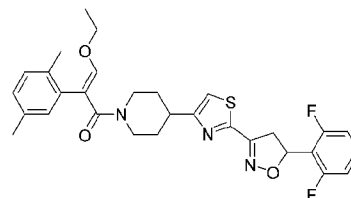
式(I-178)



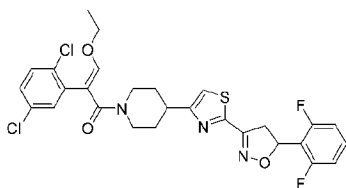
式(I-179)



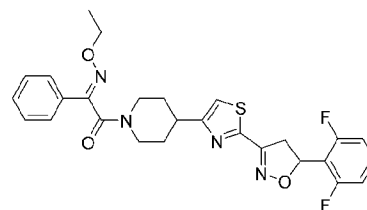
式(I-180)



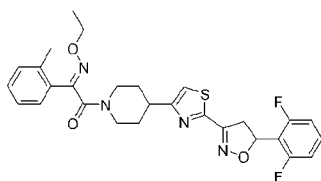
式(I-181)



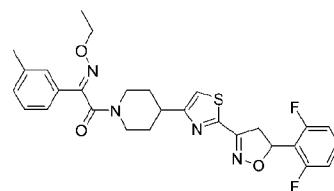
式(I-182)



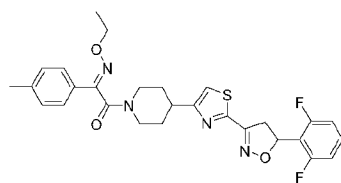
式(I-183)



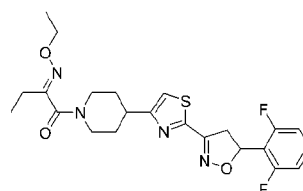
式(I-184)



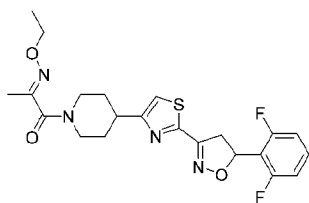
式(I-185)



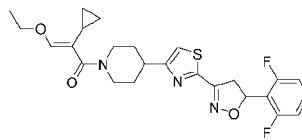
式(I-186)



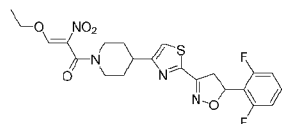
式(I-187)



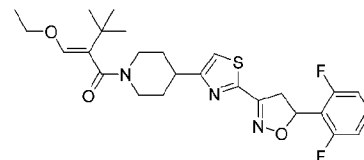
式(I-188)



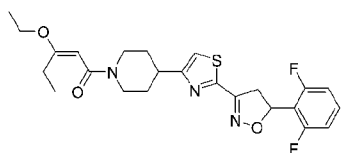
式(I-189)



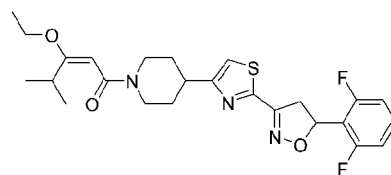
式(I-190)



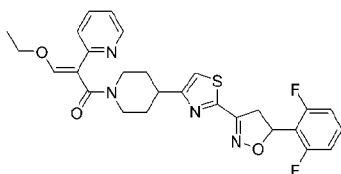
式(I-191)



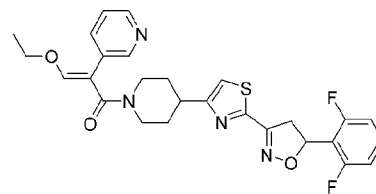
式(I-192)



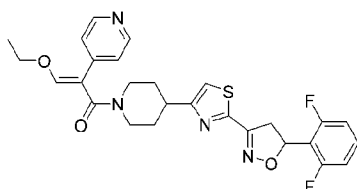
式(I-193)



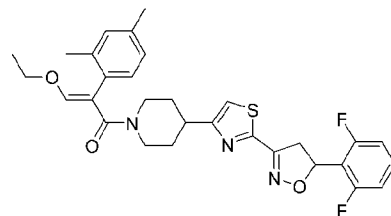
式(I-194)



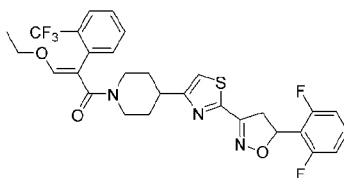
式(I-195)



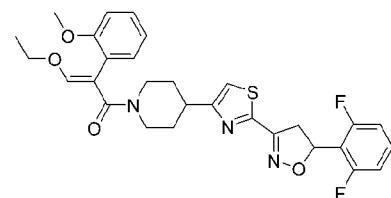
式(I-196)



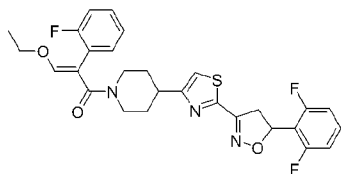
式(I-197)



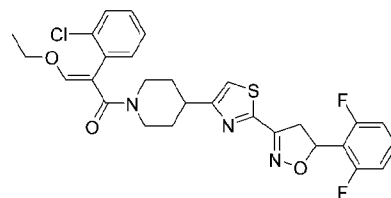
式(I-198)



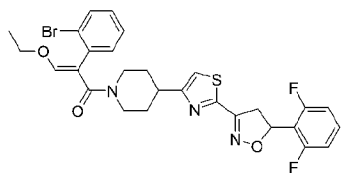
式(I-199)



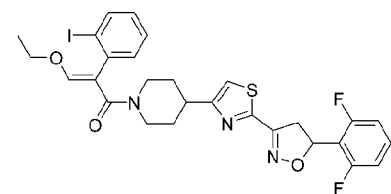
式(I-200)



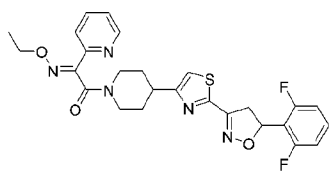
式(I-201)



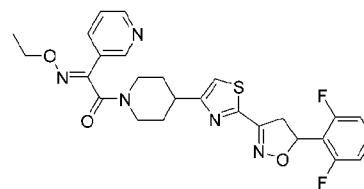
式(I-202)



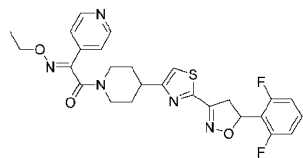
式(I-203)



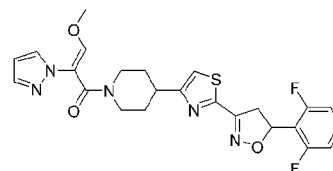
式(I-204)



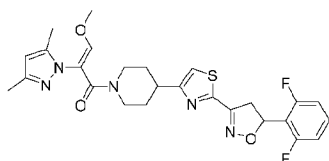
式(I-205)



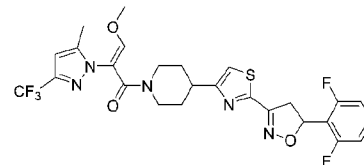
式(I-206)



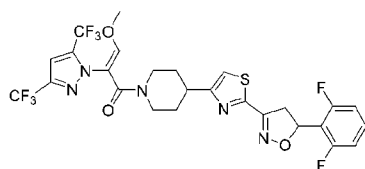
式(I-207)



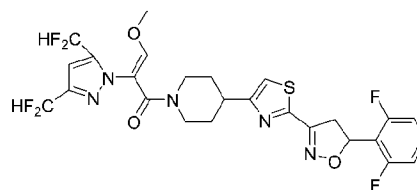
式(I-208)



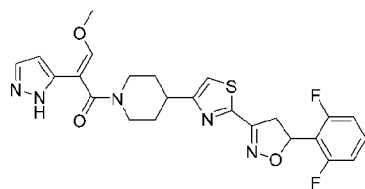
式(I-209)



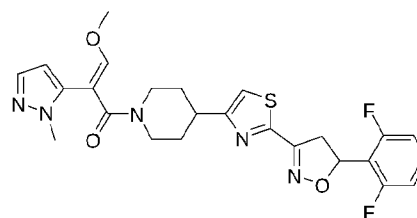
式(I-210)



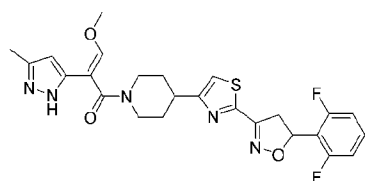
式(I-211)



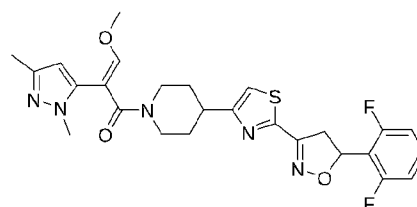
式(I-212)



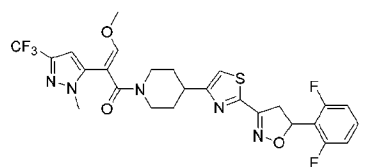
式(I-213)



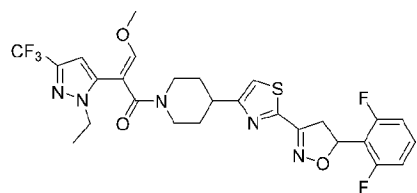
式(I-214)



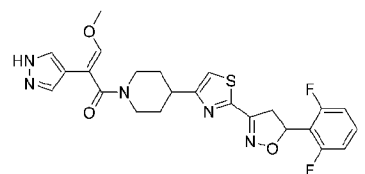
式(I-215)



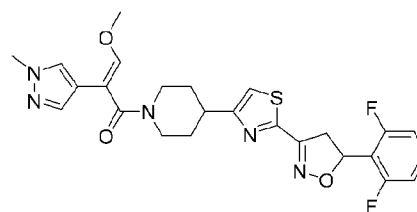
式(I-216)



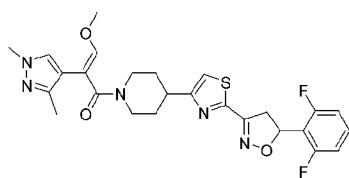
式(I-217)



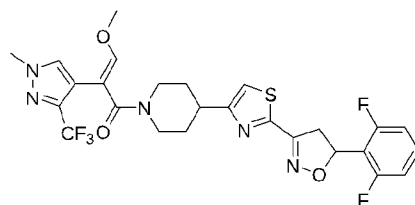
式(I-218)



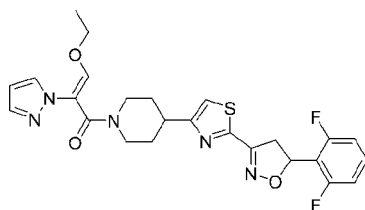
式(I-219)



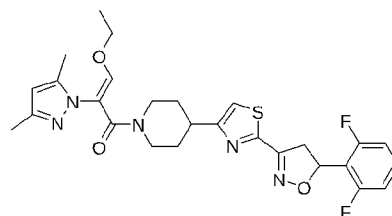
式(I-220)



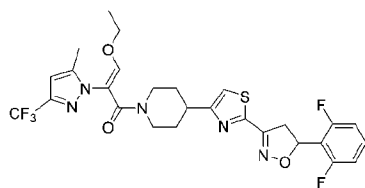
式(I-221)



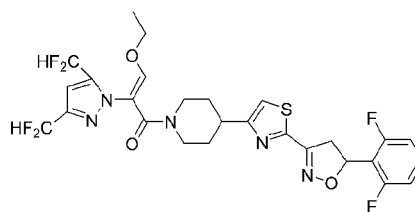
式(I-222)



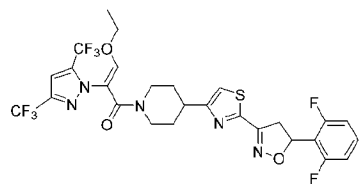
式(I-223)



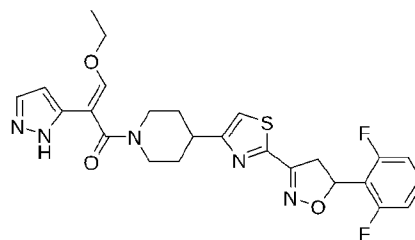
式(I-224)



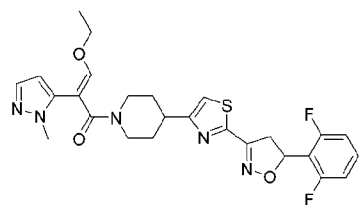
式(I-225)



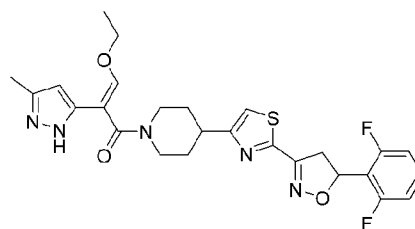
式(I-226)



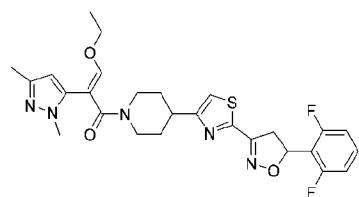
式(I-227)



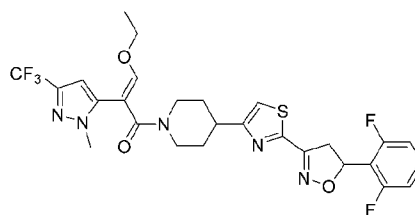
式(I-228)



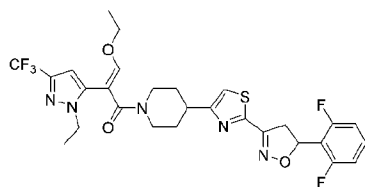
式(I-229)



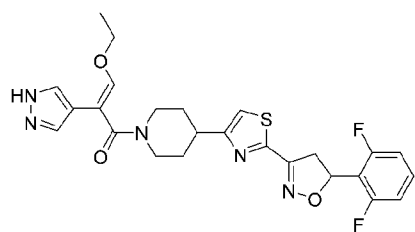
式(I-230)



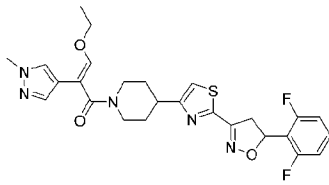
式(I-231)



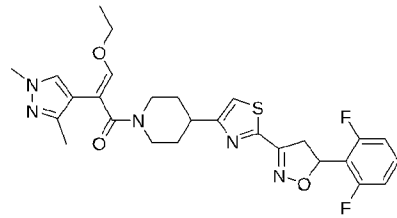
式(I-232)



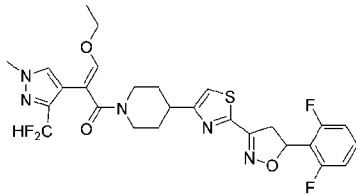
式(I-233)



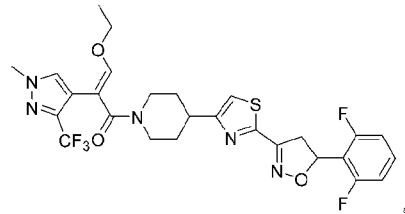
式(I-234)



式(I-235)



式(I-236)



4、根据权利要求1所述的化合物，其中，在式(I)中，

X_1 和 X_2 中的一者为 S，另一者为 CH；

R 为式(Q2)所示的结构； R^1 、 R^2 、 R^3 、 R^4 各自独立地选自 H、 C_1 - C_{12} 的烷基、 C_1 - C_{12} 的烷氧基、 C_3 - C_{12} 的环烷基、 C_1 - C_{12} 的烷硫基、由至少一个卤素取代的 C_1 - C_{12} 的烷氧基、由苯基取代的 C_1 - C_{12} 的烷氧基、卤素、苯基、由组合 A 中的至少一种基团取代的苯基、氰基、硝基、吡啶基、吡唑基、由组合 A 中的至少一种基团取代的吡唑基；且 R^1 、 R^2 、 R^3 、 R^4 中的至少一者为 C_1 - C_{12} 的烷氧基或 C_1 - C_{12} 的烷硫基，或者， R^2 和 R^3 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子作为成环原子的 3-7 元饱和杂环基；

所述组合 A 由 C_1 - C_{12} 的烷基、卤素、由至少一个卤素取代的 C_1 - C_{12} 的烷基、 C_1 - C_{12} 的烷氧基组成；

优选地，在式(I)中，

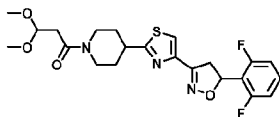
X_1 和 X_2 中的一者为 S，另一者为 CH；

R 为式(Q2)所示的结构； R^1 、 R^2 、 R^3 、 R^4 各自独立地选自 H、 C_1 - C_{10} 的烷基、 C_1 - C_{10} 的烷氧基、 C_3 - C_{10} 的环烷基、 C_1 - C_{10} 的烷硫基、由至少一个卤素取代的 C_1 - C_{10} 的烷氧基、由苯基取代的 C_1 - C_{10} 的烷氧基、卤素、苯基、由组合 A 中的至少一种基团取代的苯基、氰基、硝基、吡啶基、吡唑基、由组合 A 中的至少一种基团取代的吡唑基；且 R^1 、 R^2 、 R^3 、 R^4 中的至少一者为 C_1 - C_{10} 的烷氧基或 C_1 - C_{10} 的烷硫基，或者， R^2 和 R^3 一起环合形成未取代或由组合 A 中的至少一种基团取代的含有至少一个 O 原子作为成环原子的 3-7 元饱和杂环基；

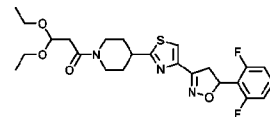
所述组合 A 由 C_1 - C_{10} 的烷基、卤素、由至少一个卤素取代的 C_1 - C_{10} 的烷基、 C_1 - C_{10} 的烷氧基组成。

5、根据权利要求4所述的化合物，其中，式(I)所示结构的化合物选自以下中的任意一种：

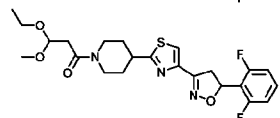
式(II-1)



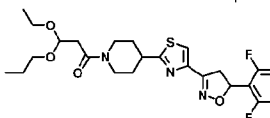
式(II-2)



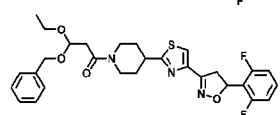
式(II-3)



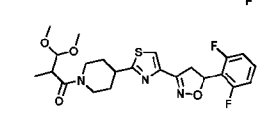
式(II-4)



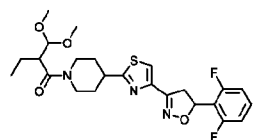
式(II-5)



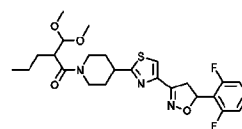
式(II-6)



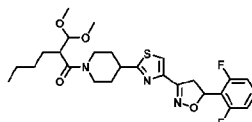
式(II-7)



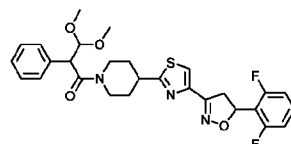
式(II-8)



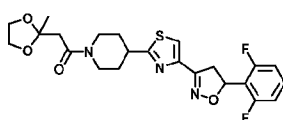
式(II-9)



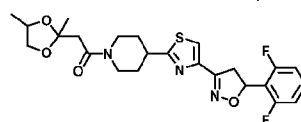
式(II-10)



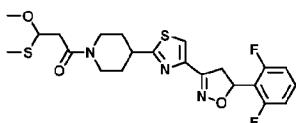
式(II-11)



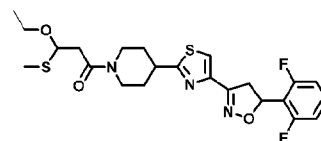
式(II-12)



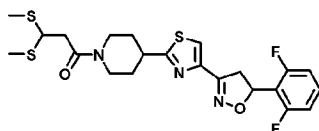
式(II-13)



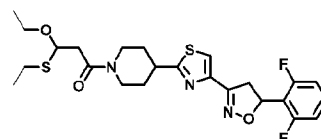
式(II-14)



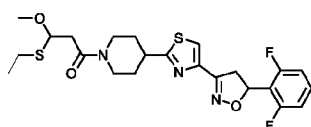
式(II-15)



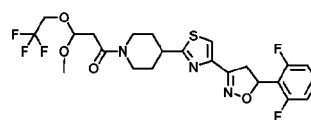
式(II-16)



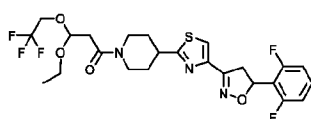
式(II-17)



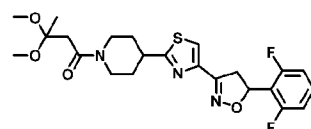
式(II-18)



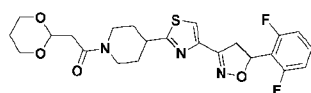
式(II-19)



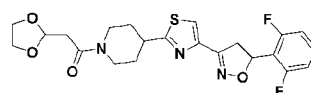
式(II-20)



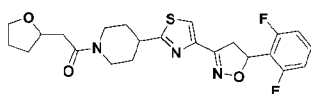
式(II-21)



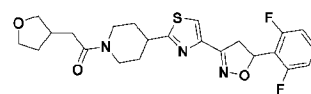
式(II-22)



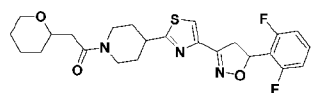
式(II-23)



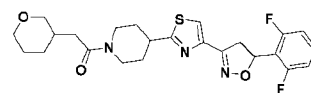
式(II-24)



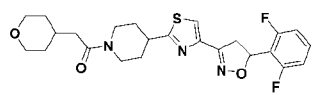
式(II-25)



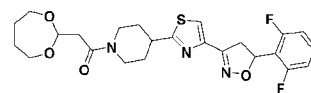
式(II-26)



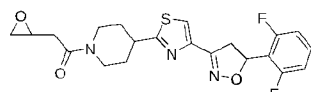
式(II-27)



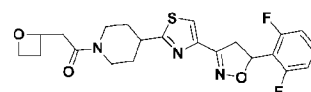
式(II-28)



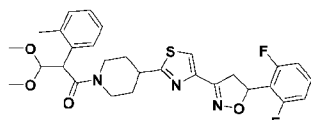
式(II-29)



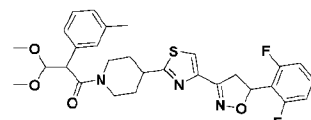
式(II-30)



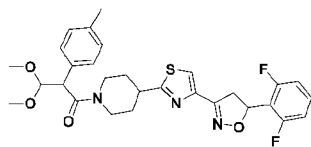
式(II-31)



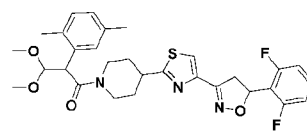
式(II-32)



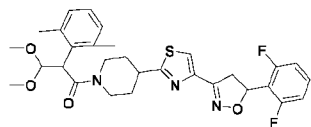
式(II-33)



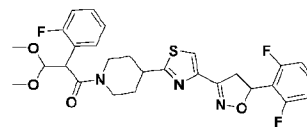
式(II-34)



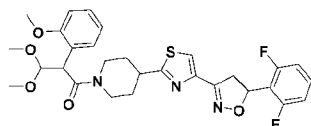
式(II-35)



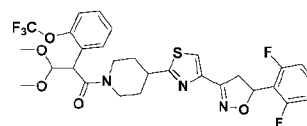
式(II-36)



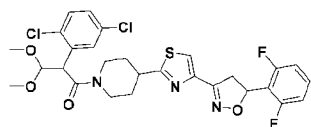
式(II-37)



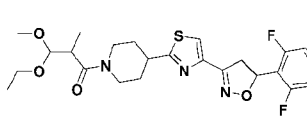
式(II-38)



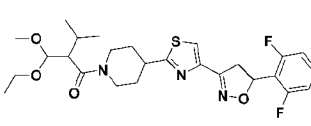
式(II-39)



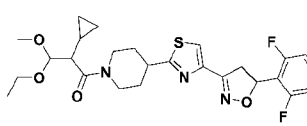
式(II-40)



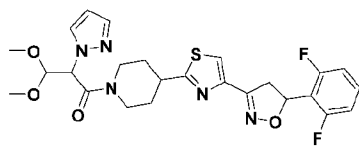
式(II-41)



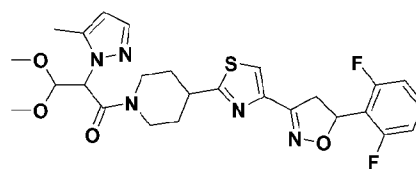
式(II-42)



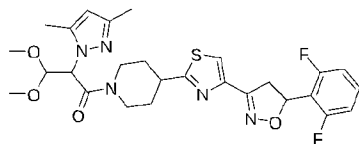
式(II-43)



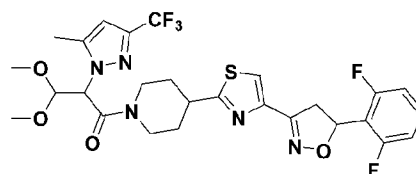
式(II-44)



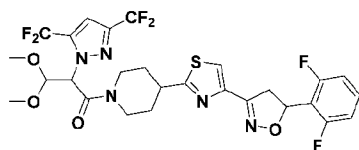
式(II-45)



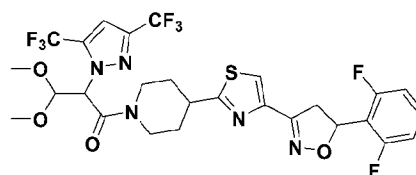
式(II-46)



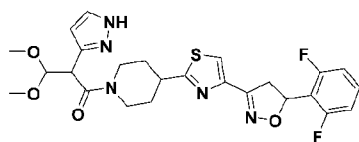
式(II-47)



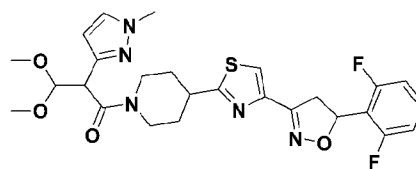
式(II-48)



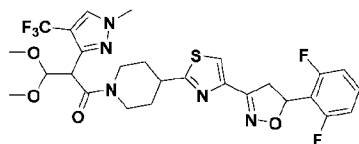
式(II-49)



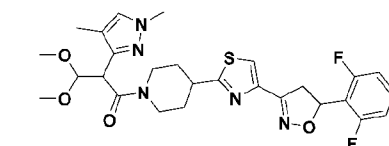
式(II-50)



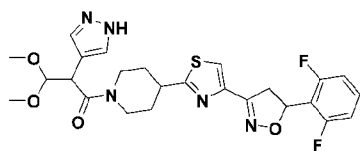
式(II-51)



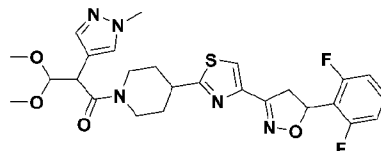
式(II-52)



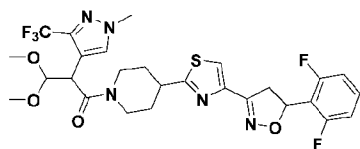
式(II-53)



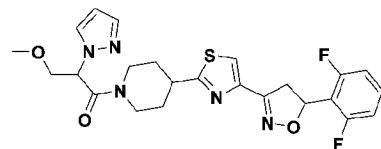
式(II-54)



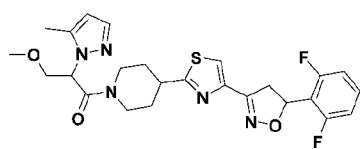
式(II-55)



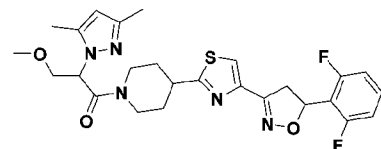
式(II-56)



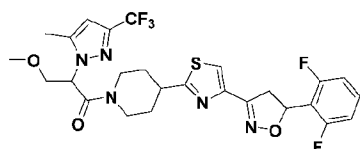
式(II-57)



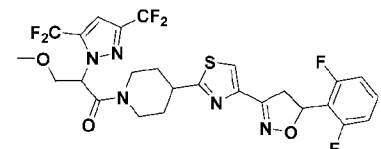
式(II-58)



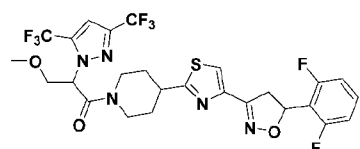
式(II-59)



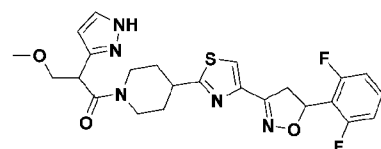
式(II-60)



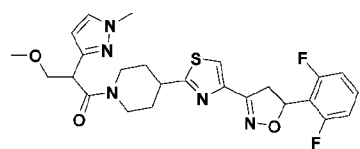
式(II-61)



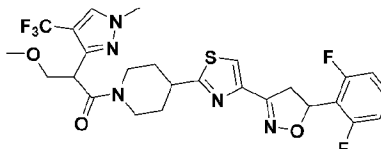
式(II-62)



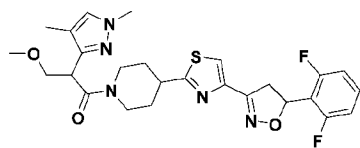
式(II-63)



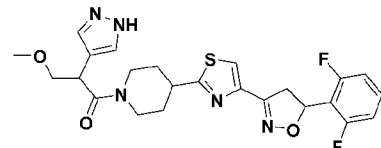
式(II-64)



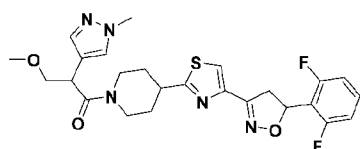
式(II-65)



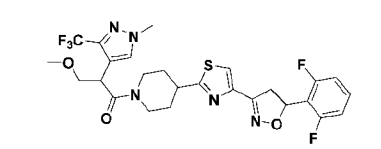
式(II-66)



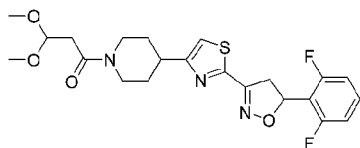
式(II-67)



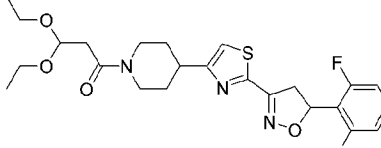
式(II-68)



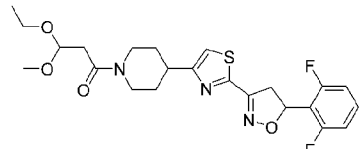
式(II-69)



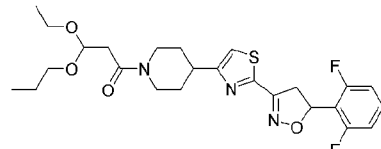
式(II-70)



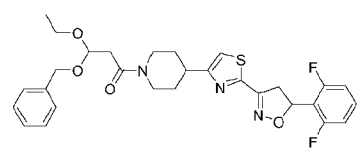
式(II-71)



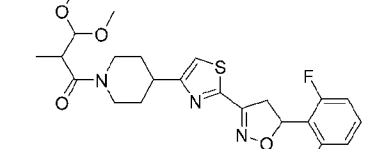
式(II-72)



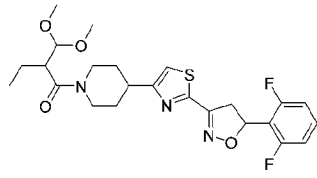
式(II-73)



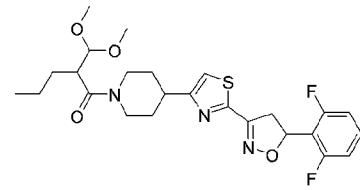
式(II-74)



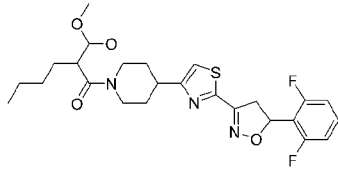
式(II-75)



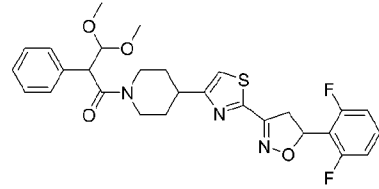
式(II-76)



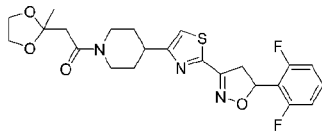
式(II-77)



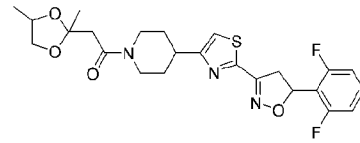
式(II-78)



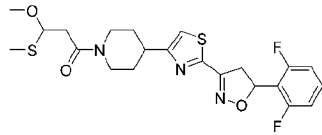
式(II-79)



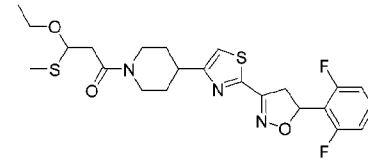
式(II-80)



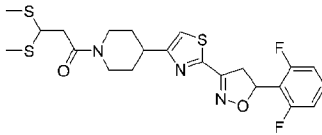
式(II-81)



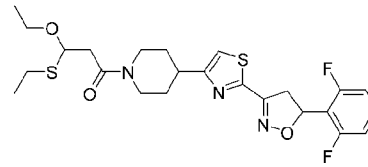
式(II-82)



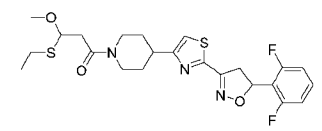
式(II-83)



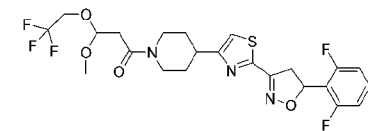
式(II-84)



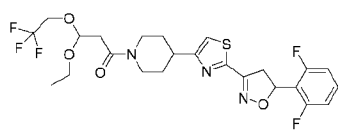
式(II-85)



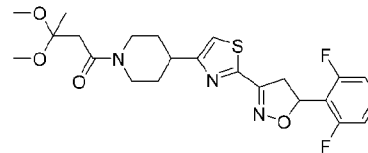
式(II-86)



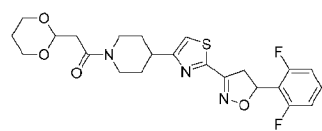
式(II-87)



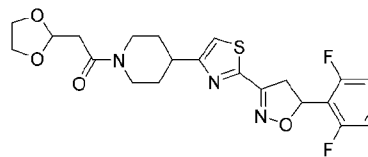
式(II-88)



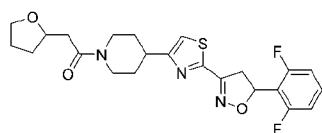
式(II-89)



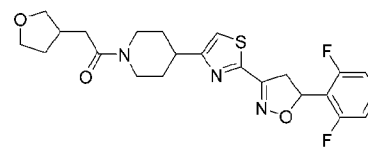
式(II-90)



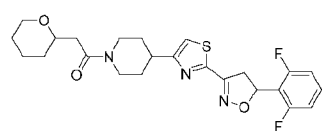
式(II-91)



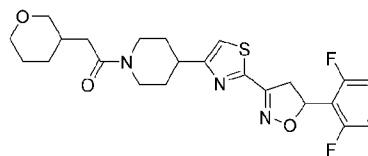
式(II-92)



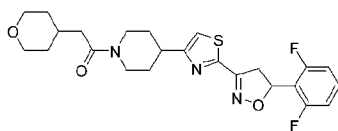
式(II-93)



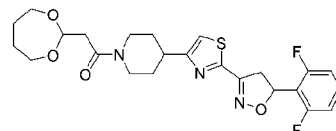
式(II-94)



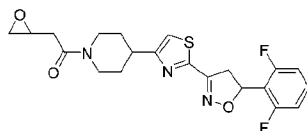
式(II-95)



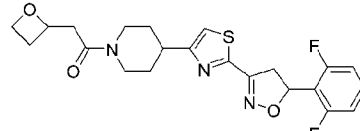
式(II-96)



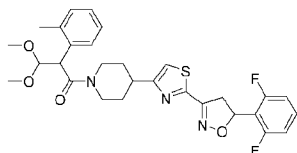
式(II-97)



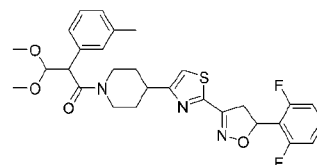
式(II-98)



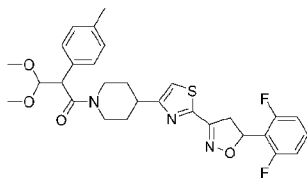
式(II-99)



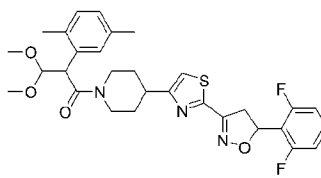
式(II-100)



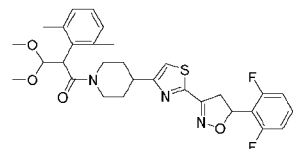
式(II-101)



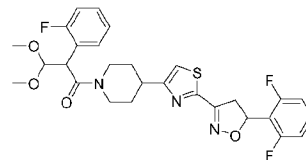
式(II-102)



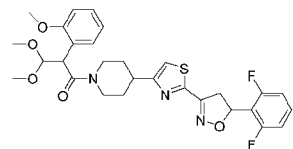
式(II-103)



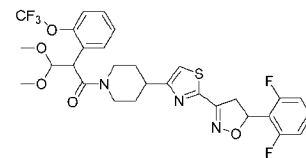
式(II-104)



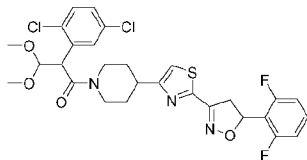
式(II-105)



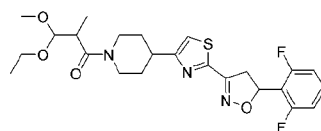
式(II-106)



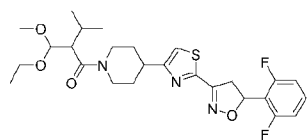
式(II-107)



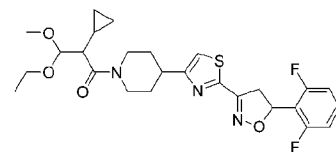
式(II-108)



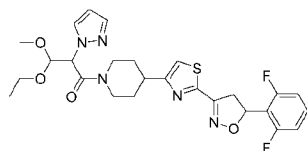
式(II-109)



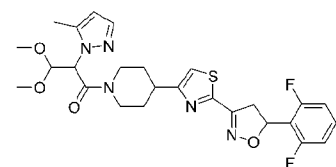
式(II-110)



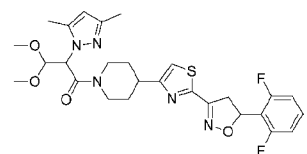
式(II-111)



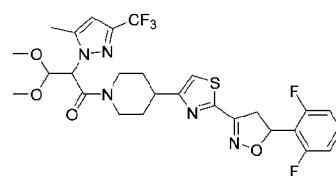
式(II-112)



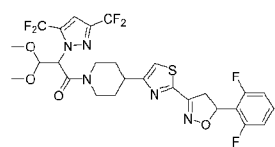
式(II-113)



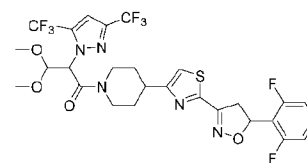
式(II-114)



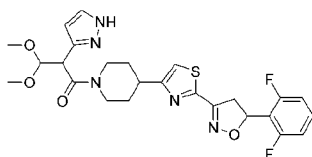
式(II-115)



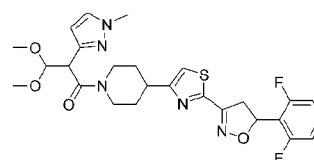
式(II-116)



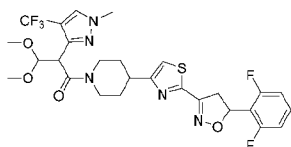
式(II-117)



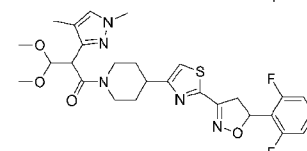
式(II-118)



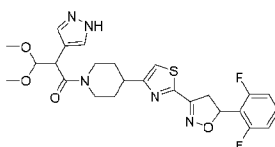
式(II-119)



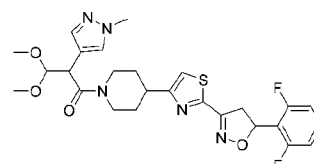
式(II-120)



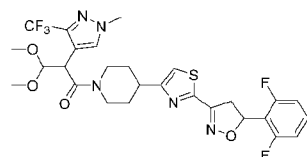
式(II-121)



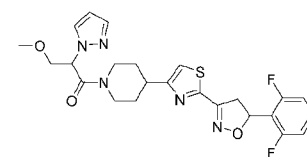
式(II-122)



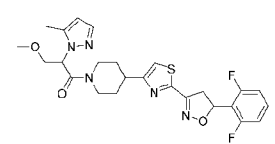
式(II-123)



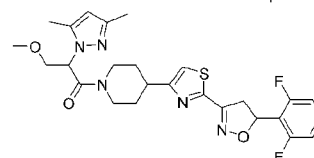
式(II-124)



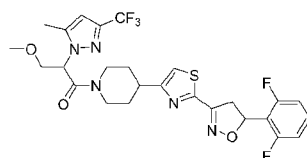
式(II-125)



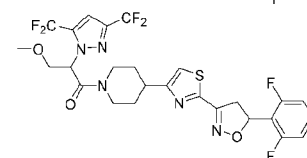
式(II-126)



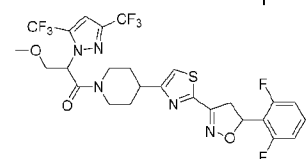
式(II-127)



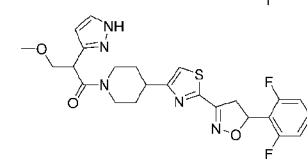
式(II-128)



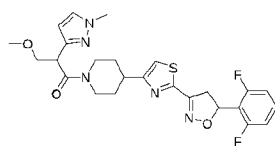
式(II-129)



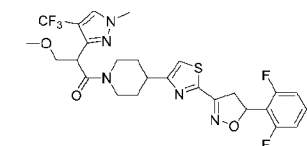
式(II-130)



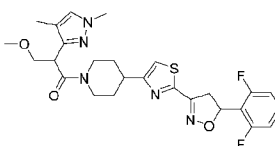
式(II-131)



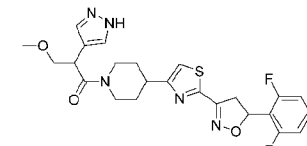
式(II-132)



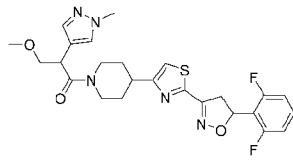
式(II-133)



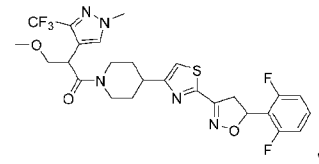
式(II-134)



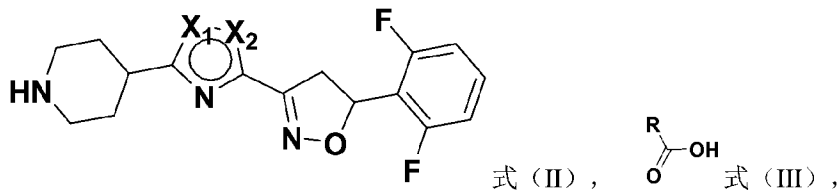
式(II-135)



式(II-136)



6、一种制备权利要求 1-5 中任意一项所述的含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物的方法，其特征在于，该方法包括：在缩合反应条件下，将式 (II) 所示的化合物与式 (III) 所示的化合物进行接触反应，



且式 (II) 所示的化合物与式 (III) 所示的化合物中的取代基的定义与权利要求 1-5 中任意一项所述的定义相同。

7、权利要求 1-5 中任意一项所述的含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物在防治植物卵菌病害中的应用；

优选地，所述植物卵菌病害选自黄瓜霜霉病、马铃薯晚疫病、辣椒疫霉病中的至少一种。

8、权利要求 1-5 中任意一项所述的含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物作为农用杀菌剂的应用。

9、一种杀菌剂，该杀菌剂由活性成分和辅料组成，所述活性成分包括权利要求 1-5 中任意一项所述的含链状羧酸酰胺结构的化合物或其农业化学上可接受的盐、水合物和溶剂化物；

优选地，所述活性成分的含量为 1-99.9 重量%。

10、根据权利要求 9 所述的杀菌剂，其中，该杀菌剂的剂型选自乳油、悬浮剂、可湿性粉剂、粉剂、粒剂、水剂、毒饵、母液和母粉中的至少一种。

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/115117

A. CLASSIFICATION OF SUBJECT MATTER

C07D417/14(2006.01)i; A01N43/78(2006.01)i; A01P3/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:C07D, A01N, A01P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT, CNKI, CNABS, DWPI, ENTXT, WOTXT, REGISTRY, CAPLUS: 杀菌剂, 农药, 农用, 卵菌病, 黄瓜霜霉病, 马铃薯晚疫病, 辣椒疫霉病, 羧酸酰胺, bactericides, pesticides, agricultural, oomycetes, cucumber downy mildew, potato blight, phytophthora capsici, carboxylic acid amides, 根据权利要求1进行的子结构检索 sub-structural search according to claim 1

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 110437224 A (CENTRAL CHINA NORMAL UNIVERSITY) 12 November 2019 (2019-11-12) entire document	1-10
A	WO 2009055514 A2 (DU, P. et al.) 30 April 2009 (2009-04-30) entire document	1-10
A	WO 2009094445 A2 (DU, P. et al.) 30 July 2009 (2009-07-30) entire document	1-10
A	WO 2010065579 A2 (DU, P. et al.) 10 June 2010 (2010-06-10) entire document	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“D” document cited by the applicant in the international application

“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

22 November 2023

Date of mailing of the international search report

24 November 2023

Name and mailing address of the ISA/CN

China National Intellectual Property Administration (ISA/
CN)
China No. 6, Xitucheng Road, Jimenqiao, Haidian District,
Beijing 100088

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2023/115117

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	110437224	A	12 November 2019	None			
WO	2009055514	A2	30 April 2009	None			
WO	2009094445	A2	30 July 2009	JP	2011510928	A	07 April 2011
				JP	5529044	B2	25 June 2014
				EP	2260032	A2	15 December 2010
				AU	2009206468	A1	30 July 2009
				AU	2009206468	B2	09 January 2014
				WO	2009094445	A3	26 August 2010
				US	2010292275	A1	18 November 2010
				US	8349870	B2	08 January 2013
				KR	20100119552	A	09 November 2010
				KR	20150065958	A	15 June 2015
				EP	2402332	A2	04 January 2012
				EP	2402332	A3	29 October 2014
				BRPI	0905759	A2	14 July 2015
				MX	2010008102	A	04 August 2010
WO	2010065579	A2	10 June 2010	None			

A. 主题的分类 C07D417/14(2006.01)i; A01N43/78(2006.01)i; A01P3/00(2006.01)i 按照国际专利分类(IPC)或者同时按照国家分类和IPC两种分类																			
B. 检索领域 检索的最低限度文献(标明分类系统和分类号) IPC:C07D, A01N, A01P 包含在检索领域中的除最低限度文献以外的检索文献 在国际检索时查阅的电子数据库(数据库的名称, 和使用的检索词(如使用)) CNTEXT, CNKI, CNABS, DWPI, ENTXT, WOTXT, REGISTRY, CAPLUS: 杀菌剂, 农药, 农用, 卵菌病, 黄瓜霜霉病, 马铃薯晚疫病, 辣椒疫霉病, 羧酸酰胺, bactericides, pesticides, agricultural, oomycetes, cucumber downy mildew, potato blight, phytophthora capsici, carboxylic acid amides,根据权利要求1进行的子结构检索																			
C. 相关文件 <table border="1"> <thead> <tr> <th>类型*</th> <th>引用文件, 必要时, 指明相关段落</th> <th>相关的权利要求</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>CN 110437224 A (华中师范大学) 2019年11月12日 (2019 - 11 - 12) 全文</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>WO 2009055514 A2 (DU PONT等) 2009年4月30日 (2009 - 04 - 30) 全文</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>WO 2009094445 A2 (DU PONT等) 2009年7月30日 (2009 - 07 - 30) 全文</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>WO 2010065579 A2 (DU PONT等) 2010年6月10日 (2010 - 06 - 10) 全文</td> <td>1-10</td> </tr> </tbody> </table> ☐ 其余文件在C栏的续页中列出。 ☒ 见同族专利附件。 <table border="0"> <tr> <td> * 引用文件的具体类型: “A” 认为不特别相关的表示了现有技术一般状态的文件 “D” 申请人在国际申请中引证的文件 “E” 在国际申请日的当天或之后公布的在先申请或专利 “L” 可能对优先权要求构成怀疑的文件, 或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件(如具体说明的) “O” 涉及口头公开、使用、展览或其他方式公开的文件 “P” 公布日先于国际申请日但迟于所要求的优先权日的文件 </td> <td> “T” 在申请日或优先权日之后公布, 与申请不相抵触, 但为了理解发明之理论或原理的在后文件 “X” 特别相关的文件, 单独考虑该文件, 认定要求保护的发明不是新颖的或不具有创造性 “Y” 特别相关的文件, 当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时, 要求保护的发明不具有创造性 “&” 同族专利的文件 </td> </tr> </table>			类型*	引用文件, 必要时, 指明相关段落	相关的权利要求	A	CN 110437224 A (华中师范大学) 2019年11月12日 (2019 - 11 - 12) 全文	1-10	A	WO 2009055514 A2 (DU PONT等) 2009年4月30日 (2009 - 04 - 30) 全文	1-10	A	WO 2009094445 A2 (DU PONT等) 2009年7月30日 (2009 - 07 - 30) 全文	1-10	A	WO 2010065579 A2 (DU PONT等) 2010年6月10日 (2010 - 06 - 10) 全文	1-10	* 引用文件的具体类型: “A” 认为不特别相关的表示了现有技术一般状态的文件 “D” 申请人在国际申请中引证的文件 “E” 在国际申请日的当天或之后公布的在先申请或专利 “L” 可能对优先权要求构成怀疑的文件, 或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件(如具体说明的) “O” 涉及口头公开、使用、展览或其他方式公开的文件 “P” 公布日先于国际申请日但迟于所要求的优先权日的文件	“T” 在申请日或优先权日之后公布, 与申请不相抵触, 但为了理解发明之理论或原理的在后文件 “X” 特别相关的文件, 单独考虑该文件, 认定要求保护的发明不是新颖的或不具有创造性 “Y” 特别相关的文件, 当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时, 要求保护的发明不具有创造性 “&” 同族专利的文件
类型*	引用文件, 必要时, 指明相关段落	相关的权利要求																	
A	CN 110437224 A (华中师范大学) 2019年11月12日 (2019 - 11 - 12) 全文	1-10																	
A	WO 2009055514 A2 (DU PONT等) 2009年4月30日 (2009 - 04 - 30) 全文	1-10																	
A	WO 2009094445 A2 (DU PONT等) 2009年7月30日 (2009 - 07 - 30) 全文	1-10																	
A	WO 2010065579 A2 (DU PONT等) 2010年6月10日 (2010 - 06 - 10) 全文	1-10																	
* 引用文件的具体类型: “A” 认为不特别相关的表示了现有技术一般状态的文件 “D” 申请人在国际申请中引证的文件 “E” 在国际申请日的当天或之后公布的在先申请或专利 “L” 可能对优先权要求构成怀疑的文件, 或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件(如具体说明的) “O” 涉及口头公开、使用、展览或其他方式公开的文件 “P” 公布日先于国际申请日但迟于所要求的优先权日的文件	“T” 在申请日或优先权日之后公布, 与申请不相抵触, 但为了理解发明之理论或原理的在后文件 “X” 特别相关的文件, 单独考虑该文件, 认定要求保护的发明不是新颖的或不具有创造性 “Y” 特别相关的文件, 当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时, 要求保护的发明不具有创造性 “&” 同族专利的文件																		
国际检索实际完成的日期 2023年11月22日	国际检索报告邮寄日期 2023年11月24日																		
ISA/CN的名称和邮寄地址 中国国家知识产权局 中国北京市海淀区蓟门桥西土城路6号 100088	授权官员 王少华 电话号码 (+86) 010-62086353																		

国际检索报告
关于同族专利的信息

国际申请号

PCT/CN2023/115117

检索报告引用的专利文件			公布日 (年/月/日)	同族专利			公布日 (年/月/日)
CN	110437224	A	2019年11月12日	无			
WO	2009055514	A2	2009年4月30日	无			
WO	2009094445	A2	2009年7月30日	JP	2011510928	A	2011年4月7日
				JP	5529044	B2	2014年6月25日
				EP	2260032	A2	2010年12月15日
				AU	2009206468	A1	2009年7月30日
				AU	2009206468	B2	2014年1月9日
				WO	2009094445	A3	2010年8月26日
				US	2010292275	A1	2010年11月18日
				US	8349870	B2	2013年1月8日
				KR	20100119552	A	2010年11月9日
				KR	20150065958	A	2015年6月15日
				EP	2402332	A2	2012年1月4日
				EP	2402332	A3	2014年10月29日
				BR- PI	0905759	A2	2015年7月14日
				MX	2010008102	A	2010年8月4日
WO	2010065579	A2	2010年6月10日	无			