

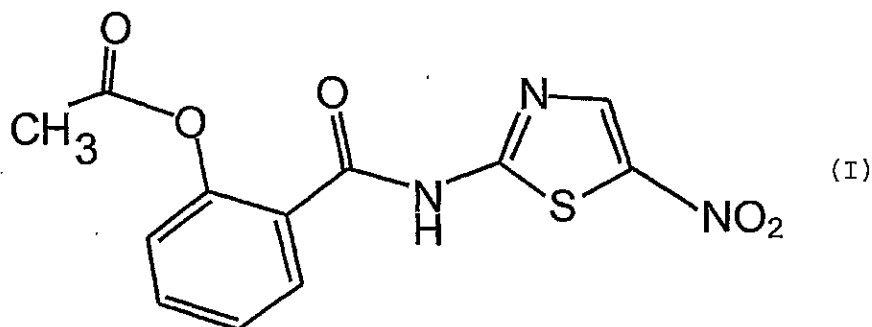
HALOGENATED BENZAMIDE DERIVATIVES

FIELD OF THE INVENTION

The invention relates to halogenated benzamide derivatives, and more specifically, benzamide derivatives characterized by greater specificity for viral pathogens and less disruptive to beneficial gut microflora.

BACKGROUND TO THE INVENTION

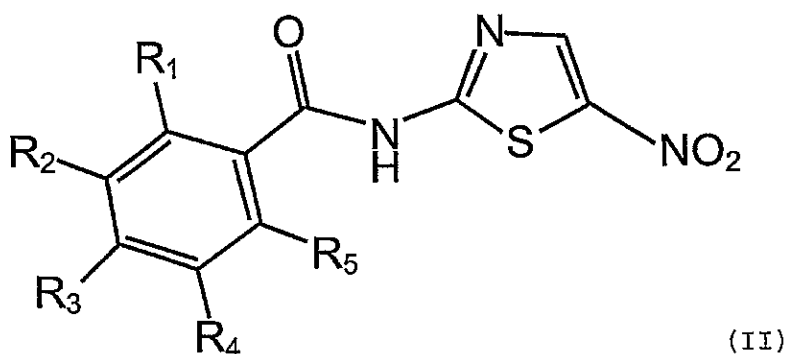
(2-(acetoxylloxy)-N-(5-nitro-2-thiazolyl) benzamide, the compound of formula (I), also referred to as nitrothiazole, nitazoxanide, or NTZ, is known for use in the treatment and prevention of parasitic infections, bacterial infections, fungal infections, diarrhea and other intestinal troubles (U.S. Patent Nos. 3,950,351, 4,315,018 and 5,578,621) including treatment of trematodes (U.S. Patent No. 5,856,348). The preparation of NTZ is disclosed in U.S. Patent No. 3,950,351. Improved pharmaceutical compositions for delivery of NTZ are disclosed in U.S. Patent Nos. 6,117,894 and 5,968,961.



It has been postulated that, in anaerobic bacteria and protozoa, NTZ exhibits a mode of action based upon reduction of its nitro group by nitroreductases, and particularly pyruvate ferredoxin oxidoreductase (PFOR) dependent electron transfer reactions that are essential for anaerobic energy

metabolism. Nothing is currently known regarding the possible mode of action of NTZ for helminthes, however, the enzymes of anaerobic electron transport are considered as potential targets, with the 5-nitro group implicated in this mechanism.

Compounds according to formula (II), in which one of R_{1-5} is -OH and the remainder of R_{1-5} being H, are known to exhibit antiviral activity, and are known for treatment of human viral diseases such as those caused by human cytomegalovirus, varicella zoster, Epstein Barr virus, HSV-I and HSV-II (U.S. Patent Nos. 5,886,013 and 6,020,353).



While potent, these compounds are not selective for only viral pathogens. They are described as having excellent efficacy against parasites, bacteria and fungus. In practice, this is associated with a problem. Namely, in humans and many animals, the gut contains beneficial populations of microflora, principally comprised of anaerobic bacteria. Oral administration of broad spectrum compounds such as those of Formula (II) kills the bacterial gut flora, which may lead to secondary complications including diarrhea requiring further treatment.

Accordingly, there is a need for therapeutic compounds that are more selective for viral pathogens. Most preferably, these compounds should possess antiviral activity, but be substantially devoid of antibacterial and antiparasite activity, at least to the extent of avoiding deleterious

effects upon the beneficial gut microflora when administered orally.

This need, and more, is achieved by the present invention, as will become clear to one of ordinary skill upon reading the following disclosure and examples.

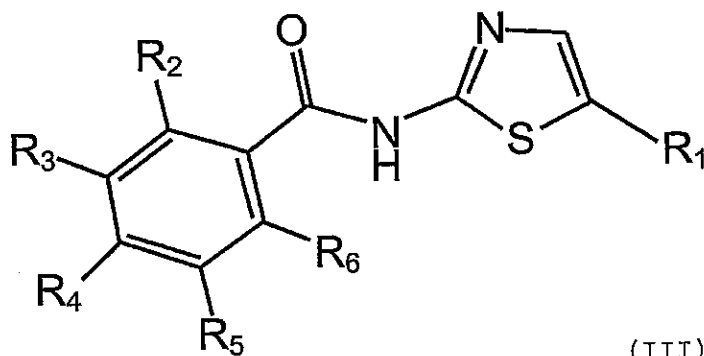
SUMMARY OF THE INVENTION

The present invention relates to antiviral benzamide derivatives that are more selective for viral pathogens, and accordingly cause reduced deleterious effects upon beneficial gut microflora when administered orally.

In a first aspect, the invention is surprisingly made by replacing the nitro substituent, which has until now been believed to be the key to the activity of NTZ, with a halogen atom. This substitution may be made in any of the known therapeutically effective 2-benzamido-5nitro-thiazoles (wherein the benzene ring may be variously substituted). Surprisingly, the novel halogenated compounds retain their antiviral properties, but they lack activity against the bacterial gut microflora when administered orally.

Examples of these known 2-benzamido-5nitro-thiazoles, which are analogues of the compounds of the present invention differing only in that in accordance with the present invention the nitro group is removed and replaced with a halogen atom, are extensively set forth in the above referenced U.S. Patents, and U.S. Patent Nos. 5,886,013 in particular, their disclosure being incorporated herein by reference.

The present invention further provides (5-halo-2-thiazolyl) benzamide compounds according to formula (III):



in which

R_1 is a halogen atom, preferably F, Cl, Br, or I, more preferably Br or Cl, most preferably Br, and

R_2 - R_6 are independently hydrogen, hydroxyl, C_1 - C_4 alkyl, - C_1 - C_4 alkoxy, acyloxy (preferably acetoxy or propionoxy), nitro, halogen, - $C(O)R_7$ where R_7 is - C_1 - C_4 alkyl, or aromatic (preferably unsubstituted or substituted phenyl or benzyl), including salts and hydrates of these compounds.

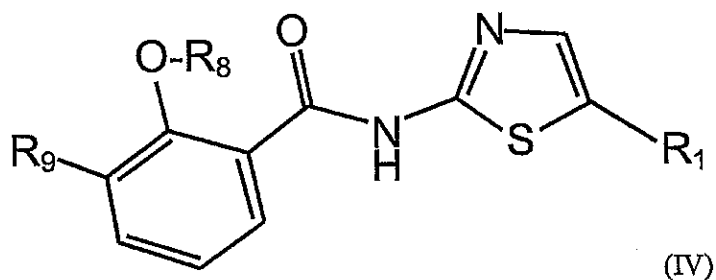
Preferably, one of R_2 - R_6 is hydroxyl.

Preferably at least one of R_2 - R_6 are other than hydrogen, and more preferably at least two of R_2 - R_6 are other than hydrogen.

Two adjacent R_2 - R_6 may together form a benzyl ring.

Preferably, R_2 - R_6 include no more than one acyloxy and no more than one halogen.

The present invention further provides antiviral compounds according to formula (IV):



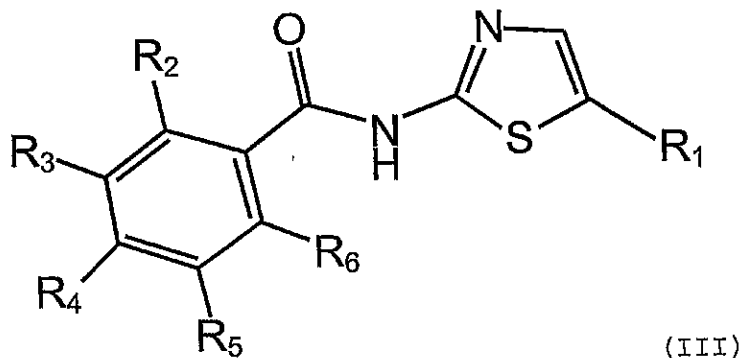
in which R_1 is a halogen atom, R_8 is $-C(O)R_{10}$, where R_{10} is $-C_1-C_4$ alkyl, and R_9 is $-C_1-C_4$ alkyl or $-C_1-C_4$ alkoxy, including salts and hydrates of these compounds.

The invention further provides antiviral pharmaceutical compositions comprising a compound of Formula (III) or (IV) and a pharmaceutically acceptable carrier.

Finally, the invention provides a method of treating or preventing a viral infection in an animal or human subject, the method comprising administering to said subject at least one dose of the pharmaceutical composition comprising an effective amount of the antiviral compound according to Formula (III) or (IV) and a pharmaceutically acceptable carrier.

DETAILED DESCRIPTION

Compounds of the present invention include those according to formula (III):



in which

R_1 is a halogen atom, preferably F, Cl, Br, or I, more preferably Br or Cl, most preferably Br, and

R_2 - R_6 are independently hydrogen, hydroxyl, C_1-C_4 alkyl, $-C_1-C_4$ alkoxy, acyloxy (preferably acetoxy or propionoxy), nitro, halogen, $-C(O)R_7$ where R_7 is $-C_1-C_4$ alkyl, or aromatic

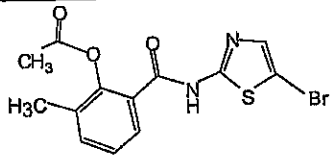
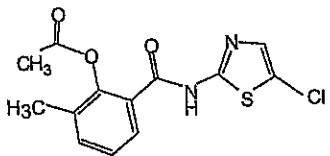
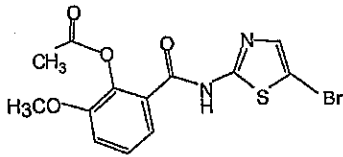
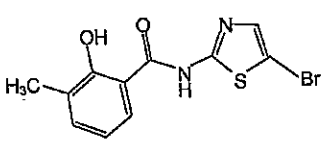
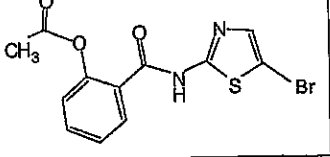
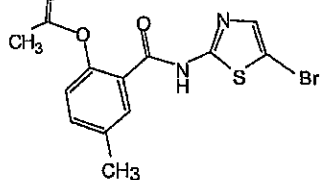
(preferably phenyl or benzyl, which may be further substituted), including salts and hydrates of these compounds.

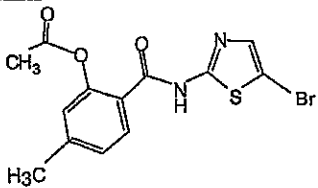
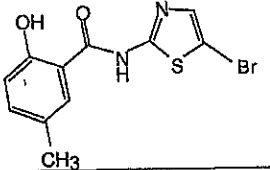
Preferably, one of R_2 - R_6 is hydroxyl.

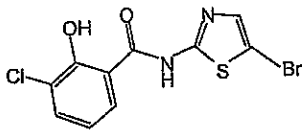
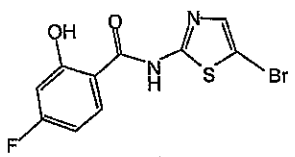
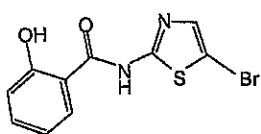
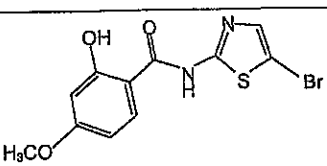
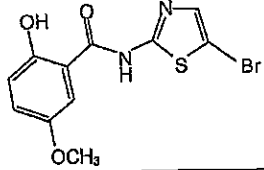
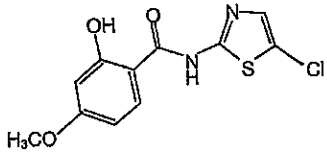
Preferably at least one of R_2 - R_6 are other than hydrogen, and more preferably at least two of R_2 - R_6 are other than hydrogen.

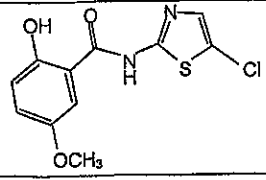
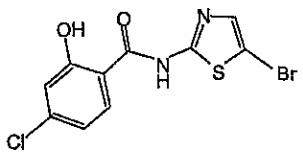
Two adjacent R_2 - R_6 may together form a benzyl ring.

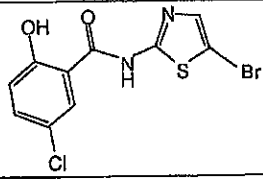
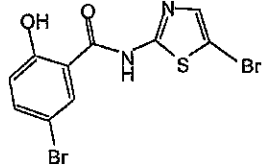
Preferably, R_2 - R_6 include no more than one acyloxy and no more than one halogen. Compounds according to the present invention are illustrated by the following non-limiting list:

Code Number	Structure	Molecular Weight	Molecular Formula
RM-4803		355.21	$C_{13}H_{11}BrN_2O_3S$
RM-4804		310.75	$C_{13}H_{11}ClN_2O_3S$
RM-4806		371.21	$C_{13}H_{11}BrN_2O_4S$
RM-4819		313.17	$C_{11}H_9BrN_2O_2S$
RM-4820		341.18	$C_{12}H_9BrN_2O_3S$
RM-4821		355.21	$C_{13}H_{11}BrN_2O_3S$

RM-4822		355.21	$C_{13}H_{11}BrN_2O_3S$
RM-4826		313.17	$C_{11}H_9BrN_2O_2S$

Code Number	Structure	Molecular Weight	Molecular Formula
RM-4827		333.59	$C_{10}H_6BrClN_2O_2S$
RM-4831		317.13	$C_{10}H_6BrFN_2O_2S$
RM-4832		299.14	$C_{10}H_7BrN_2O_2S$
RM-4833		329.17	$C_{11}H_9BrN_2O_3S$
RM-4834		329.17	$C_{11}H_9BrN_2O_3S$
RM-4835		284.72	$C_{11}H_9ClN_2O_3S$

RM-4836		284.72	$C_{11}H_9ClN_2O_3S$
RM-4838		333.59	$C_{10}H_6BrClN_2O_2S$

Code Number	Structure	Molecular Weight	Molecular Formula
RM-4839		333.59	$C_{10}H_6BrClN_2O_2S$
RM-4840		378.04	$C_{10}H_6Br_2N_2O_2S$

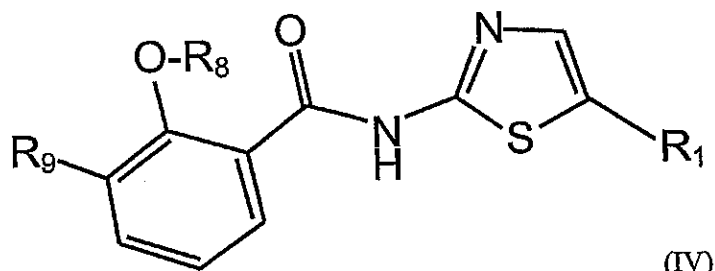
Preferred examples of compounds within Formula (III) include:

- 2-(acetolyloxy)-3-methyl-N-(5-bromo-2-thiazolyl)benzamide (RM4803);
- 2-(hydroxy)-3-methyl-N-(5-bromo-2-thiazolyl)benzamide (RM4819);
- 2-(acetolyloxy)-N-(5-bromo-2-thiazolyl)benzamide (RM4820);
- 2-(acetolyloxy)-5-methoxy-N-(5-bromo-2-thiazolyl)benzamide (RM4821); and
- 2-(acetolyloxy)-5-methoxy-N-(5-bromo-2-thiazolyl)benzamide (RM4822).

It has further been discovered that compounds with a hydroxyl substituent in the ortho position of the benzene ring have good efficacy. Thus, from among the above illustrative compounds, the following compounds are preferred: RM-4819, RM-

4826, RM-4827, RM-4831, RM-4832, RM-4833, RM-4834, RM-4835, RM-4836, RM-4838, RM-4839, RM-4840.

Compounds according to the invention preferably include those of formula (IV):



wherein:

R_1 is halogen, preferably F, Cl, Br, or I, more preferably Br or Cl, most preferably Br,

R_8 is $-C(O)R_{10}$, in which R_{10} is $-C_1-C_4$ alkyl. R_{10} includes methyl, ethyl, propyl and butyl, including isomers thereof. Methyl is preferred, whereby the benzamide substituent is acetolyloxy, and

R_9 is $-C_1-C_4$ alkyl or $-C_1-C_4$ alkoxy. Methyl and methoxy are preferred. Methyl is most preferred.

Examples of compounds within Formula (IV) include:

2-(acetolyloxy)-3-methyl-N-(5-bromo-2-thiazolyl)benzamide
(RM4803);

2-(acetolyloxy)-3-methyl-N-(5-chloro-2-thiazolyl)benzamide
(RM4804); and

2-(acetolyloxy)-3-methoxy-N-(5-bromo-2-thiazolyl)benzamide
(RM4806).

The compositions of the present invention may be formulated as solid or liquid dosage forms, or as pastes or ointments, and may optionally contain further active ingredients.

The pharmaceutical compositions of the present invention comprise a pharmaceutically acceptable carrier, which is not particularly limited, and includes a wide range of carriers known to those of ordinary skill in the art, and including wetting or dispersing agents (U.S. Patent 5,578,621), starch derivatives (U.S. Patent 5,578,621), excipients, and the like. Tablet embodiments may optionally comprise a coating of a substance that constitutes an enteric coating, i.e. a coating that substantially insoluble in gastric secretion but substantially soluble in intestinal fluids.

Pharmaceutical compositions comprising compounds according to Formula (III) or (IV) are preferably formulated for oral administration and are optionally in the form of a liquid, for example an emulsion or a solution or a suspension in water or oil such as arachis oil, or other liquid. Formulations of non-aqueous micellar solutions may be prepared according to the method disclosed in U.S. Patent 5,169,846. Alternatively, tablets can be manufactured, for example, by performing the following steps: wet granulation; drying; and compression. Film coating is generally performed with organic solvents.

The term "selective antiviral" as used herein means that, at dosages effective for the prevention or treatment of a viral disease, the activity is more antiviral than antibacterial, antifungal, or antiparasite, and gut flora of the subject is not disrupted to levels expected with broad spectrum antibiotics.

The preferred antiviral treatment or prophylactic dosages of the compounds of the present invention may depend upon the weight of the subject, and may be inferred by one of ordinary skill without undue experimentation by reference to the following examples, which are set forth for purposes of illustration and are not intended to be limiting.

EXAMPLE 1: TESTING AGAINST VIRUSES**METHODS****Non-hepatic viruses**

Cell cultures and Treatments. HEp-2 laryngeal carcinoma cells, monkey kidney 37RC, MA104 and VERO cells, canine Madin-Darby kidney (MDCK) and mammary adenocarcinoma (A72) cells, were grown at 37°C in a 5% CO₂ atmosphere in RPMI medium (Gibco-Invitrogen, Carlsbad, CA), supplemented with 10% fetal calf serum (FCS), 2 mM glutamine and antibiotics. Compounds dissolved in DMSO stock solution (50 mg/ml) were diluted in culture medium and added to infected cells immediately after the 1 hour adsorption period. Compounds were maintained in the medium for the duration of the experiment. Controls received equal amounts of DMSO diluent. Each concentration of each compound was tested in duplicate and each experiment was repeated twice.

Virus infection and titration. The following viruses were utilized: Influenza A: strain Puertorico (PR8); Paramyxovirus (Parainfluenza): Sendai virus (SV); Rhabdovirus: Vesicular Stomatitis Virus (VSV); Rotavirus: Simian Rotavirus SA-11 (SA-11); Herpes Simplex virus type 1: strain F1 (HSV-1); Coronavirus: canine coronavirus strain S-378 (CCoV). Confluent cell monolayers were infected with Influenza A virus (MDCK cells) or parainfluenza SV (37RC cells) for 1 h at 37°C at a multiplicity of infection (m.o.i.) of 5 HAU (Hemagglutinating Units)/10⁵ cells. Alternatively, confluent cell monolayers were infected with HSV-1 (HEp-2 cells), VSV (MA104 cells), CCoV (A72 cells) or Rotavirus SA-11 (MA104 cells) for 1 h at 37°C at a m.o.i. of 5 PFU (Plaque Forming Units)/10⁵ cells for HSV-1, VSV and CCoV and 1 PFU/10⁵ cells for SA-11. After the

adsorption period, the viral inoculum was removed and cell monolayers were washed three times with phosphate-buffer saline (PBS). Cells were maintained at 37°C in appropriate culture medium containing 2% FCS in the presence of the test compound or control diluent. Virus yield was determined 24 hours post infection (p.i.) by hemagglutinin titration (WSN, PR8, SV and SA-11) or CPE50% assay (VSV, HSV-1, and CCoV), according to standard procedures (Amici, C., Belardo, G., Rossi, A. & Santoro, M.G. Activation of I κ B kinase by Herpes Simplex virus type 1. A novel target for anti-herpetic therapy. *J. Biol. Chem.* 276, 28759-28766 (2001) and Bernasconi, D., Amici, C., La Frazia, S., Ianaro, A. & Santoro, M.G. The I κ B kinase is a key factor in triggering Influenza A virus -induced inflammatory cytokine production in airway epithelial cells. *J. Biol. Chem.* 280, 24127-24134 (2005)).

Cell toxicity. Cell viability was determined by the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) to MTT formazan conversion assay (Sigma-Aldrich, St Louis, MO). For MTT assay, reduced MTT (formazan) was extracted from cells by adding 100 μ l of acidic isopropanol containing 10% Triton X-100, and formazan absorbance was measured in an ELISA microplate reader at two different wavelengths (540 and 690 nm).

Hepatitis B virus

Anti-Hepatitis B Virus (HBV) analyses and an assessment of cytotoxicity were performed in a 9-day assay in the chronically-producing HBV human hepatoblastoma cell line, 2.2.15, as previously described (Korba, B.E. & Gerin, J.L. Use of a standardized cell culture assay to assess activities of nucleosides analogues against hepatitis B virus replication. *Antivir. Res.* 19, 55-70 (1992)).

Hepatitis C virus

Anti-Hepatitis C Virus (HCV) analyses and an assessment of cytotoxicity were performed in a 3-day assay in the HCV replicon-containing human hepatoblastoma cell line, AVA5 (Okuse, C., Rinaudo, J.A., Farrar, K., Wells, F. & Korba, B.E. Enhancement of antiviral activity against hepatitis C virus *in vitro* by interferon combination therapy. *Antivir. Res.* 65, 23-34 (2005)) as previously described (Blight, K.J., Kolykhalov, A.A. & Rice, C.M. Efficient initiation of HCV RNA replication in cell culture. *Science* 290, 1972-1974 (2000)).

RESULTS OF TESTING AGAINST VIRUSES

Table 1. Activity of RM-4803 and RM-4819 against viruses in cell culture.

Virus	EC ₅₀ (μM)/SI		Cell Culture
	RM4819	RM4803	
Rotavirus: Simian rotavirus SA-11	0.3/>500	0.06/>2500	MA104
Influenza A: PR8 strain	9.6/>17	2.8/>50	MDCK
Paramyxovirus: Sendai virus	1.3/>125	1.1/>125	37RC
Coronavirus: canine coronavirus strain S-378	4.9/>33	4.2/13	A72
Rhabdovirus: Vesicular stomatitis virus	1.6/>100	2.8/>50	MA104
Herpes Simplex type 1: strain F1	0.6/>250	5.6/3	HEp-2

EC₅₀ = drug concentration at which a 2-fold depression of viral DNA or RNA (relative to the average levels in untreated cultures) was observed. CC₅₀ = drug concentration at which a 2-fold depression of reduced MTT was observed relative to average levels in untreated cultures. SI (selectivity index) = CC₅₀/EC₅₀.

Table 2. Activity of other compounds against paramyxovirus: sendai virus in cell culture.

Compound	Paramyxovirus: Sendai virus	
	EC ₅₀ (μM)	SI
RM-4820	0.34	35
RM-4821	0.36	>50
RM-4822	0.36	7

EC₅₀ = drug concentration at which a 2-fold depression of viral RNA (relative to the average levels in untreated cultures) was observed. CC₅₀ = drug concentration at which a 2-fold depression of reduced MTT was observed relative to average levels in untreated cultures. SI (selectivity index) = CC₅₀/EC₅₀.

Table 3. Activity of compounds against HBV replication in 2.2.15 cell culture.

Compound	Extracellular Virion DNA		Intracellular HBV R.I.		CC ₅₀ (μM)	Selectivity Index	
	EC ₅₀ (μM)	EC ₉₀ (μM)	EC ₅₀ (μM)	EC ₉₀ (μM)		Virion	R.I.
Lamivudine	0.058±0.006	0.164±0.015	0.172±0.020	0.660±0.068	2229±76	1295	33
RM4803	6.3 ± 0.7	15 ± 1.1	12 ± 1.5	50 ± 5.5	>1000 ^s	>67	>2
RM4819	3.5 ± 0.5	9.0 ± 0.8	7.6 ± 0.9	22 ± 2.6	>1000 ^s	>111	>4
							6

Values presented (± standard deviations [S.D.]) were calculated by linear regression analysis using data combined from all treated cultures. S.D. were calculated using the standard error of regression generated from linear regression analyses (QuattroPro™). EC₅₀, EC₉₀ = drug concentration at which a 2-fold, or a 10-fold depression of HBV DNA (relative to the average levels in untreated cultures), respectively, was observed. CC₅₀ = drug concentration at which a 2-fold depression of neutral red dye uptake (relative to the average levels in untreated cultures) was observed. The EC₉₀ values were used for the calculation of the Selectivity Indexes [S.I.] since at least a 3-fold depression of HBV levels is typically required to achieve statistical significance in this assay system. HBV R.I. = intracellular HBV DNA replication intermediates.

^s No significant cytotoxic effects were observed up to the highest indicated concentration.

Table 4. Activity of compounds against hepatitis C virus replication in AVA5 cell culture.

Compound	CC ₅₀ (μM)	EC ₅₀ (μM)	EC ₉₀ (μM)	Selectivity Index
α -	>10,000* [§]	2.2 ±	8.5 ±	>4,545
Interferon		0.2*	0.6*	
Ribavirin	61 ± 2.9	94 ± 10	>100 [§]	0.6
RM4803	282 ± 21	37 ± 2.7	98 ± 9.3	7.6
RM4819	164 ± 18	8.9 ± 0.7	79 ± 8.2	18

Values presented (± standard deviations [S.D.]) were calculated by linear regression analysis using data combined from all treated cultures. S.D. were calculated using the standard error of regression generated from the linear regression analyses (QuattroPro™). EC₅₀, EC₉₀ = drug concentration at which a 2-fold, or a 10-fold depression of HCV RNA (relative to the average levels in untreated cultures), respectively, was observed. CC₅₀ = drug concentration at which a 2-fold depression of neutral red dye uptake was observed relative to the average levels in untreated cultures. Selectivity index = CC₅₀/EC₅₀.

* Values for interferon are expressed as "IU/ml."

§ No significant cytotoxic or antiviral effects were observed up to the highest indicated concentration.

EXAMPLE 2: TESTING AGAINST ANAEROBIC BACTERIA

Methods. Recent clinical anaerobic isolates (2000 to date) comprised 40 *B.fragilis* group, 26 *Prevotella/Porphyromonas*, 28 fusobacteria, 16 anaerobic Gram positive cocci, 14 anaerobic Gram-positive non-sporeforming rods and 18 clostridia. CLSI

agar dilution MIC methodology with enriched Brucella blood agar and inocula of 1×10^5 cfu/spot was used. Plates were incubated in an anaerobic glove box at 35°C for 48 h.

Results. MIC₅₀ /MIC₉₀ values (µg/ml) were as follows:

Drug	B.fra gil- is gp (40)	Prev/Porp hy (26)	Fusoba ct- eria (28)	Gram + cocci (16)	Gram + rods (14)	Clost rid- ia (18)	All (142)
Nitazox -anide	2/4	4/8	1/4	0.5/2	16/>3 2	0.5/4	2/4
Tizoxan ide	2/4	2/16	0.5/2	0.5/1	8/>32	0.25/ 2	2/4
RM 4803	>32/> 32	>32/>32	>32/>3 2	>32/> 32	>32/> 32	>32/> 32	>32/> 32
RM 4819	>32/> 32	>32/>32	>32/>3 2	>32/> 32	>32/> 32	>32/> 32	>32/> 32
Amoxici llin- clavula nic acid	1/ 4	0.06/0.5	0.5/4	0.125 /0.5	0.25/ 1.0	0.125 /1.0	0.5/2 .0
Clinda- mycin	2/>32	≤0.015/≤0 .015	0.06/0 .125	0.125 /0.5	0.125 /4	1/>32	0.125 /8.0
Metroni d-azole	1/ 2	0.5/2	0.25/0 .25	0.5/1 .0	>16/> 16	0.25/ 2	1.0/2 .0

Results showed that nitazoxanide, tizoxanide, potent against all anaerobic bacteria groups except for Gram-positive anaerobic rods including lactobacilli (which are in reality mostly microaerophils). By contrast, RM 4803 and RM 4819 were without significant activity.

EXAMPLE 3 - ANTIVIRAL ACTIVITY

Compounds within Formula (IV) of the present invention exhibit potent antiviral activity, as shown in Table 5.

EC₅₀ (μg/mL) values for 2-(acetolyloxy)-3-methyl-N-(5-bromo-2-thiazolyl)benzamide (RM4803), 2-(acetolyloxy)-3-methyl-N-(5-chloro-2-thiazolyl)benzamide (RM4804), and 2-(acetolyloxy)-3-methoxy-N-(5-bromo-2-thiazolyl)benzamide (RM4806), on Human Rhinovirus Type 39 (HRV-39), and H3N2 influenza virus, type A, using a multiple cycle CPE inhibition assay on OH-I Hela and Madin Darby Canine Kidney (MDCK) cell monolayers, respectively, were measured by microscopic and spectrophotometric methods. Pirodavir and Oseltamivir were included as positive controls.

Table 5. Activity of RM-4803, RM-4804 and RM-4806 against viruses in cell monolayer

Compound	Human Rhinovirus Type 39 OH-Hela 2% McCoy's + Hepes Buffer Microscopic Spectrophotometer		Influenza A Virus MDCK 0% EMEM + Hepes + Trypsin Microscopic Spectrophotometer	
R ₁ = Br R ₄ = methyl R ₃ = methyl (RM 4803)	0.06	0.03	0.45	0.18
R ₁ = Cl R ₄ = methyl R ₃ = methyl (RM 4804)	0.57	0.32	0.93	0.57
R ₁ = Br R ₄ = methyl R ₃ =	5.0	4.0	0.46	0.57

methoxy (RM 4806)				
Pirodavir	0.007	0.004	NA	NA
Oseltamivir	NA	NA	0.13-0.17	0.08-0.36

EXAMPLE 4 - SELECTIVE ANTI-VIRAL ACTIVITY

The above identified compounds according to Formula (IV) were tested by conventional means against *Trichomis vaginalis*, *Giardia Intestinalis*, and *Trypanosoma brucei*. 2-(acetolyloxy)-3-methyl-N-(5-bromo-2-thiazolyl)benzamide (RM4803), 2-(acetolyloxy)-3-methyl-N-(5-chloro-2-thiazolyl)benzamide (RM4804), and 2-(acetolyloxy)-3-methoxy-N-(5-bromo-2-thiazolyl)benzamide (RM4806) each failed to exhibit antiparasite activity against *Trichomonas vaginalis*, *Giardia intestinalis*, or *Trypanosoma brucei* at concentrations of at least 50 µg/mL.

Accordingly, it has been demonstrated that in accordance with the present invention, novel compounds can be provided which are generally characterized by selective antiviral activity.

As an additional benefit, it has been discovered that the above halogen-substituted benzamide compounds are effective against intracellular protozoa including *Cryptosporidium* spp., *Neospora* spp. and *Sarcocystis neurona* (RM-4820, RM-4821 and RM-4822).

With respect to the above description, it is to be realized that the optimum formulations and methods of the invention are deemed readily apparent and obvious to one skilled in the art, and all equivalent relationships to those described in the specification are intended to be encompassed by the present invention.

Therefore, the foregoing is considered as illustrative only of the principles of the invention. Further, since

numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

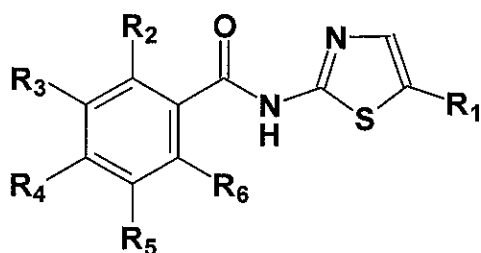
Certain references, patents and other printed publications have been referred to herein: the teachings and scope of each of said publications are hereby incorporated in their respect entirety by reference.

Now that the invention has been described:

CLAIMS

What is claimed is:

1. A compound according to formula (III):



(III)

in which

R₁ is a halogen atom, and

R₂-R₆ are independently hydrogen, hydroxyl,

-C₁-C₄ alkoxy, acyloxy, -C(O)R₇ where R₇ is -C₁-C₄ alkyl, or, aromatic including salts and hydrates of these compounds, wherein at least one of R₂-R₆ is other than hydrogen.

2. A compound as in claim 1, wherein at least one of R₂-R₆ is hydroxyl.

3. A compound as in claim 2, wherein said at least one hydroxyl is in the ortho position.

4. A compound as in claim 2, wherein the remainder of R₂-R₆ are hydrogen.

5. A compound as in claim 1, wherein at least two of R₂-R₆ are other than hydrogen.

6. A compound as in claim 1, wherein one of R₂-R₆ is hydroxyl, and the remainder of R₂-R₆ are independently hydrogen, --C₁-C₄ alkoxy, acyloxy (preferably acetoxy or propionoxy), --C(O)R₇ where R₇ is -C₁-C₄ alkyl, or, aromatic, including salts and hydrates of these compounds.

7. A compound as in claim 1, wherein one of R₂-R₆ is hydroxyl, and at least one of R₂-R₆ is -C₁-C₄ alkoxy, acyloxy, -C(O)R₇ where R₇ is -C₁-C₄ alkyl, or aromatic, including salts and hydrates of these compounds.

8. A compound as in claim 1, wherein said acyloxy is acetoxy or propionoxy, and wherein said aromatic is phenyl or benzyl, which may be further substituted.

9. A compound as in claim 1, wherein R₁ is Br or Cl.

10. A compound as in claim 1, wherein R₂-R₆ include no more than one acyloxy.

11. A compound as in claim 1, wherein two adjacent R₂-R₆ together form a benzyl ring.

12. A compound as in claim 1, wherein one of R₂-R₆ is hydroxyl, and the remainder of R₂-R₆ are independently hydrogen, -C₁-C₄ alkoxy, acyloxy, or -C(O)R₇ where R₇ is --C₁-C₄ alkyl, including salts and hydrates of these compounds.

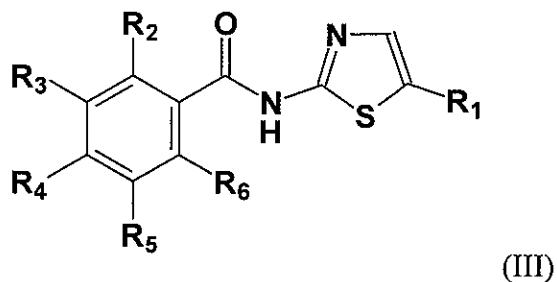
13. A compound as in claim 1, selected from the group consisting of

2-(acetolyloxy)-N-(5-bromo-2-thiazolyl)benzamide (RM4820);

2-(acetolyloxy)-5-methoxy-N-(5-bromo-2-thiazolyl)benzamide (RM4821); and

2-(acetolyloxy)-5-methoxy-N-(5-bromo-2-thiazolyl)benzamide (RM4822).

14. A compound according to formula (III):



wherein:

R₁ is halogen,

R₂ is OR₈ in which R₈ is -C(O)R₁₀, in which R₁₀ is -C₁-C₄ alkyl,

R₃ is -C₁-C₄ alkyl or -C₁-C₄ alkoxy, and

R₄-R₆ are independently hydrogen, hydroxyl, C₁-C₄ alkyl, -C₁-C₄ alkoxy, acyloxy, halogen, -C(O)R₇ where R₇ is -C₁-C₄ alkyl, or, aromatic including salts and hydrates of these compounds.

15. A compound as in claim 14, wherein R₁ is Cl or Br.

16. A compound as in claim 14, wherein R₈ is -C(O)R₁₀, in which R₁₀ is methyl, ethyl, propyl or butyl, including isomers thereof.

17. A compound as in claim 14, wherein R₉ is methyl or methoxy.

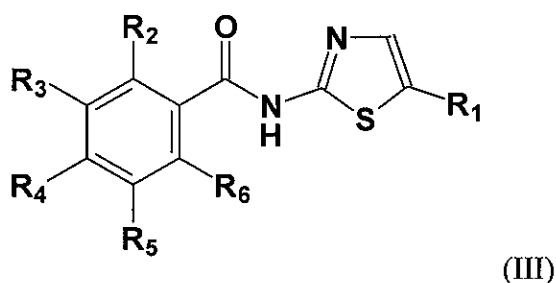
18. A compound as in claim 14, selected from the group consisting of:

2-(acetolyloxy)-3-methyl-N-(5-bromo-2-thiazolyl)benzamide (RM4803);

2-(acetolyloxy)-3-methyl-N-(5-chloro-2-thiazolyl)benzamide (RM4804); and

2-(acetolyloxy)-3-methoxy-N-(5-bromo-2-thiazolyl)benzamide (RM4806).

19. A pharmaceutical composition comprising as active agent a compound according to formula (III):

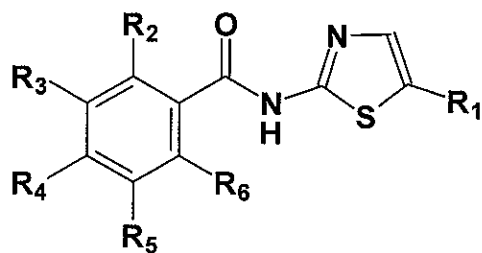


in which

R₁ is a halogen atom, and

R₂-R₆ are independently hydrogen, hydroxyl, -C₁-C₄ alkoxy, acyloxy, -C(O)R₇ where R₇ is -C₁-C₄ alkyl, or, aromatic including salts and hydrates of these compounds, wherein at least one of R₂-R₆ is other than hydrogen.

20. A method for treating viral infections, comprising administering to a subject in need of treatment an effective amount of a pharmaceutical composition comprising as active agent a compound according to formula (III):



(III)

in which

R₁ is a halogen atom, and

R₂-R₆ are independently hydrogen, hydroxyl, C₁-C₄ alkyl, -C₁-C₄ alkoxy, acyloxy, nitro, halogen, -C(O)R₇ where R₇ is -C₁-C₄ alkyl, or, aromatic including salts and hydrates of these compounds.

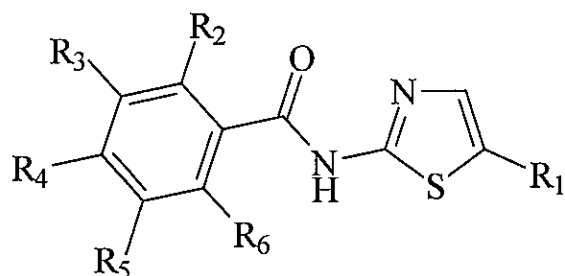
21. The method of claim 20, wherein R₁ is a halogen atom, and R₂-R₆ are independently hydrogen, hydroxyl, C₁-C₄ alkyl, -C₁-C₄ alkoxy, acyloxy, -C(O)R₇ where R₇ is -C₁-C₄ alkyl, or, aromatic including salts and hydrates of these compounds, wherein at least one of R₂-R₆ is other than hydrogen.

22. The method of claim 20, wherein R₁ is a halogen atom, R₂-R₆ are independently hydrogen, halogen, nitro, hydroxyl, C₁-C₄ alkyl, -C₁-C₄ alkoxy, acyloxy, -C(O)R₇ where R₇ is -C₁-C₄ alkyl, or, aromatic including salts and hydrates of these compounds, wherein at least two of R₂-R₆ is other than hydrogen and at least one of R₂-R₆ is hydroxyl or acyloxy.

23. The method of claim 20, wherein R₁ is a halogen atom, and R₂-R₆ are independently hydrogen, hydroxyl, -C₁-C₄ alkoxy, acyloxy, -C(O)R₇ where R₇ is -C₁-C₄ alkyl, or, aromatic including salts and hydrates of these compounds, and wherein at least one of R₂-R₆ is other than

hydrogen.

24. A compound according to formula (III):



(III)

in which R₁ is a halogen atom, R₂-R₆ are independently hydrogen, halogen, nitro, hydroxyl, C₁-C₄ alkyl, --C₁-C₄ alkoxy, acyloxy, -C(O)R₇ where R₇ is --C₁-C₄ alkyl, or, aromatic including salts and hydrates of these compounds, wherein at least two of R₂-R₆ is other than hydrogen and at least one of R₂-R₆ is hydroxyl or acyloxy.

25. A compound as in claim 24, wherein at least one of R₂-R₆ is hydroxyl, and at least one of R₂-R₆ is halogen, nitro, C₁-C₄ alkyl, -C₁-C₄ alkoxy, acyloxy, -C(O)R₇ where R₇ is --C₁-C₄ alkyl, or aromatic, including salts and hydrates of these compounds.

26. A compound as in claim 24, wherein at least one of R₂-R₆ is acyloxy, and at least one of R₂-R₆ is halogen, nitro, C₁-C₄ alkyl, -C₁-C₄ alkoxy, hydroxy, -C(O)R₇ where R₇ is --C₁-C₄ alkyl, or aromatic, including salts and hydrates of these compounds.

27. A compound as in claim 24, wherein said acyloxy is acetoxy or propionoxy, and wherein said aromatic is phenyl or benzyl, which may be further substituted.

28. A compound as in claim 24, wherein R_1 is Br or Cl.

29. A compound as in claim 24, wherein two adjacent R_2 - R_6 together form a benzyl ring.

30. A compound as in claim 24, selected from the group consisting of 2-(acetolyloxy)-3-methyl-N-(5-bromo-2-thiazolyl)benzamide (RM4803) and 2-(hydroxy)-3-methyl-N-(5-bromo-2-thiazolyl)benzamide (RM4819).

31. A compound as in claim 24, selected from the group consisting of 2-(acetolyloxy)-5-methyl-N-(5-chloro-2-thiazolyl)benzamide and 2-(hydroxy)-5-methyl-N-(5-chloro-2-thiazolyl)benzamide.