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(54) Title: COMPOUNDS, COMPOSITIONS AND METHODS FOR TREATING OR PREVENTING A SYMPTOM ASSOCIATED WITH GOUT OR HYPERURICEMIA

(57) **Abrégé/Abstract:**

The inventive subject matter provides compounds, compositions and methods for lowering serum acid (sUA) for the treatment of gout, and having reduced liver toxicity, associated with CYP2C9 metabolic pathway.

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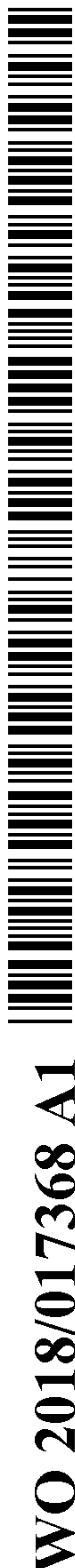
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(54) Title: COMPOUNDS, COMPOSITIONS AND METHODS FOR TREATING OR PREVENTING A SYMPTON ASSOCIATED WITH GOUT OR HYPERURICEMIA

(57) Abstract: The inventive subject matter provides compounds, compositions and methods for lowering serum acid (sUA) for the treatment of gout, and having reduced liver toxicity, associated with CYP2C9 metabolic pathway.



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## **COMPOUNDS, COMPOSITIONS AND METHODS FOR TREATING OR PREVENTING A SYMPTOM ASSOCIATED WITH GOUT OR HYPERURICEMIA**

[0001] This application claims the benefit of priority to U.S. provisional patent application no. 62/363,473, filed on July 18, 2016. This and all other extrinsic materials discussed herein are incorporated by reference in their entirety. Where a definition or use of a term in an incorporated reference is inconsistent or contrary to the definition of that term provided herein, the definition of that term provided herein applies and the definition of that term in the reference does not apply.

### **Field of the Invention**

[0002] The field of the invention is compounds, compositions and methods for treating or preventing a symptom or condition associated with gout or hyperuricemia.

### **Background**

[0003] The background description includes information that may be useful in understanding the present invention. It is not an admission that any of the information provided herein is prior art or relevant to the presently claimed invention, or that any publication specifically or implicitly referenced is prior art.

[0004] Hyperuricemia is caused by the overproduction or under-excretion of uric acid, and is considered to be a causative factor of several diseases that significantly impair the quality of life. For example, hyperuricemia is considered the causative factor of gout – the most prevalent form of inflammatory arthritis, characterized by severe pain and tenderness in joints caused by urate crystal accumulation.

[0005] Uricosuric agents and xanthine oxidase inhibitors are often prescribed to lower uric acid levels and treat an underlying cause of gout. Xanthine oxidase inhibitors such as allopurinol or febuxostat can reduce the formation of uric acid, and uricosuric agents can inhibit the absorption of uric acid from the kidney back to the blood via the URAT1 transporter.

[0006] Benzbromarone is a uricosuric agent and could be an inhibitor of xanthine oxidase, and is known to be highly effective in lowering serum uric acid (sUA). It has been found that therapy using benzbromarone can lead to lowering of sUA even following a single dose and continue to



be lowered following multiple doses, and that chronic therapy can bring sUA into target levels of <6 mg/dL. Unfortunately, like many other drugs, benzbromarone is associated with rare cases of hepatotoxicity and acute liver failure. The toxicity of the drug was believed by many to outweigh the benefits, and benzbromarone was reduced to limited use in the European market by its sponsor in 2003.

[0007] Several attempts have been made to formulate compounds and pharmaceuticals with high potency, and reduced toxicity, for example in U.S. 2013/0225673 (to Wempe *et al.*) describes uric acid transport inhibitors that can potentially be applied topically. Unfortunately and in part because the mechanism of damage / toxicity has not been clear, all or almost all prior attempts suffer from several disadvantages. For example, there is no evidence of the reproducibility and effectiveness of topical administration of such compounds.

[0008] These and all other extrinsic materials discussed herein are incorporated by reference in their entirety. Where a definition or use of a term in an incorporated reference is inconsistent or contrary to the definition of that term provided herein, the definition of that term provided herein applies and the definition of that term in the reference does not apply.

[0009] There have been many efforts to stabilize drugs and reduce production of unwanted metabolites. For example, US 2016/0031879 to Karra *et al.* teaches deuterated indolizine compounds to stabilize drugs for the treatment of multiple sclerosis and Alzheimer's disease. Karra, however, does not appear to teach application of this approach to modified benzbromarone compounds.

[0010] Others, for example in US 2015/031768 to Groves *et al.*, have contemplated modifying some carbon containing compounds. However, the taught modifications were directed to labeling such compounds to generate imaging agents for PET applications, and not directed towards reducing toxicity.

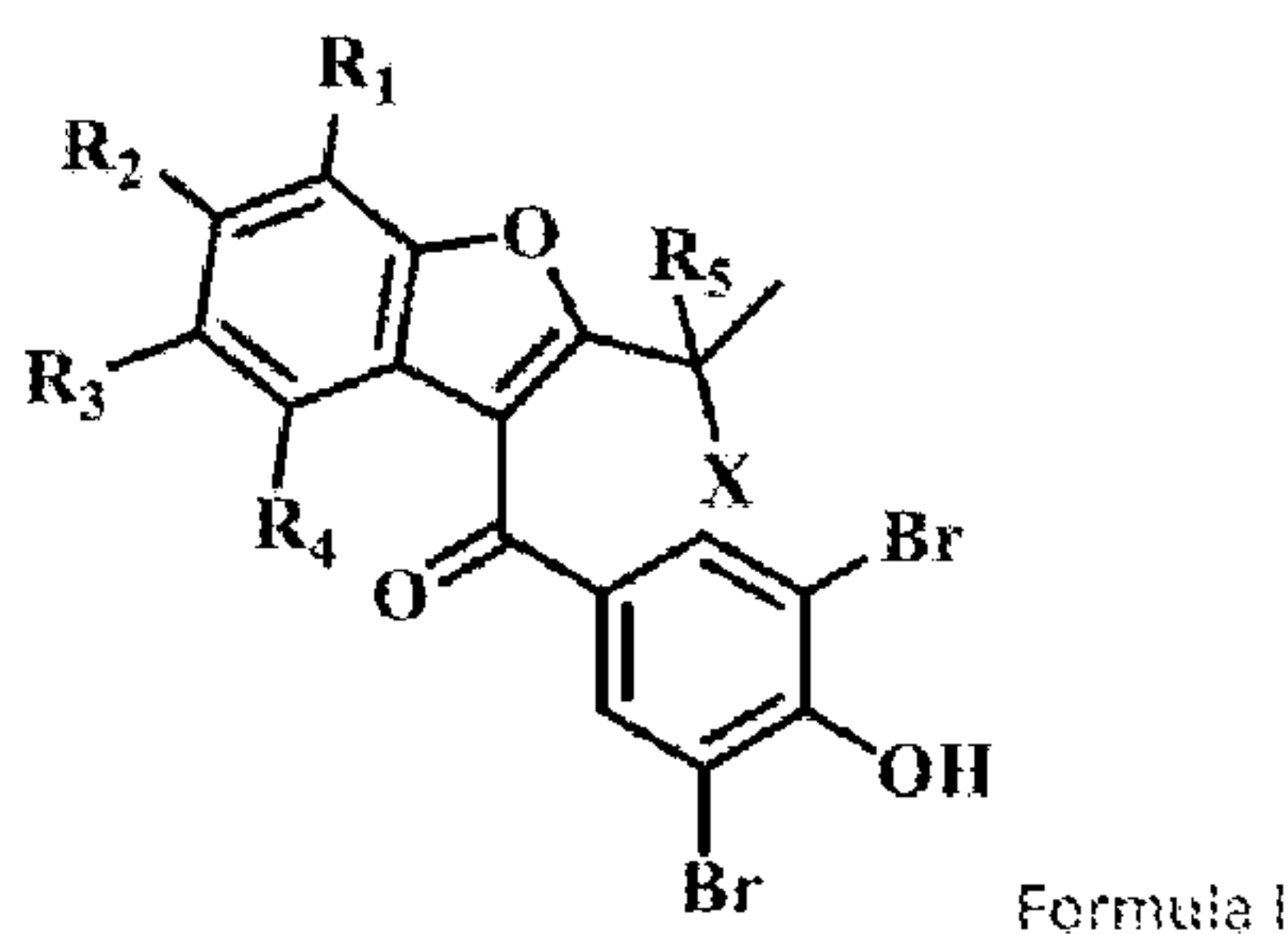
[0011] Thus, there is still a need in the art for a highly potent gout/hyperuricemia drug with reduced toxicity.

### Summary of the Invention

[0012] Recent developments in hepatic clearance of benzbromarone has shown that significant portion of benzbromarone's biotransformation is mediated through CYP2C9, and benzbromarone itself is a potent CYP2C9 inhibitor. This complex interplay limited the identification of cause of liver toxicity both *in vitro* and *in vivo*, although the involvement of CYP2C9 is generally believed to be a cause of liver toxicity (particularly in poor CYP2C9 metabolizers).

[0013] Applicant has developed a series of compounds that show improved stability and reduction in the dependence on the CYP2C9 biotransformation pathway relative to benzbromazone, but that retain the activity of benzbromarone against URAT1 transporter.

[0014] The inventive subject matter provides compounds, compositions, and methods in which a novel compound represented by Formula 1, is capable of lowering serum acid (sUA) for the treatment of gout.



[0015] Applicant has found that compounds of Formula 1 wherein  $-X$  is  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$  or  $-I$ , where  $-R$  is a  $-H$ ,  $-C_1-C_{10}$  alkyl, or a  $-C_1-C_{10}$  substituted alkyl; where  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6$ -alkyl,  $C_6-C_{14}$ -aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$ -alkoxy,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6$ -alkylsulfonyl,  $-trifluoromethyl$ ,  $-C_1-C_6$ -alkanoyloxy,  $-C_1-C_6$ -alkylthio,  $-C_1-C_6$ -alkylsulfonyl,  $-C_2-C_6$ -alkoxycarbonyl,  $-C_2-C_6$ -alkanoylamino,  $-O-R_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NHCO_2R_6$ , and  $-NHCO_2R_6$ , where  $-R_6$  is phenyl or naphthyl, and optionally substituted with one to three groups selected from  $-C_1-C_6$ -alkyl,  $-C_6-C_{10}$ -aryl,  $-C_1-C_6$ -alkoxy and halogen, and  $-C_4-C_{20}$ -hydroxyheteroaryl, and where the heteroatoms in  $-C_4-C_{20}$ -hydroxyheteroaryl are selected from

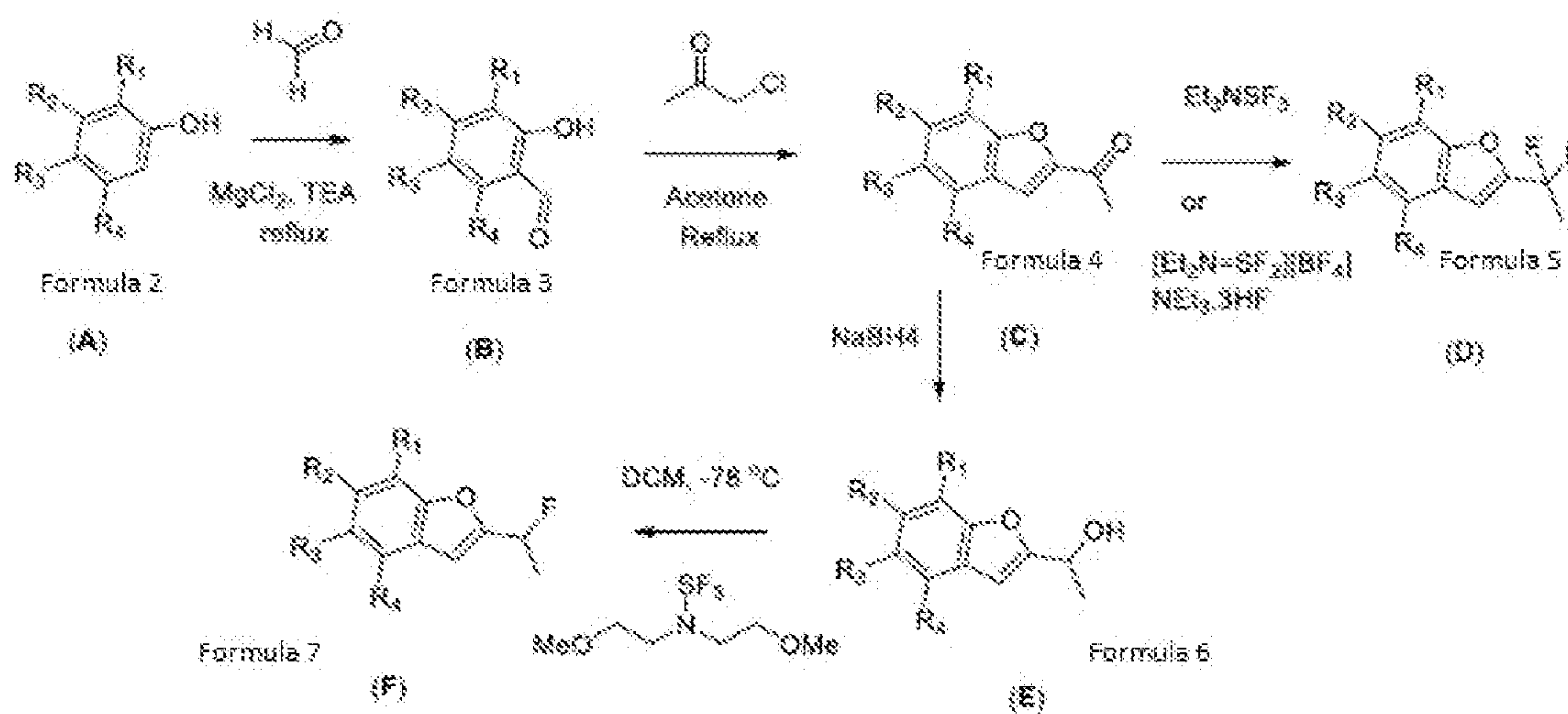
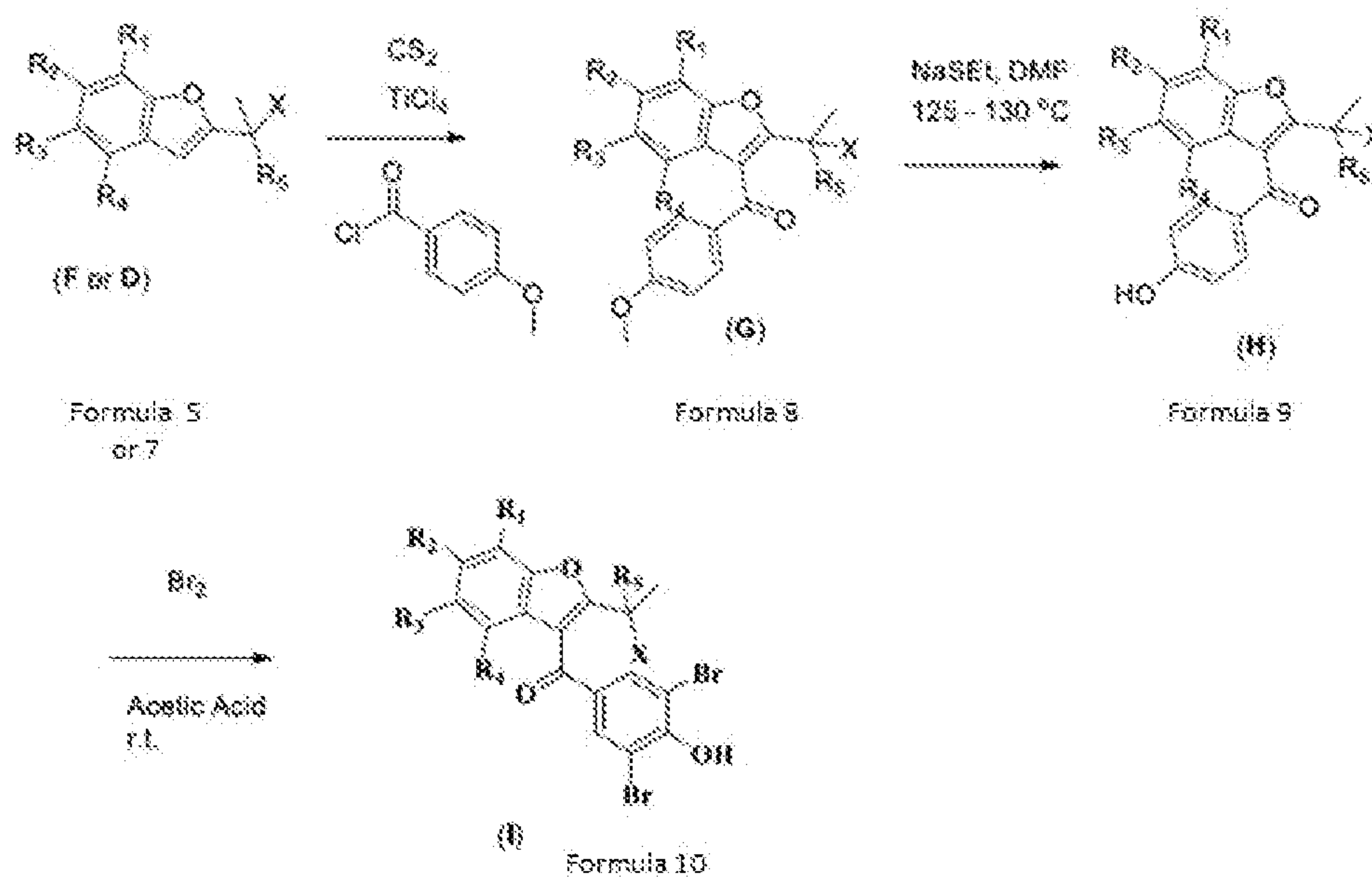


nitrogen or oxygen; and where at least one of  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  is  $-deuterium$  or a halogen (*e.g.*,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ) when  $X$  is a halogen,  $-OH$ , or  $-OR$ , are useful for this purpose.

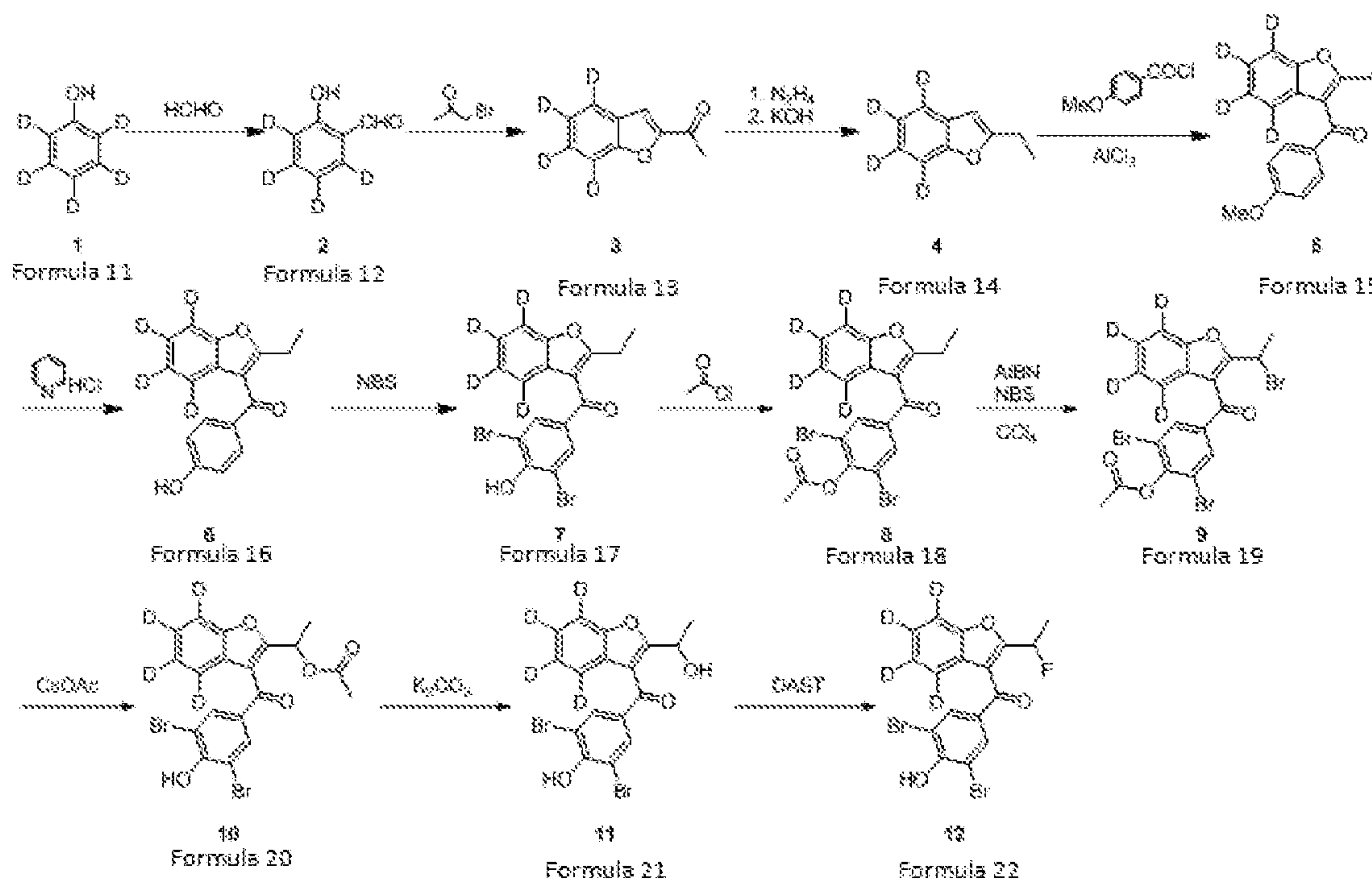
**[0016]** The chemically modified benzbromarone (BBR) compounds presented herein reduce CYP2C9 involvement in the biotransformation of one or more parent compound(s) and are presumed to be capable of reducing liver toxicity, while providing the hyperuricemia treating and URAT1 inhibiting benefits of BBR (in particular, for poor CYP2C9 metabolizers).

**[0017]** In some contemplated methods, genetic, gene expression, proteomic, or other (for example, metabolic and/or metabolite) tests can be administered to determine the presence of genotypes that affect the metabolism of a drug metabolized by CYP2C9. When, for example, a patient is determined to be a poor CYP2C9 metabolizer, a compound or composition of the inventive subject matter can be provided, alone or in combination with one or more other compositions, to reduce the likelihood of liver failure.

**[0018]** The person having ordinary skill in the art should be apprised of many ways to synthesize compounds of the inventive subject matter. For example, one contemplated general scheme for producing a compound of the inventive subject matter is shown below in Schemes 1 and 2. Building blocks (D) and (F) (Formula 5 and Formula 7, respectively) can be synthesized from (A) (Formula 2) with procedures from Scheme 1. Phenol (A) (Formula 2) reacts with formaldehyde with  $MgCl_2$  to produce aldehyde (B) (Formula 3). Subsequent reaction of (B) (Formula 3) with chloroacetone produces ketone (C) (Formula 4). Fluorination of (C) (Formula 4) produces di-fluoro compound (D) (Formula 5). Alternatively or additionally, reduction of (C) (Formula 4) gives alcohol (E) (Formula 6), which undergoes fluorination to produce mono-fluoro product (F) (Formula 7). It is contemplated that a compound of the inventive subject matter (I) (Formula 10) can be made from starting material (F) (Formula 7) or (D) (Formula 5) in three steps, as shown in Scheme 2. (F) (Formula 7) or (D) (Formula 5) can be treated with anisoyl chloride to form an intermediate product (G) (Formula 8), followed by demethylation by sodium ethanethiolate (NaSEt) to produce alcohol (H) (Formula 9), followed by bromination with  $Br_2$  in acetic acid (*e.g.*, at room temperature) to form a compound of the inventive subject matter (I) (Formula 10).

**Scheme 1****Scheme 2**

[0019] As another example, (2,6-dibromo-4-hydroxyphenyl)(2-(1-fluoroethyl)benzofuran-3-yl-4,5,6,7-D<sub>4</sub>)methanone (Formula 22) can be synthesized as shown in Scheme 3:



**Scheme 3**

[0020] It should be appreciated that while -D (-deuterium) is shown as each of the R<sub>1</sub>-R<sub>4</sub> in the above example (Scheme 3), it is contemplated that -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> can each independently be selected from -H (-hydrogen), -deuterium, -F (-fluorine), -Cl, -Br, -I, -CN, -C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-C<sub>14</sub>-aryl, substituted -C<sub>6</sub>-C<sub>14</sub>-aryl, C<sub>1</sub>-C<sub>14</sub> alkoxy, -hydroxyl, -carboxyl, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -O-R<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub> and -NHCO<sub>2</sub>R<sub>6</sub>, wherein -R<sub>6</sub> is phenyl or naphthyl, optionally substituted with one or three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and wherein the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen.

[0021] One should appreciate that the disclosed subject matter provides many advantageous technical effects, including highly effective treatment of conditions associated with



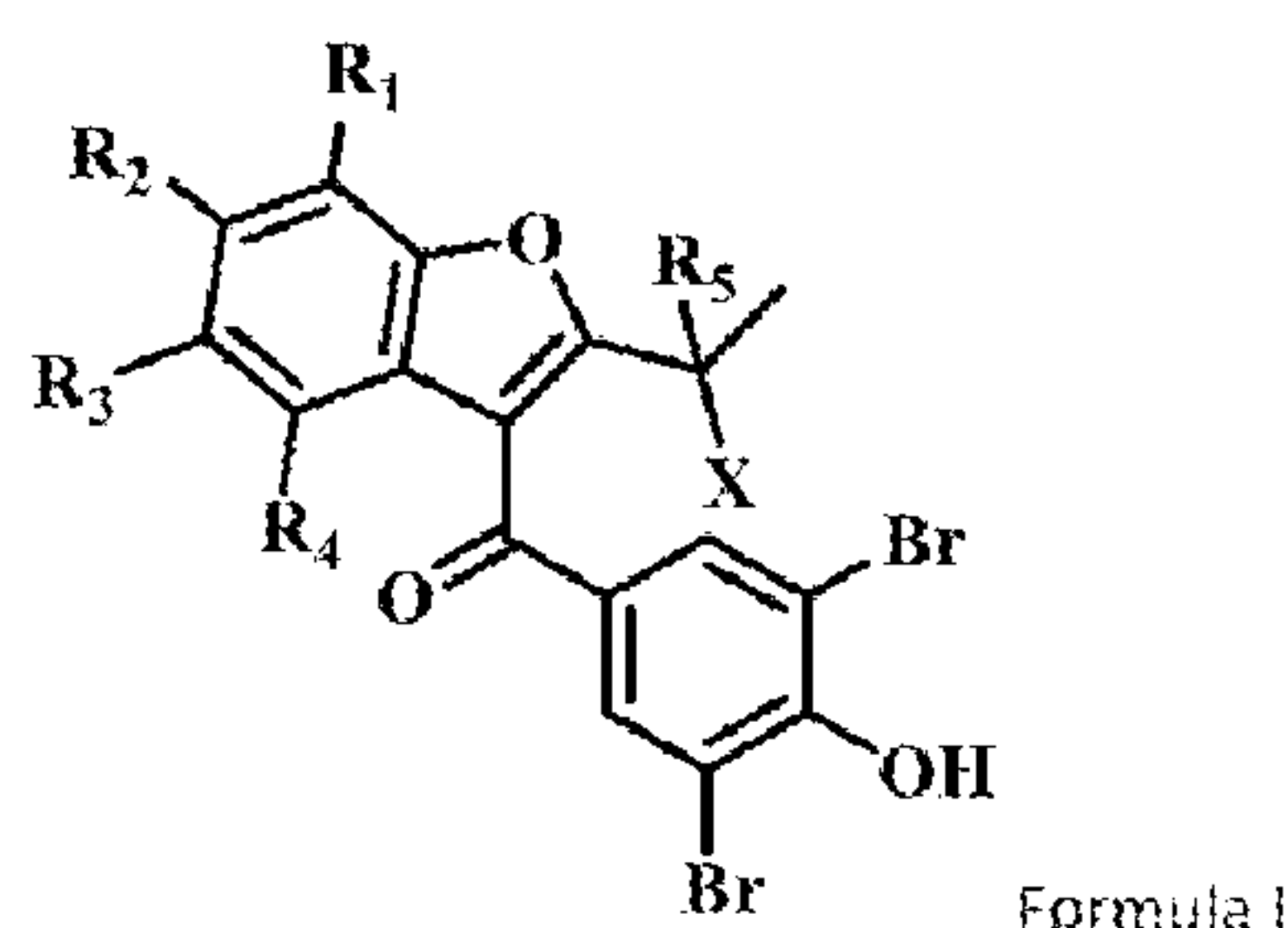
hyperuricemia and gout while reducing the likelihood of hepatotoxicity compared to similarly effective compounds.

[0022] Various objects, features, aspects and advantages of the inventive subject matter will become more apparent from the following detailed description of preferred embodiments, along with the accompanying drawing figures in which like numerals represent like components.

### Detailed Description

[0023] The following discussion provides example embodiments of the inventive subject matter. Although each embodiment represents a single combination of inventive elements, the inventive subject matter is considered to include all possible combinations of the disclosed elements. Thus if one embodiment comprises elements A, B, and C, and a second embodiment comprises elements B and D, then the inventive subject matter is also considered to include other remaining combinations of A, B, C, or D, even if not explicitly disclosed.

[0024] The inventive subject matter provides compounds, compositions, and methods in which a novel compound represented by Formula 1 is provided:



[0025] It should be appreciated that, as depicted in Formula 1,  $-X$  can be  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$ , or  $-I$ ;  $-R$  can be a  $-H$ ,  $-C_1-C_{10}$  alkyl or a  $-C_1-C_{10}$  substituted alkyl;  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  can each independently be  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6$ -alkyl,  $C_6-C_{14}$ -aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$ -alkoxy,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6$ -alkylsulfonyl,  $-trifluoromethyl$ ,  $-C_1-C_6$ -alkanoyloxy,  $-C_1-C_6$ -alkylthio,  $-C_1-C_6$ -alkylsulfonyl,  $-C_2-C_6$ -alkoxycarbonyl,  $-C_2-C_6$ -alkanoylamino,  $-O-R_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NHSO_2R_6$ , or  $-NHCO_2R_6$ ;  $-R_6$  can be phenyl or naphthyl, and in some embodiments substituted with one to three groups selected from  $-C_1-C_6$ -

alkyl,  $-C_6-C_{10}$ -aryl,  $-C_1-C_6$ -alkoxy, halogen, and  $-C_4-C_{20}$ -hydroxyheteroaryl, where the heteroatoms in  $-C_4-C_{20}$ -hydroxyheteroaryl can be nitrogen or oxygen.

**[0026]** In some embodiments, at least one of  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  is  $-deuterium$  when X is a halogen,  $-OH$ , and/or a pharmaceutically acceptable pro-drug. In some contemplated embodiments,  $-X$  is  $-OH$  or  $-F$ ,  $R_3$  is a halogen ( $-F$ ,  $-Cl$ ,  $-Br$  or  $-I$ ), and  $-R_1$ ,  $-R_2$ ,  $-R_4$ , and  $-R_5$  are each independently selected from  $-H$  or deuterium. In some other contemplated embodiments,  $-R_1$ ,  $-R_2$ ,  $-R_3$ , and  $-R_4$  are each deuterium,  $-X$  is  $-OH$ , and  $-R_5$  is hydrogen. In some contemplated embodiments,  $-R_1$ ,  $-R_2$ ,  $-R_3$ , and  $-R_4$  are each deuterium,  $-X$  is  $-F$ , and  $-R_5$  is hydrogen. In some contemplated embodiments,  $-R_1$ ,  $-R_2$ , and  $-R_4$  are each deuterium,  $-X$  is  $OH$ ,  $-R_3$  is  $-F$ , and  $-R_5$  is hydrogen. In some contemplated embodiments,  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$ , and  $-R_5$  are each independently selected from hydrogen and deuterium, and  $-X$  is  $-OH$ . In some contemplated embodiments,  $-R_1$ ,  $-R_2$ ,  $-R_3$ , and  $-R_4$  are each independently selected from hydrogen and deuterium,  $-X$  is a  $-F$  or  $-OH$ , and  $-R_5$  is hydrogen,  $-F$ , or deuterium. However, it is also contemplated that compounds of the inventive subject matter could include a halogen, for example fluorine at the 1' position, and comprise a hydrogen at each of the  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  positions.

**[0027]** In some contemplated embodiments, X is  $-OH$ ,  $-R_1$ ,  $-R_2$ ,  $-R_3$ , and  $-R_4$  are each deuterium, and  $-R_5$  is  $-H$ . As another example, in some contemplated embodiments, X is  $-F$ ,  $-R_1$ ,  $-R_2$ ,  $-R_3$ , and  $-R_4$  are each deuterium, and  $-R_5$  is  $-H$ . As another example, in some contemplated embodiments, X and  $-R_3$  are each  $-F$ , and  $-R_1$ ,  $-R_2$ ,  $-R_4$ , and  $-R_5$  are each  $-H$ . As yet another example, in some contemplated embodiments, X is  $-OH$ ,  $-R_3$  is  $-F$ , and  $-R_1$ ,  $-R_2$ ,  $-R_4$ , and  $-R_5$  are each  $-H$ .

**[0028]** It should be appreciated that in some embodiments, for example where a compound includes a  $-F$  in the  $-R_3$  position,  $-R_1$ ,  $-R_2$ ,  $-R_4$ , and  $-R_5$  could each be a  $-H$ . Viewed from a different perspective, it is contemplated that some compounds, for example compounds having  $-F$  in the  $-R_3$  position, could lack deuterium.

**[0029]** In some contemplated embodiments,  $-X$  is  $-F$  ( $-fluorine$ ). For example, some contemplated compounds include  $-deuterium$  at  $-R_2$ ,  $-F$  at  $-X$ ,  $-H$  at each of  $-R_1$ ,  $-R_3$ , and  $-R_4$ , and  $-H$  at  $-R_5$ . In some contemplated compounds,  $-X$  is  $-F$ , each of  $-R_2$  and  $-R_4$  is  $-deuterium$ ,

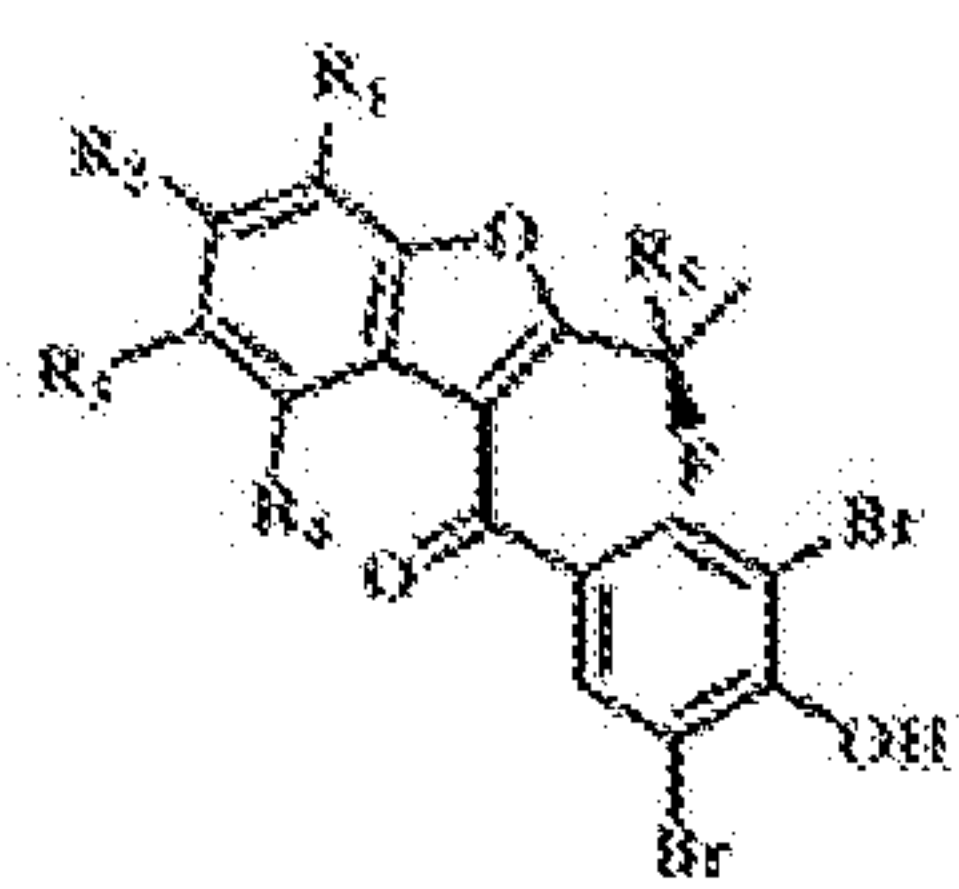


and each of  $-R_1$ ,  $-R_3$ , and  $-R_5$  is a  $-H$ . In some other contemplated compounds,  $-X$  is  $-F$ , each of  $-R_2$  and  $-R_3$  is  $-deuterium$ , and each of  $-R_1$ ,  $-R_4$ , and  $-R_5$  is a  $-H$ . In yet other contemplated embodiments,  $-X$  is  $-F$ , each of  $-R_1$ ,  $-R_2$ ,  $-R_3$  and  $-R_4$ , is  $-deuterium$ , and  $-R_5$  is a  $-H$ .

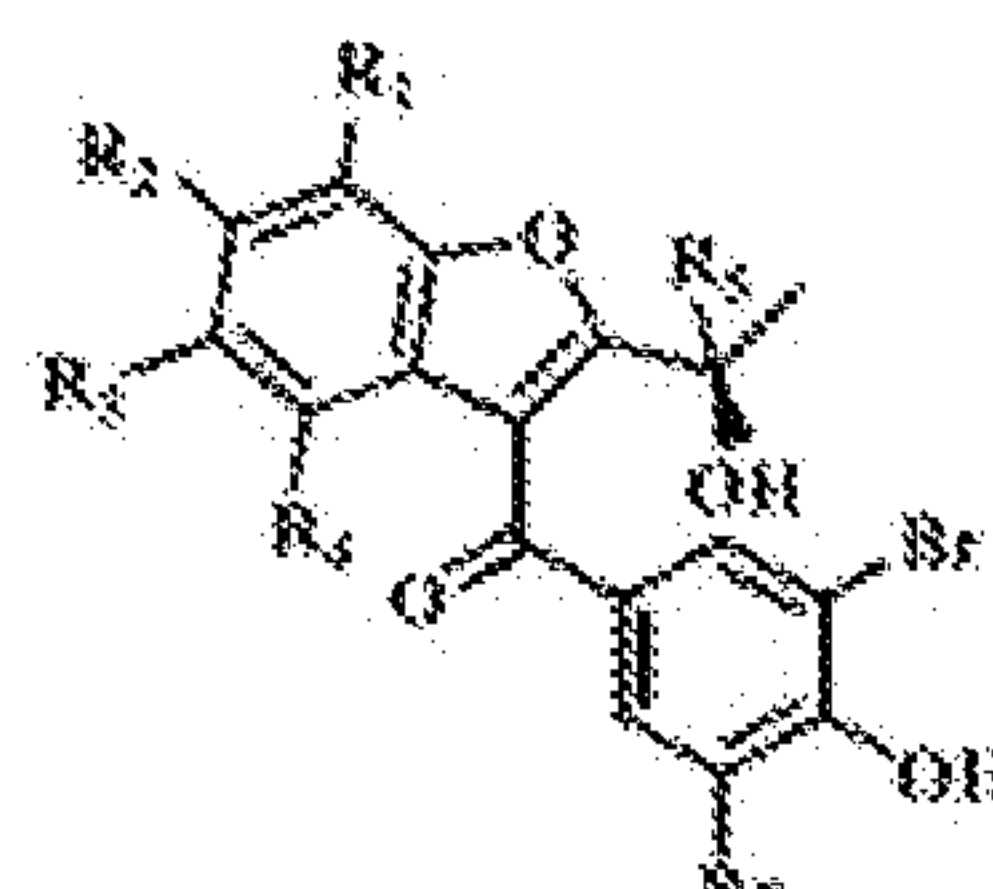
Compounds wherein  $-X$  is  $-F$ , each of  $-R_1$ ,  $-R_2$ ,  $-R_3$  and  $-R_4$  is  $-deuterium$ , and  $-R_5$  is a  $-H$  are also contemplated.

**[0030]** In some contemplated embodiments, both the  $-X$  and  $-R_5$  are fluorinated. For example, in some contemplated compounds, each of  $-X$  and  $-R_5$  is  $-F$ ,  $-R_2$  is  $-deuterium$ , and each of  $-R_1$ ,  $-R_3$  and  $-R_4$ , is a  $-H$ . In some other contemplated embodiments, each of  $-X$  and  $-R_5$  is  $-F$ , and each of  $-R_1$ ,  $-R_2$ ,  $-R_3$  and  $-R_4$  is  $-deuterium$ .

**[0031]** The inventive subject matter also provides compounds, compositions and methods in which novel compounds represented by Formula 23 and/or 24 are provided:



Formula 23

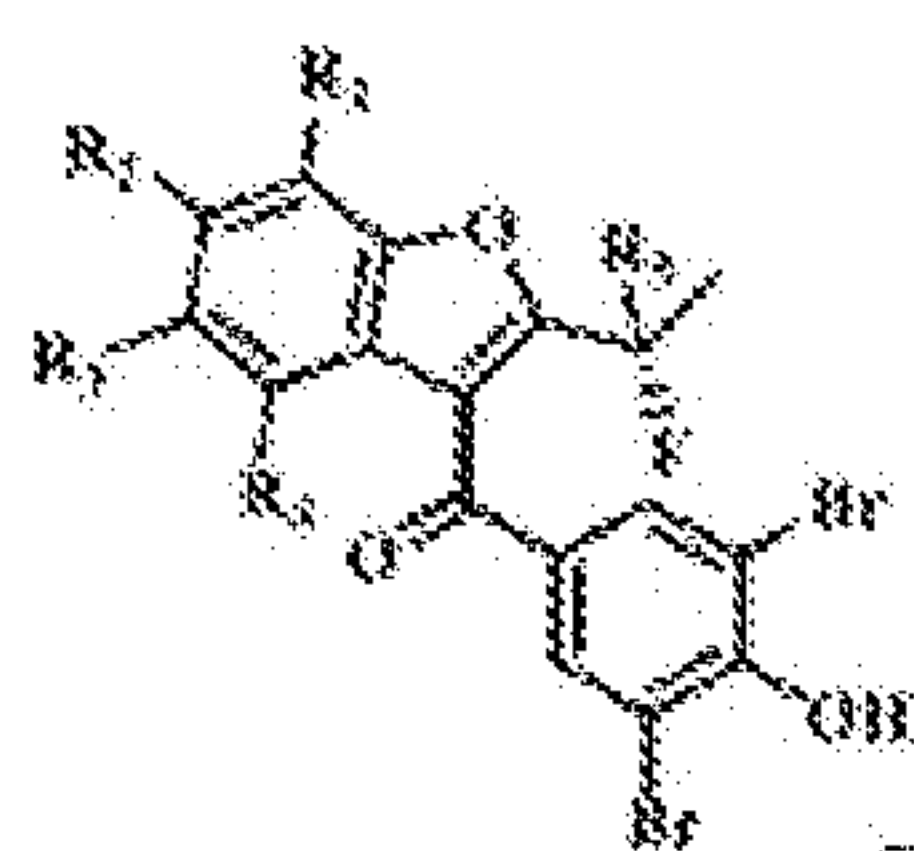


Formula 24

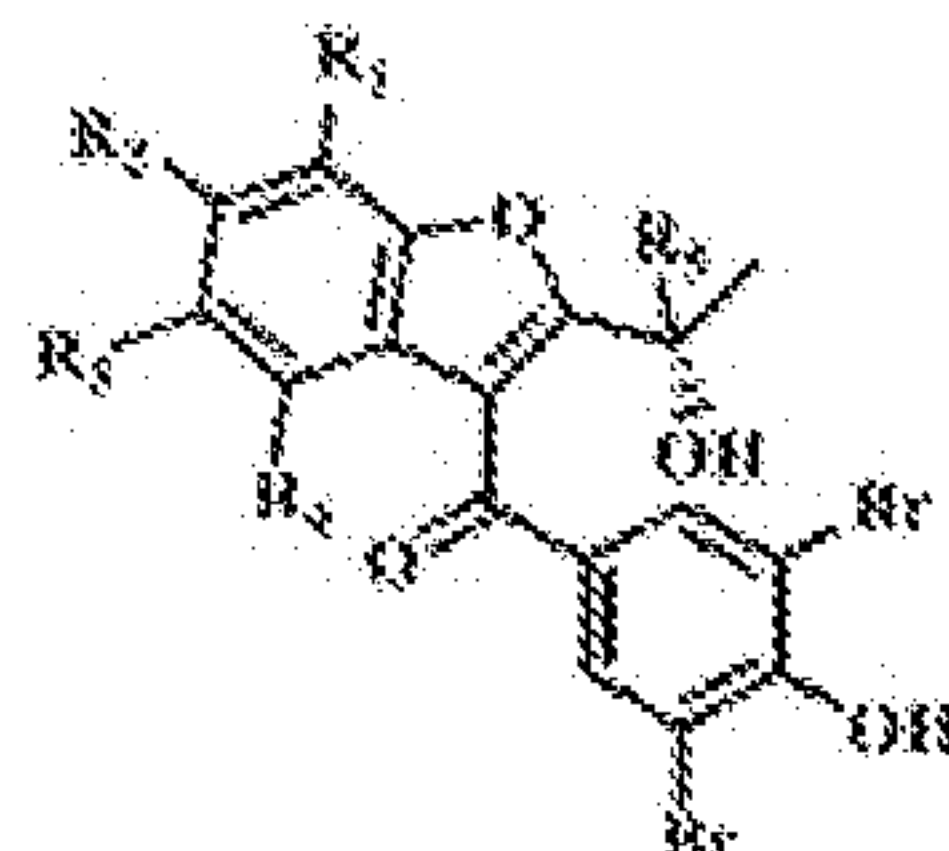
**[0032]** In such compounds  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6-alkyl$ ,  $C_6-C_{14}-aryl$ , substituted  $-C_6-C_{14}-aryl$ ,  $C_1-C_{14}-alkoxy$ ,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6-alkylsulfonyl$ ,  $-trifluoromethyl$ ,  $-C_1-C_6-alkanoyloxy$ ,  $-C_1-C_6-alkylthio$ ,  $-C_1-C_6-alkylsulfonyl$ ,  $-C_2-C_6-alkoxycarbonyl$ ,  $-C_2-C_6-alkanoylamino$ ,  $-O-R_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NHSO_2R_6$ , and  $-NHCO_2R_6$ , where  $-R_6$  is phenyl or naphthyl, and can be substituted with one to three groups selected from  $-C_1-C_6-alkyl$ ,  $-C_6-C_{10}-aryl$ ,  $-C_1-C_6-alkoxy$  and halogen, and  $-C_4-C_{20}-hydroxyheteroaryl$ , and where the heteroatoms in  $-C_4-C_{20}-hydroxyheteroaryl$  are nitrogen or oxygen.

**[0033]** The inventive subject matter also provides compounds, compositions and methods in which a novel compounds represented by Formula 25 and/or 26 are provided:





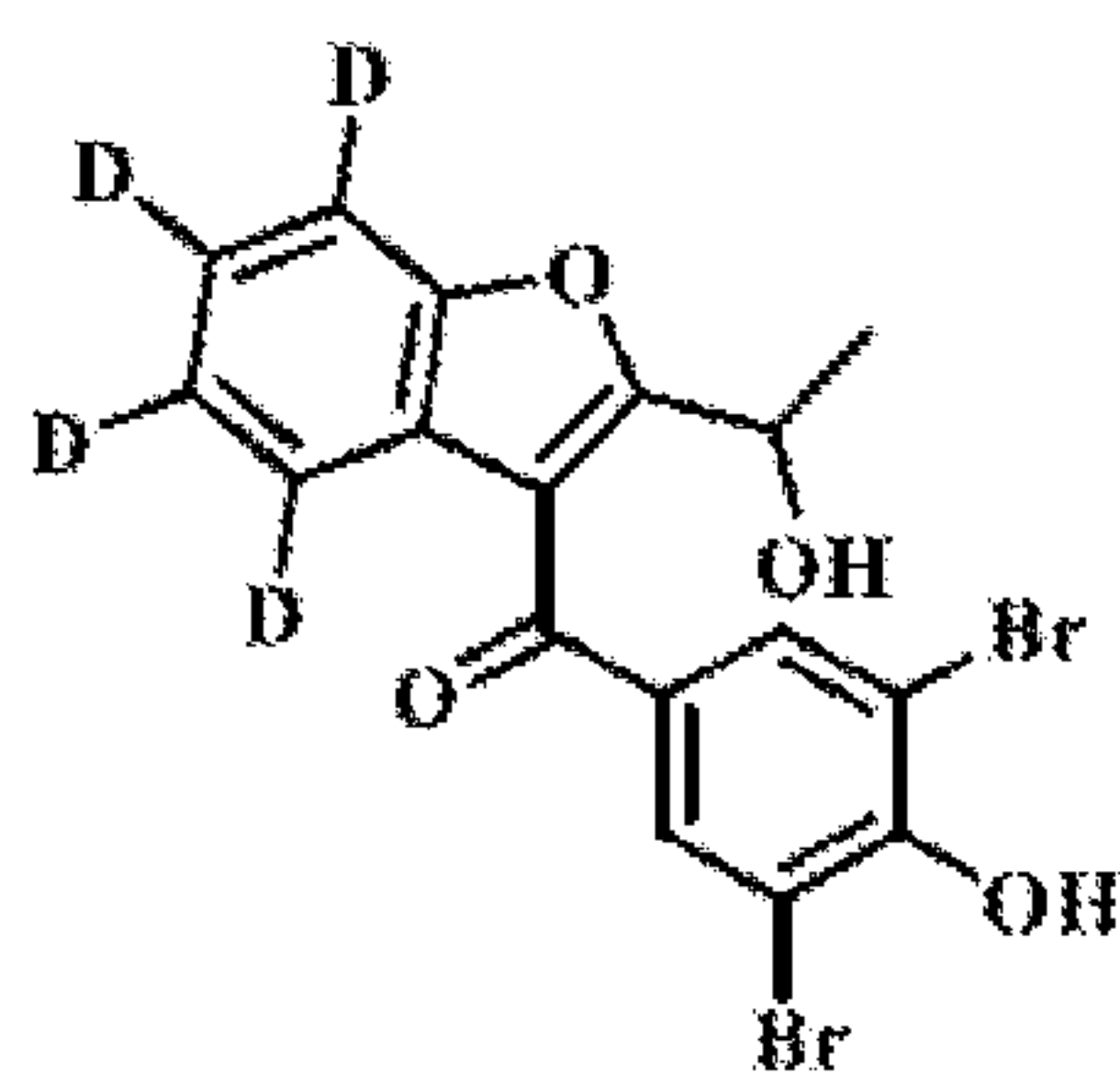
Formula 23



Formula 25

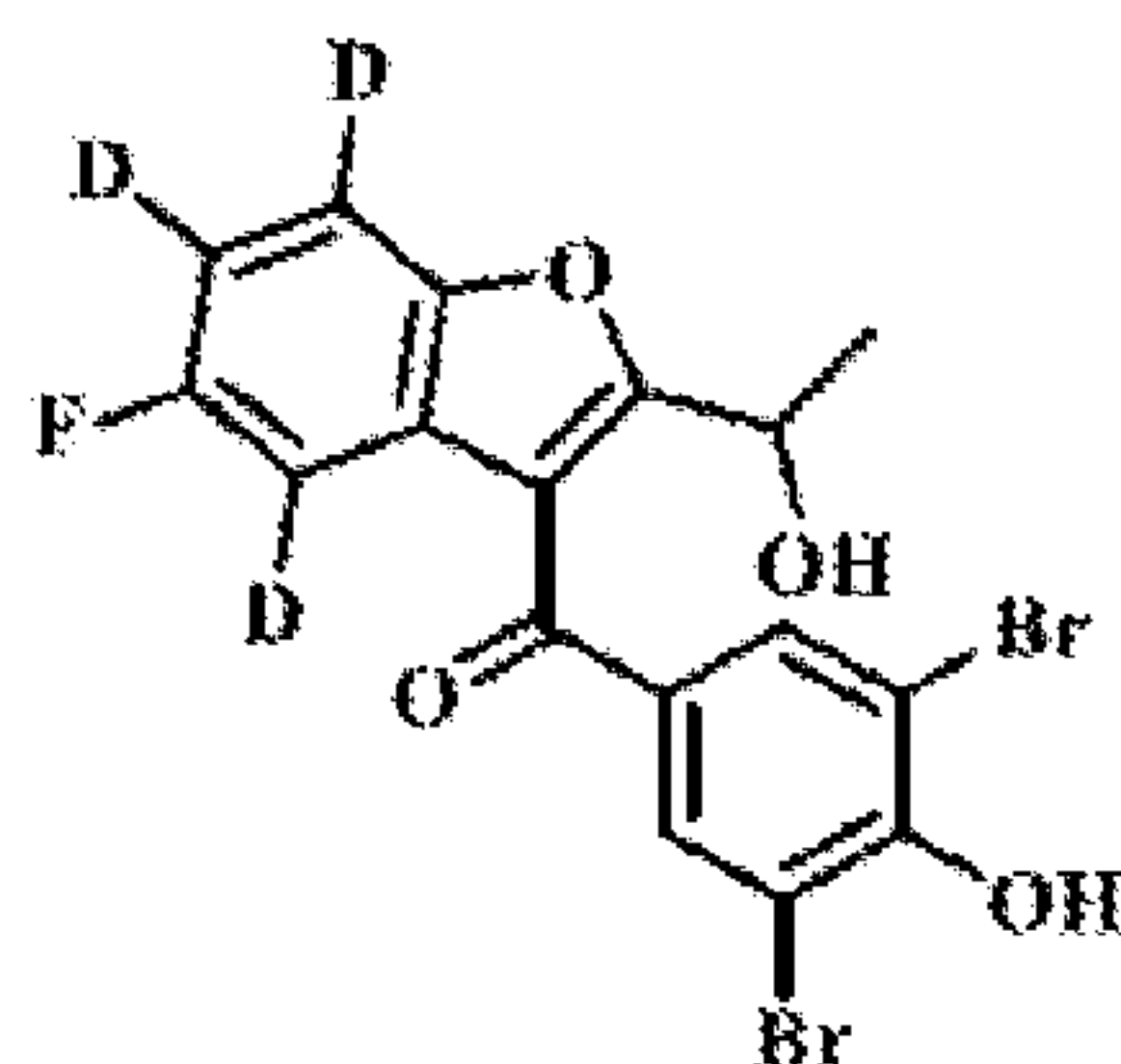
[0034] In such compounds  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  can each be independently selected from  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6$ -alkyl,  $C_6-C_{14}$ -aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$ -alkoxy,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6$ -alkylsulfonyl,  $-trifluoromethyl$ ,  $-C_1-C_6$ -alkanoyloxy,  $-C_1-C_6$ -alkylthio,  $-C_1-C_6$ -alkylsulfonyl,  $-C_2-C_6$ -alkoxycarbonyl,  $-C_2-C_6$ -alkanoylamino,  $-O-R_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NHSO_2R_6$ , and  $-NHCO_2R_6$ , where  $-R_6$  is phenyl or naphthyl, and optionally substituted with one or three groups selected from  $-C_1-C_6$ -alkyl,  $-C_6-C_{10}$ -aryl,  $-C_1-C_6$ -alkoxy and halogen, and  $-C_4-C_{20}$ -hydroxyheteroaryl, and wherein the heteroatoms in  $-C_4-C_{20}$ -hydroxyheteroaryl are selected from nitrogen or oxygen.

[0035] Viewed from another perspective, the inventive subject matter provides, among other compounds, the following (or salts, chelates, or pro-drugs thereof) compounds, formulations including one or more of the following compounds, and methods of treating a condition associated with hyperuricemia or gout that includes administering a formulation including a therapeutically effective amount of one or more of the following compounds:

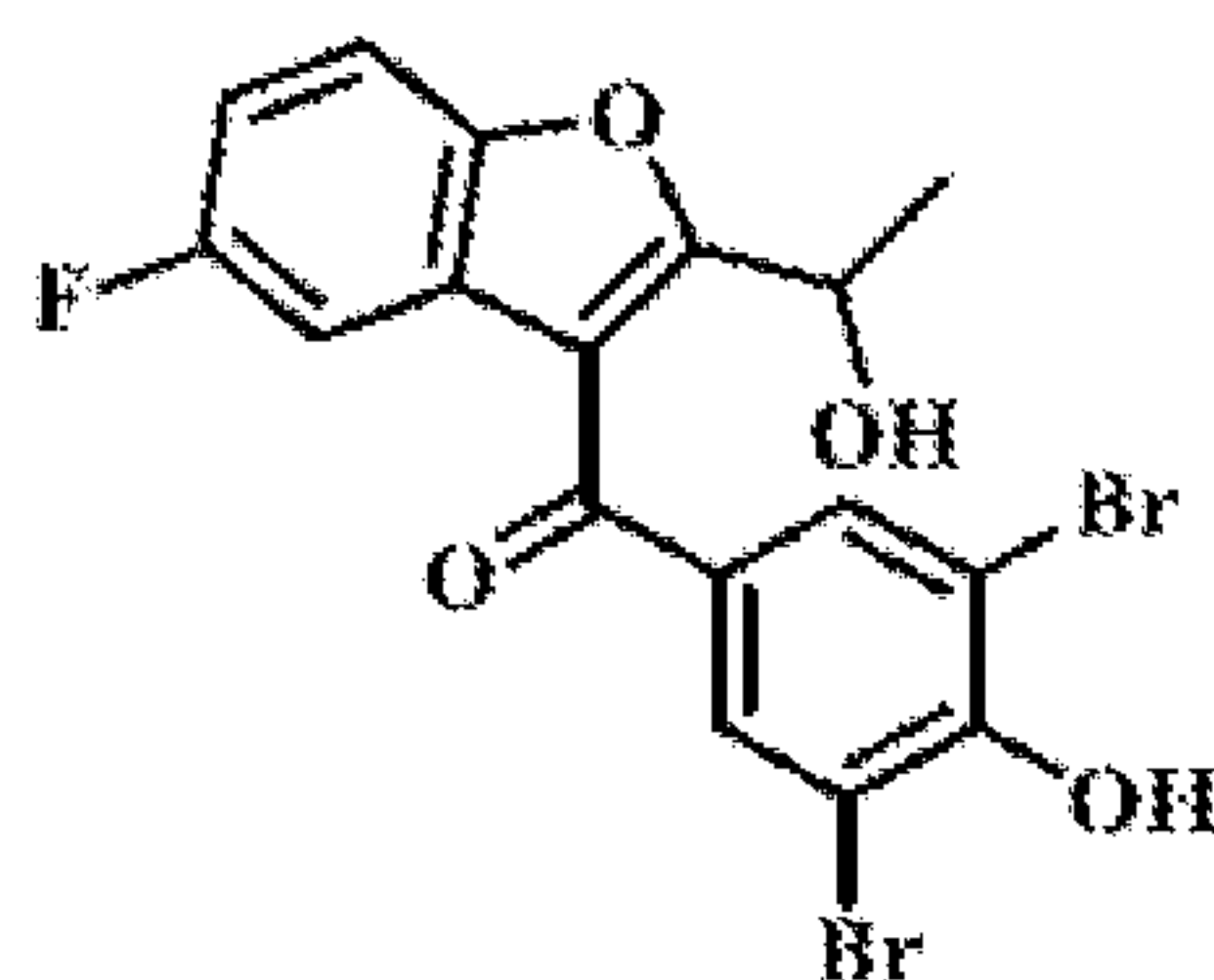


Formula 27

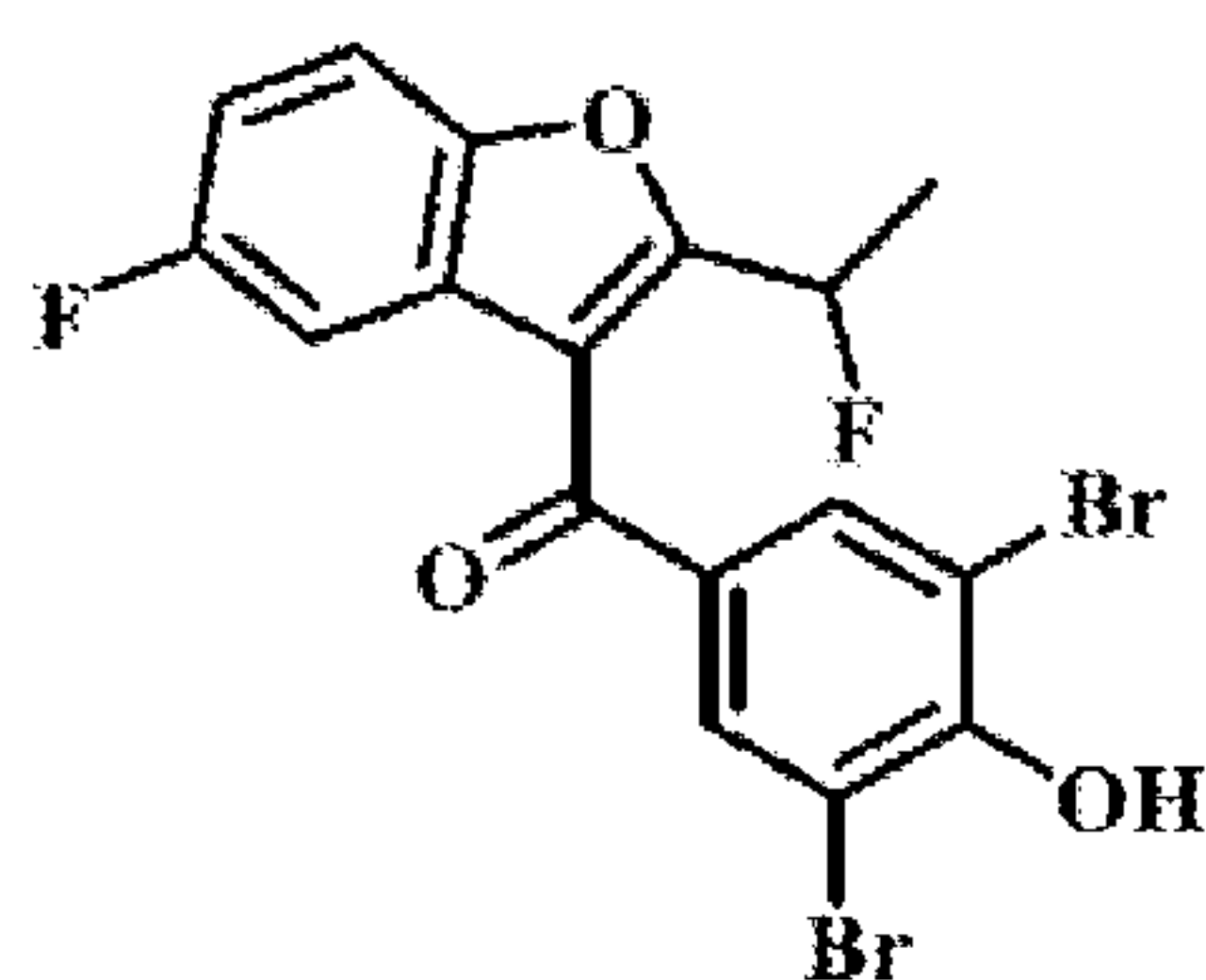
2,6-dibromo-4-[2-(1-hydroxyethyl)(4,5,6,7- $^2H_4$ )-1-benzofuran-3-carbonyl]phenol

**Formula 28**

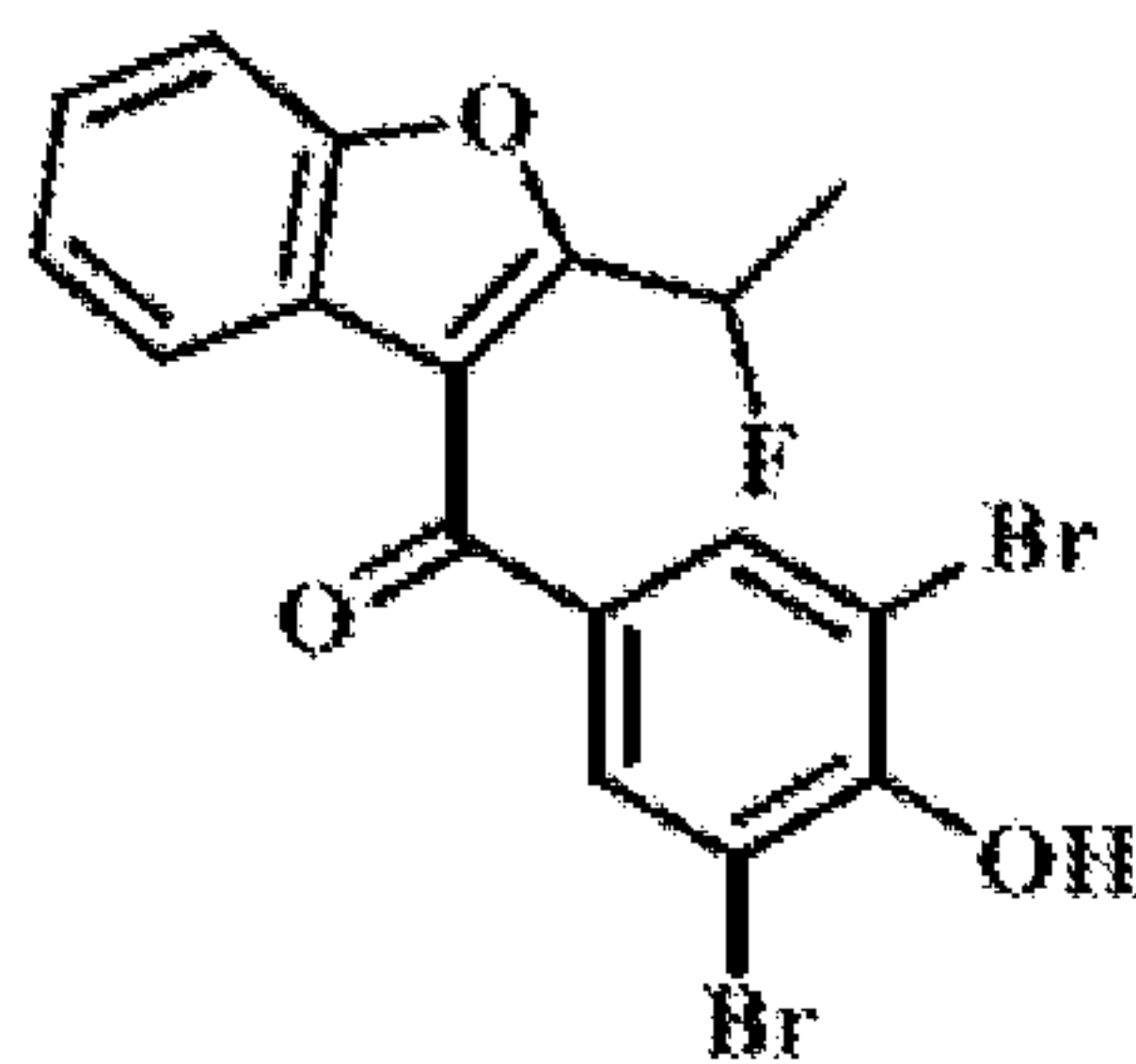
2,6-dibromo-4-[5-fluoro-2-(1-hydroxyethyl)(4,6,7-<sup>2</sup>H<sub>3</sub>)-1-benzofuran-3-carbonyl]phenol

**Formula 29**

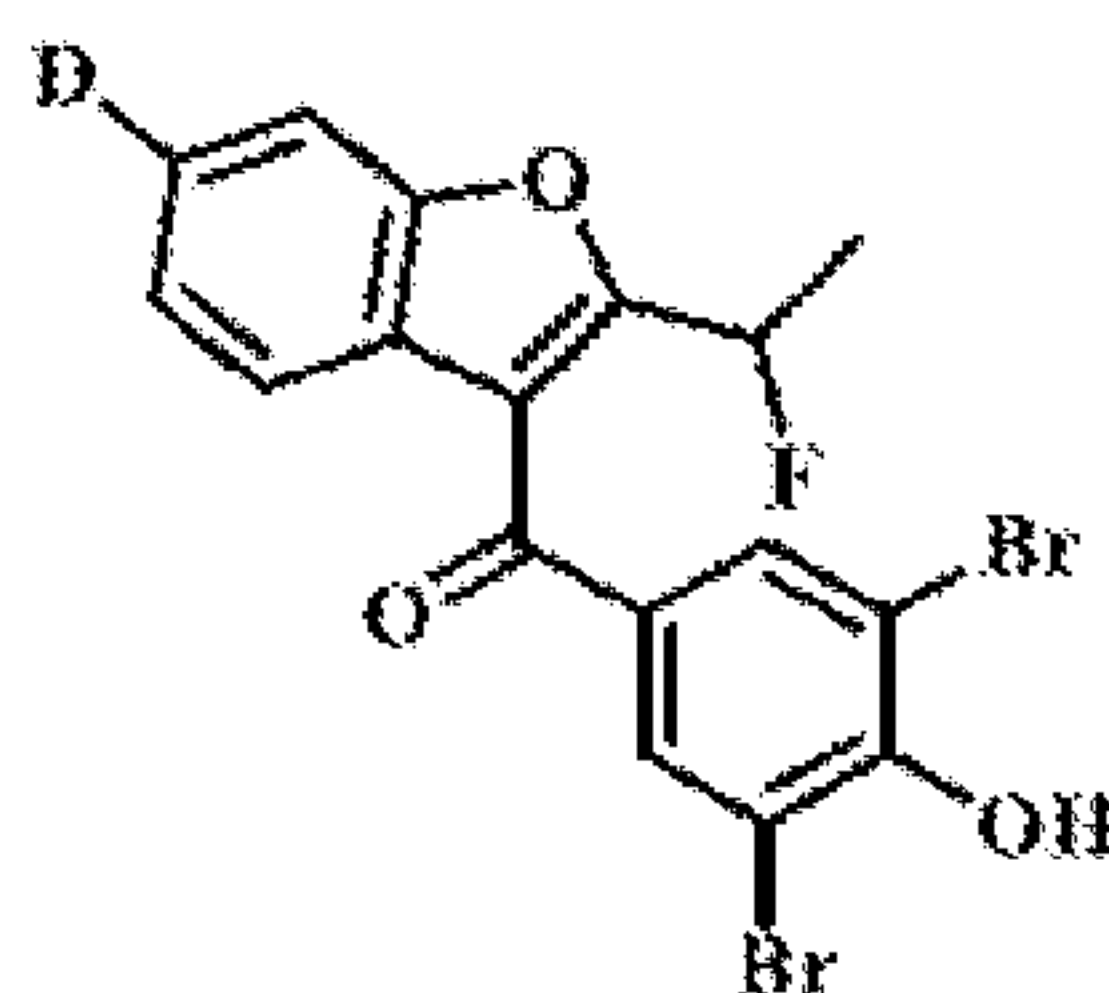
2,6-dibromo-4-[5-fluoro-2-(1-hydroxyethyl)-1-benzofuran-3-carbonyl]phenol

**Formula 30**

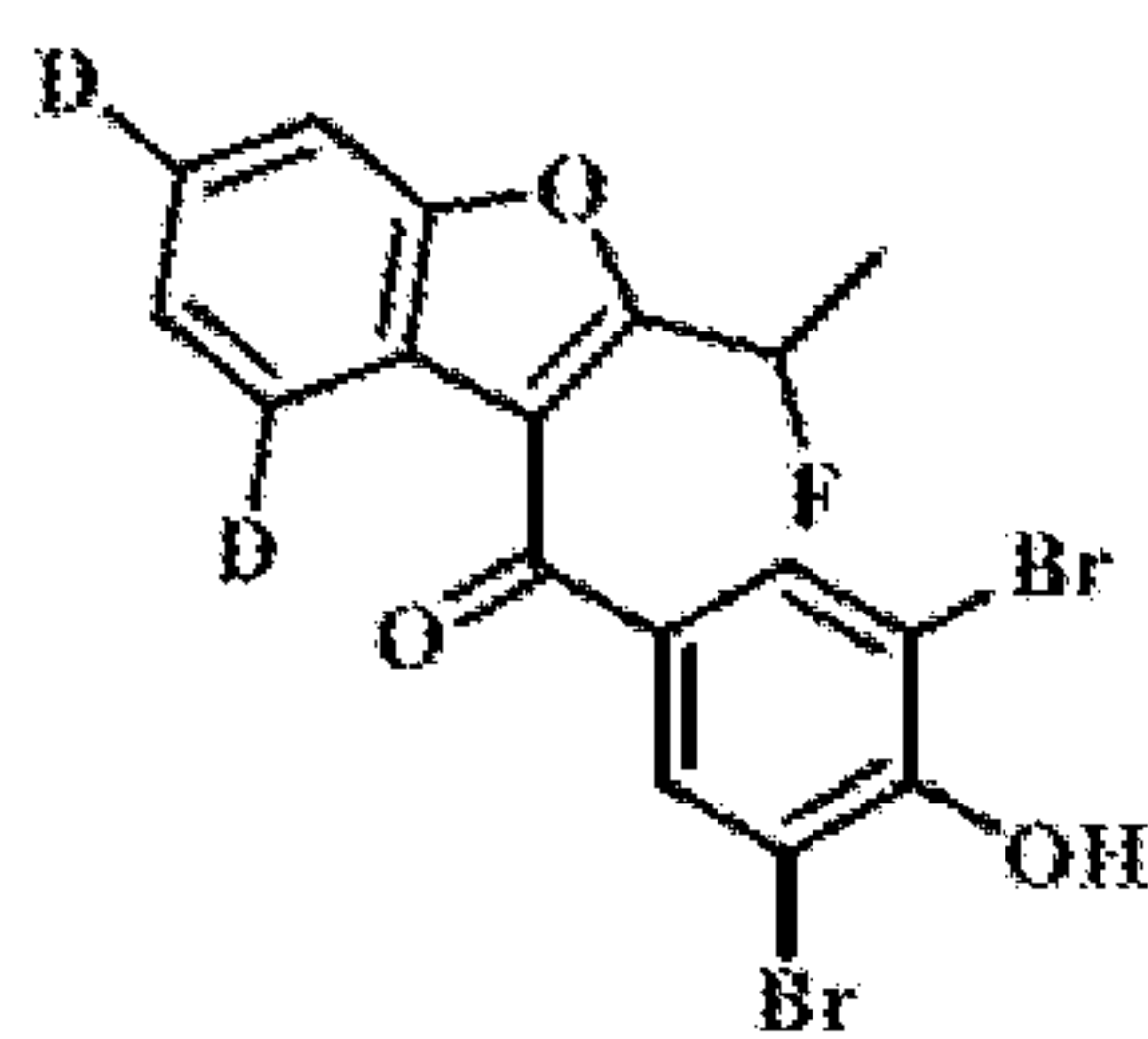
2,6-dibromo-4-[5-fluoro-2-(1-fluoroethyl)-1-benzofuran-3-carbonyl]phenol

**Formula 31**

2,6-dibromo-4-[2-(1-fluoroethyl)-1-benzofuran-3-carbonyl]phenol

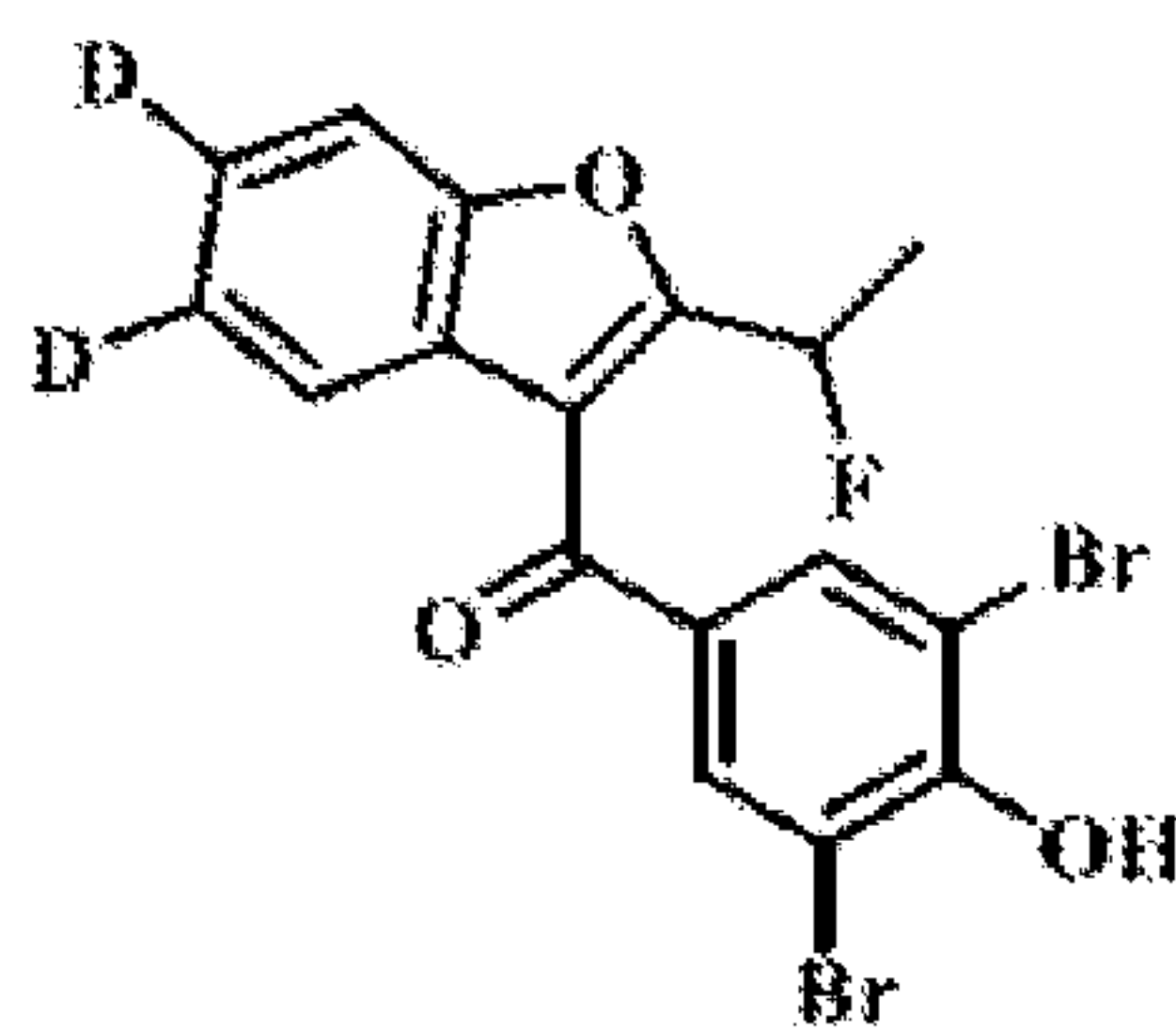
**Formula 32**

2,6-dibromo-4-[2-(1-fluoroethyl)(6-<sup>2</sup>H)-1-benzofuran-3-carbonyl]phenol

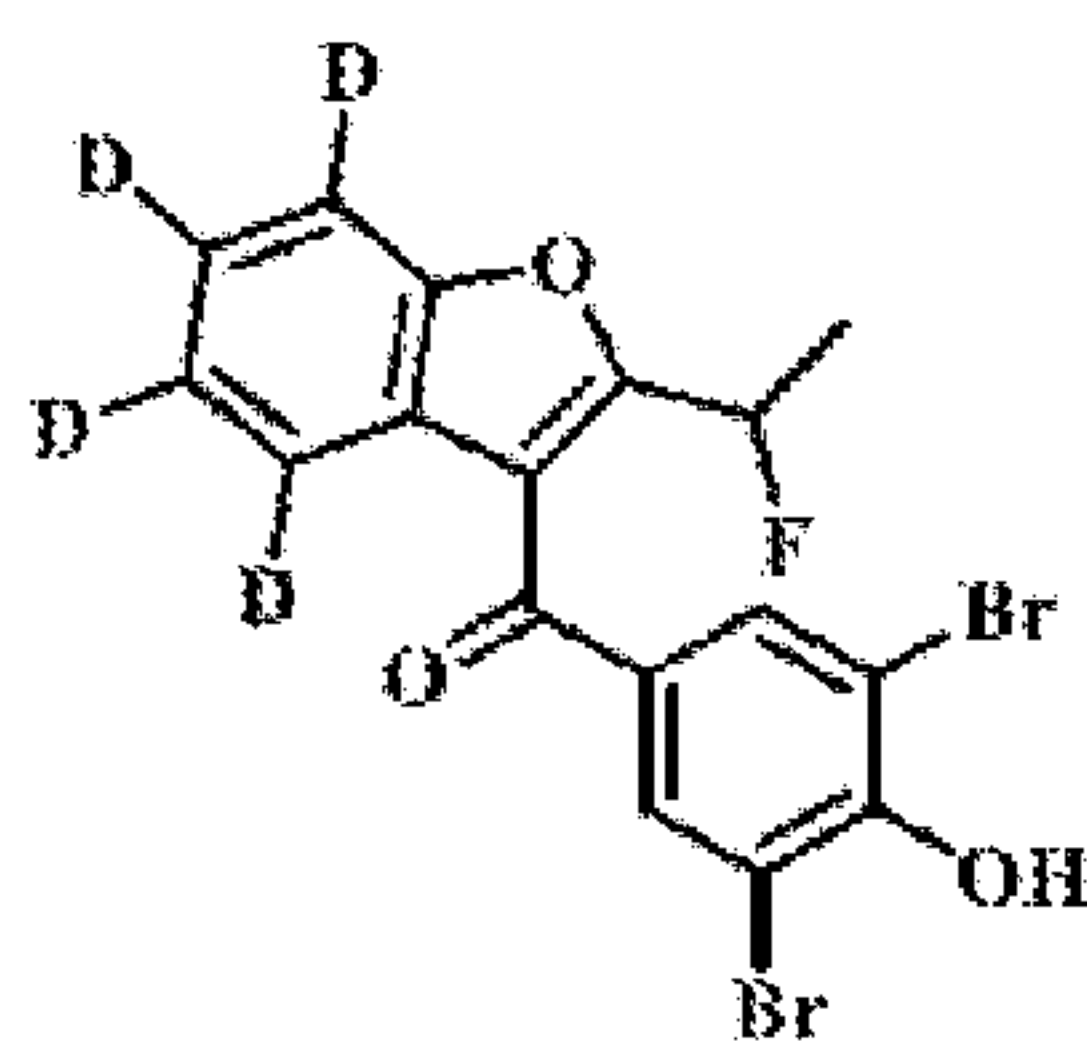
**Formula 33**

2,6-dibromo-4-[2-(1-fluoroethyl)(4,6-<sup>2</sup>H<sub>2</sub>)-1-benzofuran-3-carbonyl]phenol

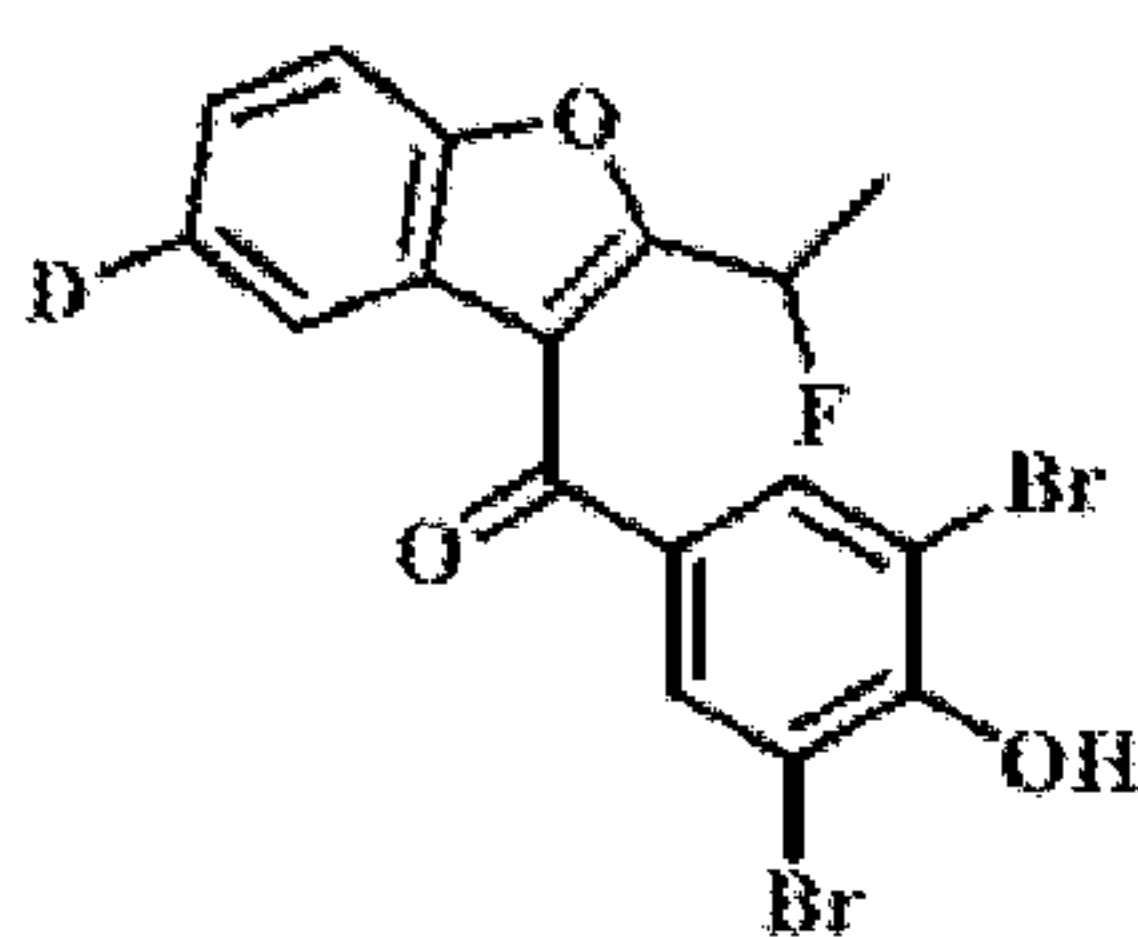


**Formula 34**

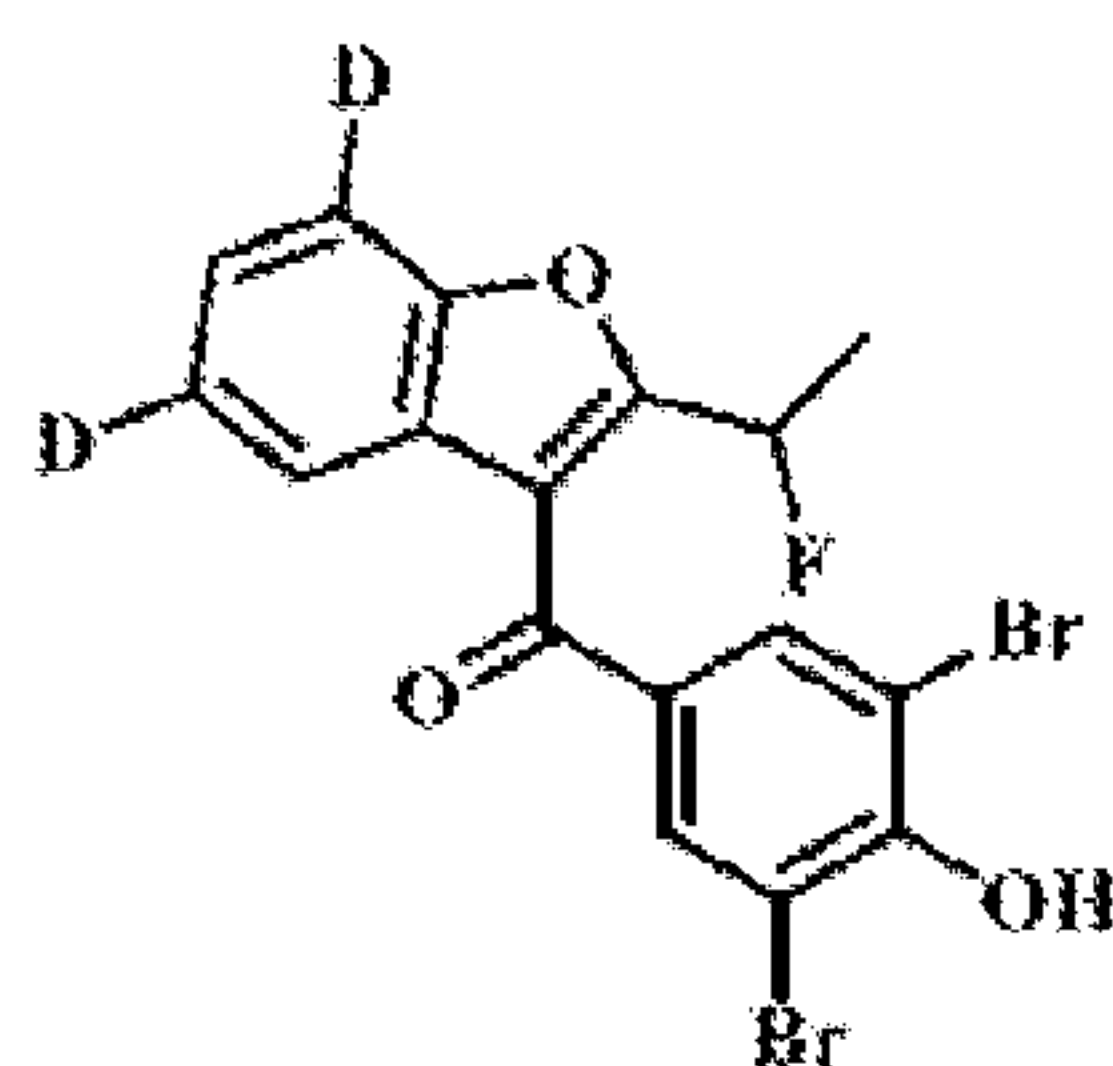
2,6-dibromo-4-[2-(1-fluoroethyl)(5,6-<sup>2</sup>H<sub>2</sub>)-1-benzofuran-3-carbonyl]phenol

**Formula 35**

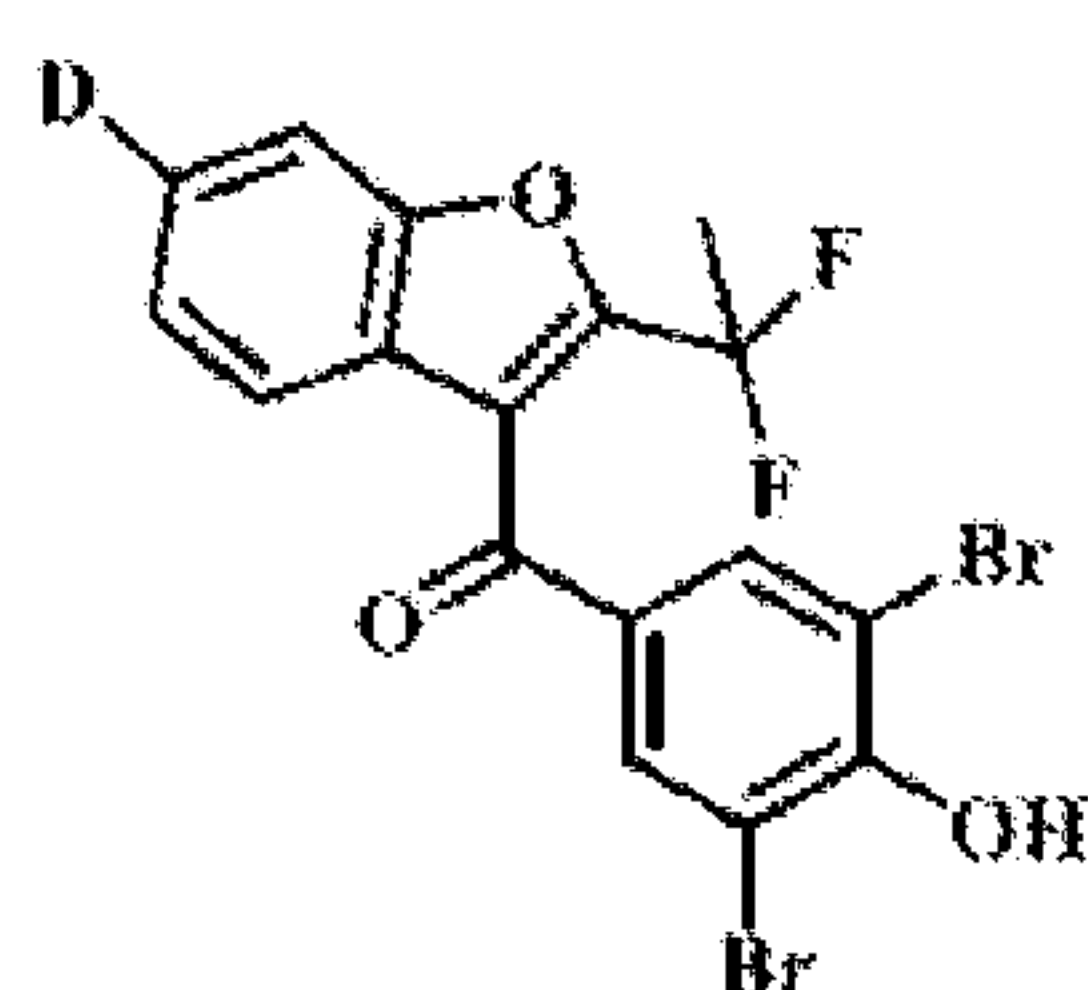
2,6-dibromo-4-[2-(1-fluoroethyl)(<sup>2</sup>H<sub>4</sub>)-1-benzofuran-3-carbonyl]phenol

**Formula 36**

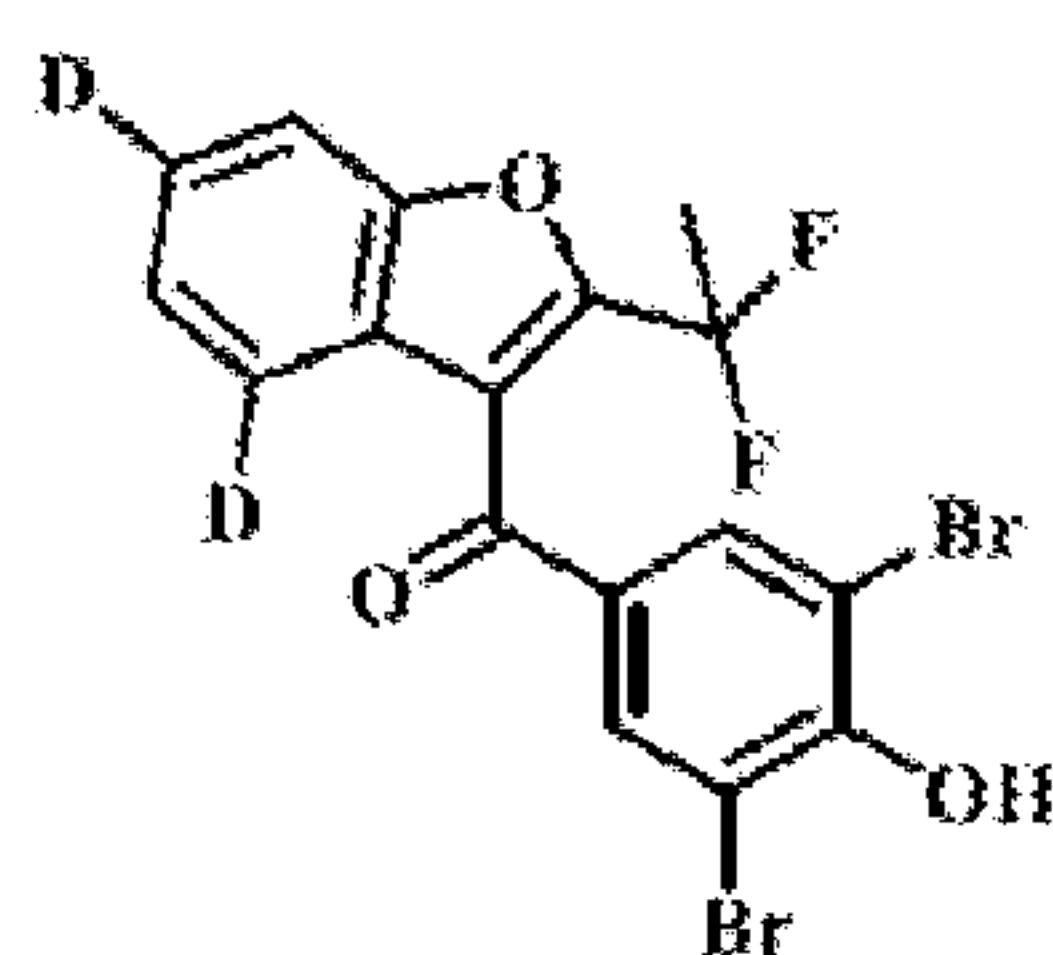
2,6-dibromo-4-[2-(1-fluoroethyl)(5-<sup>2</sup>H)-1-benzofuran-3-carbonyl]phenol

**Formula 37**

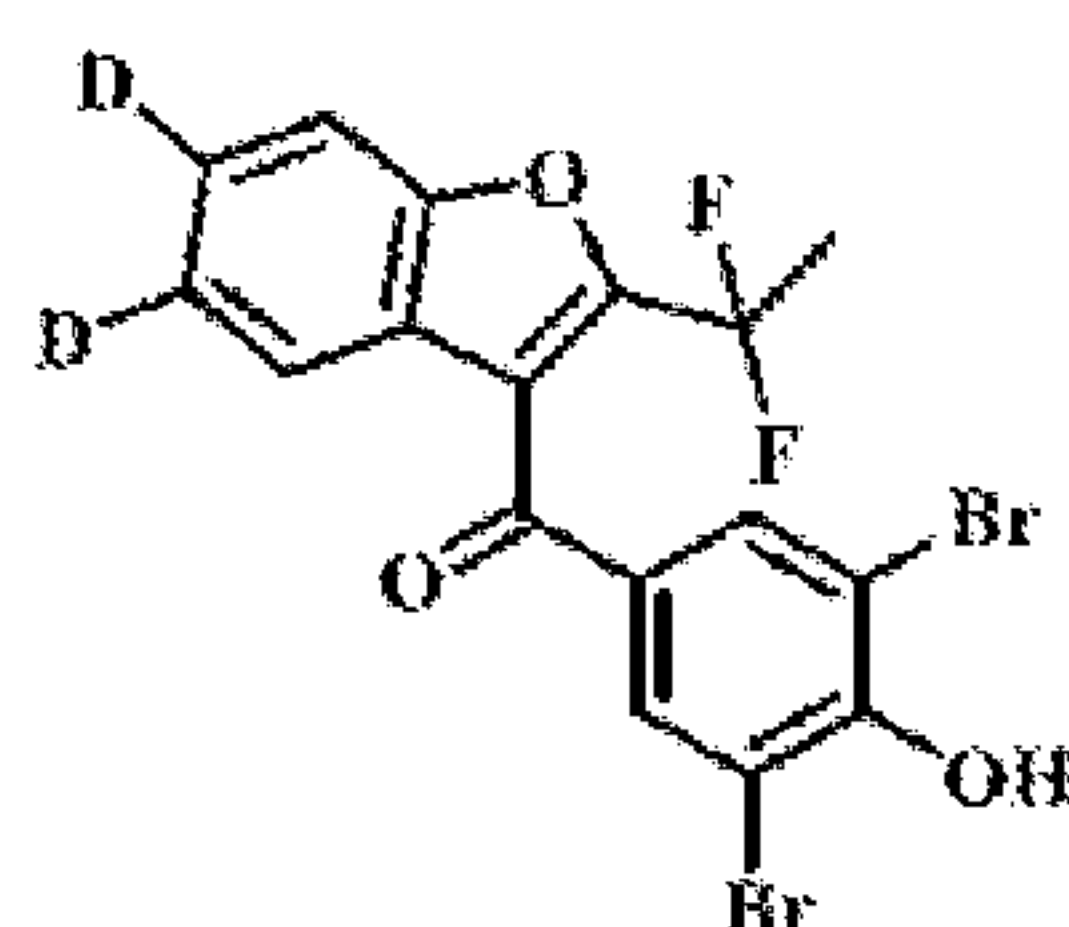
2,6-dibromo-4-[2-(1-fluoroethyl)(5,7-<sup>2</sup>H<sub>2</sub>)-1-benzofuran-3-carbonyl]phenol

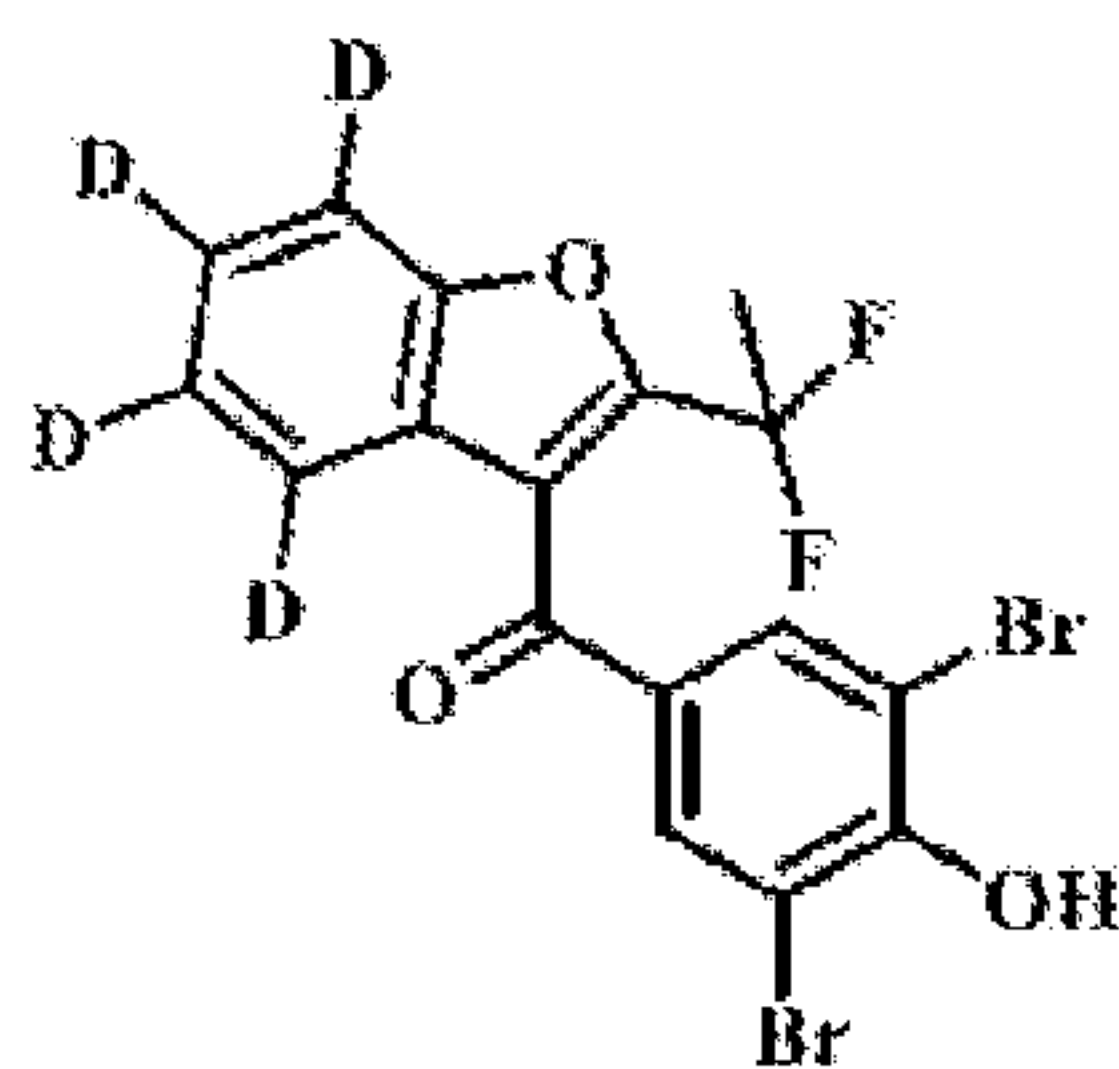
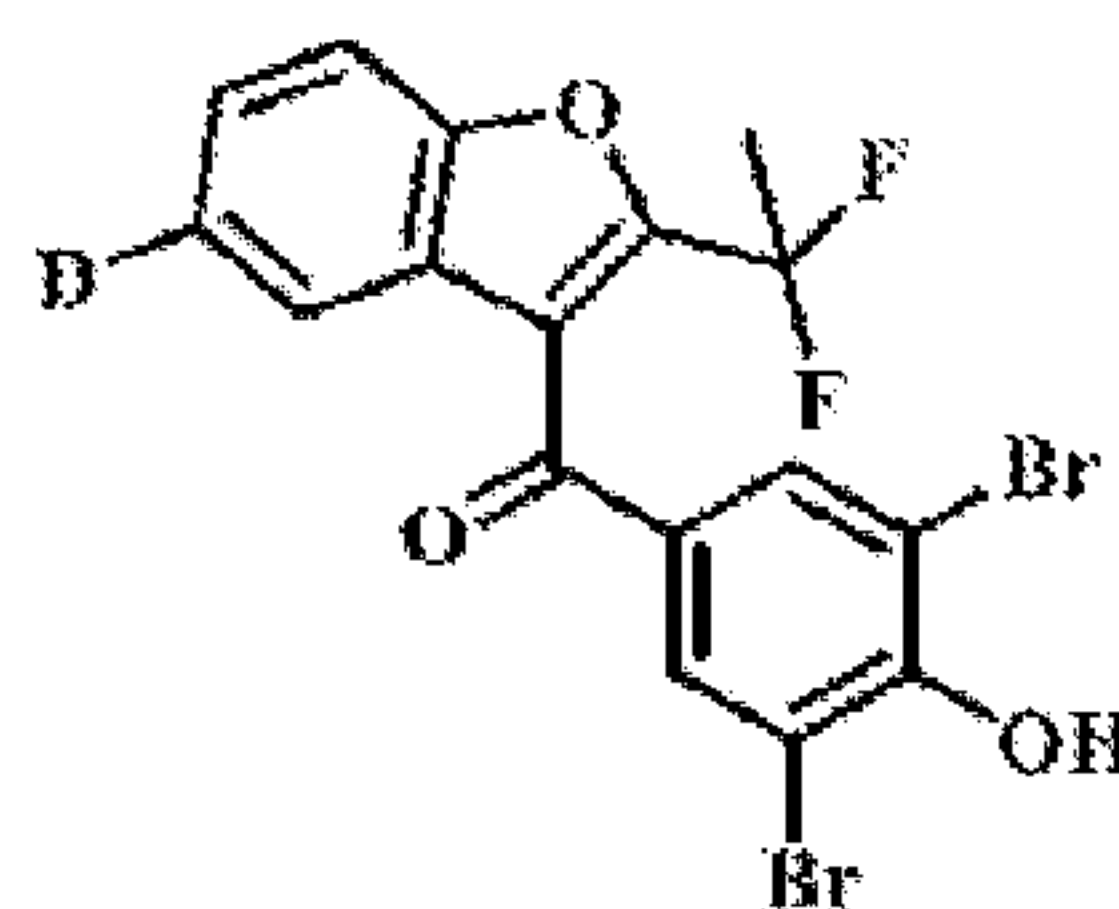
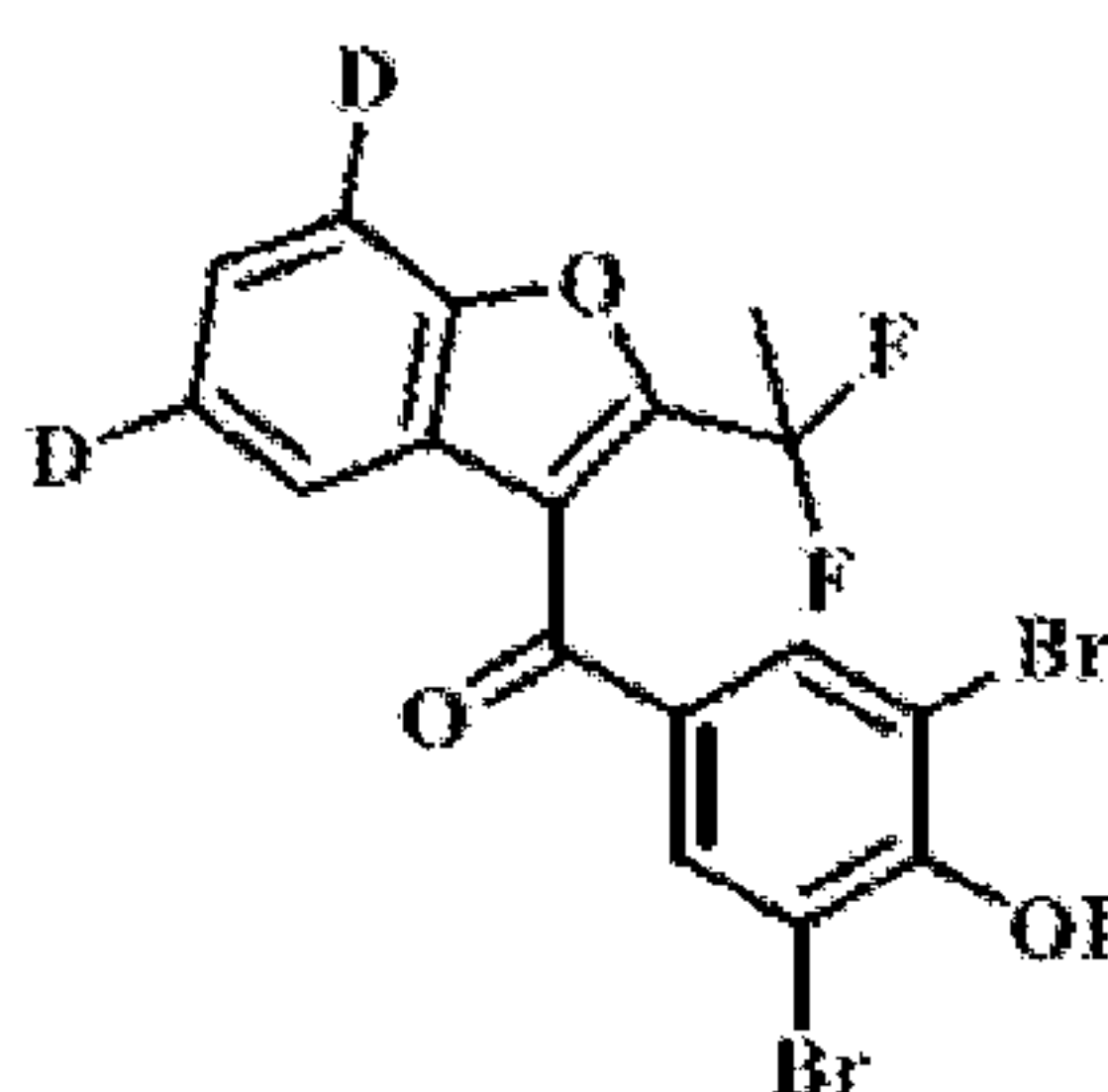
**Formula 38**

2,6-dibromo-4-[2-(1,1-difluoroethyl)(6-<sup>2</sup>H)-1-benzofuran-3-carbonyl]phenol

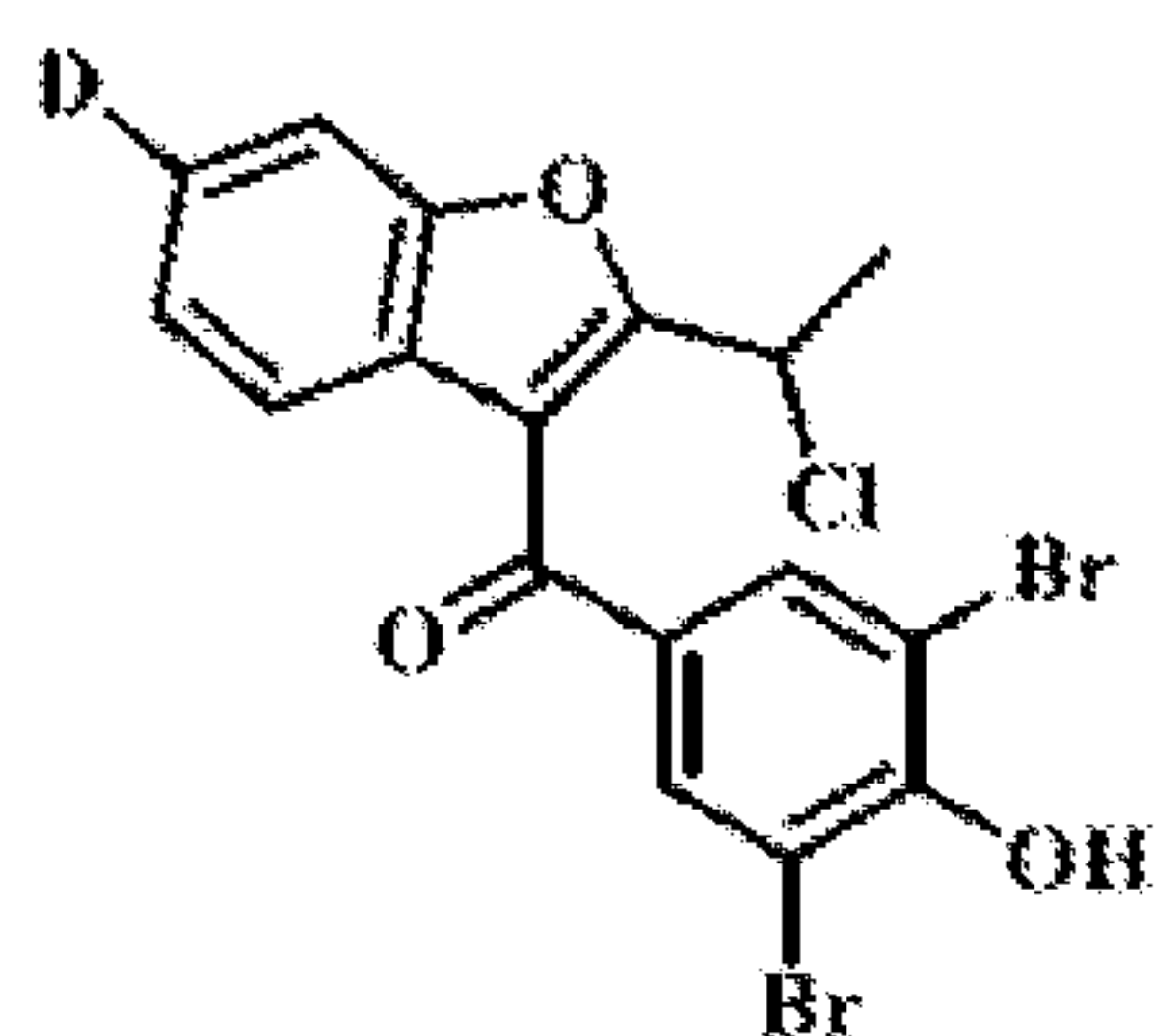
**Formula 39**

2,6-dibromo-4-[2-(1,1-difluoroethyl)(4,6-<sup>2</sup>H<sub>2</sub>)-1-benzofuran-3-carbonyl]phenol

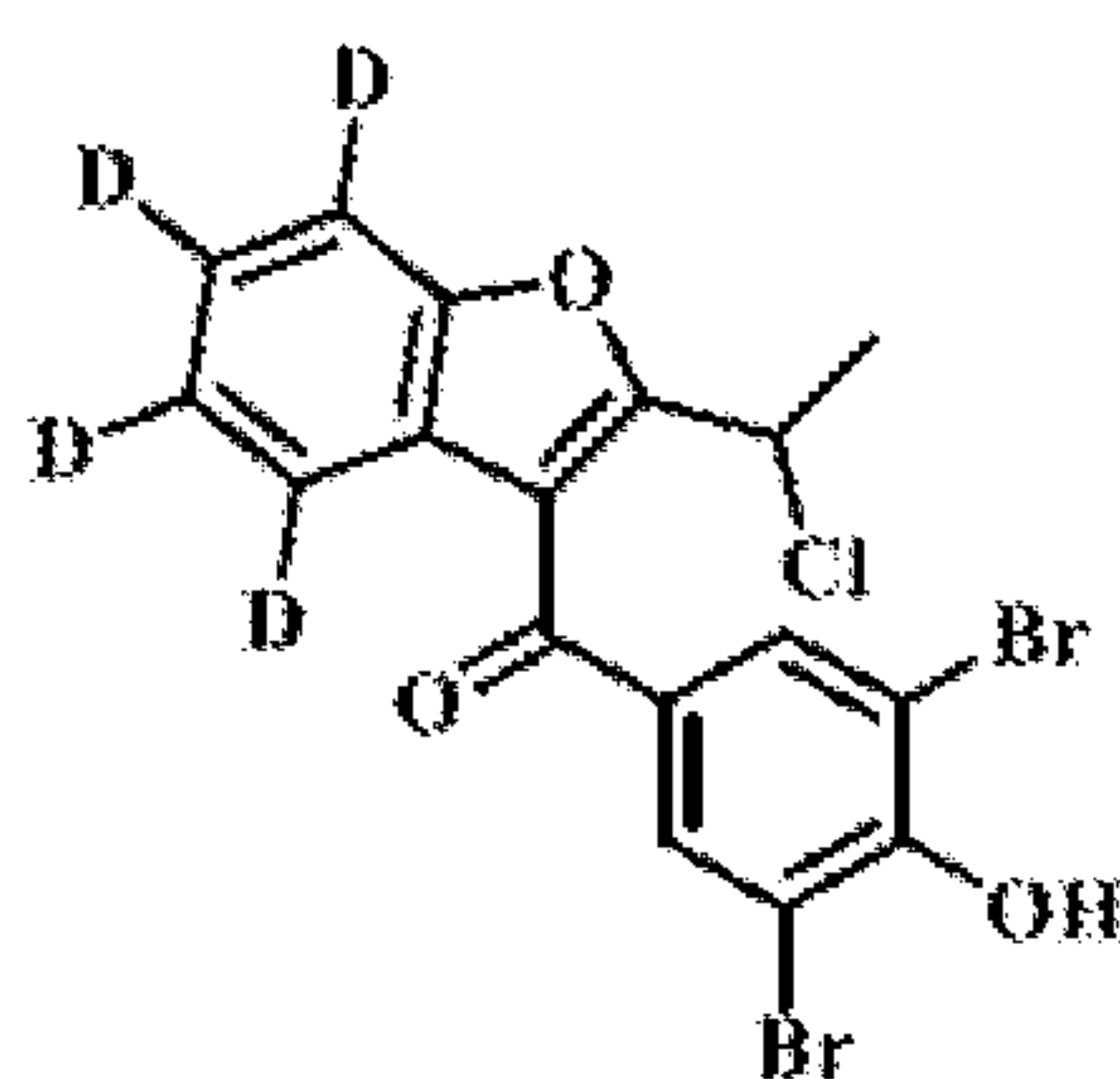


**Formula 40**2,6-dibromo-4-[2-(1,1-difluoroethyl)(5,6-<sup>2</sup>H<sub>2</sub>)-1-benzofuran-3-carbonyl]phenol**Formula 41**2,6-dibromo-4-[2-(1,1-difluoroethyl)(<sup>2</sup>H<sub>4</sub>)-1-benzofuran-3-carbonyl]phenol**Formula 42**2,6-dibromo-4-[2-(1,1-difluoroethyl)(5-<sup>2</sup>H)-1-benzofuran-3-carbonyl]phenol**Formula 43**2,6-dibromo-4-[2-(1,1-difluoroethyl)(5,7-<sup>2</sup>H<sub>2</sub>)-1-benzofuran-3-carbonyl]phenol

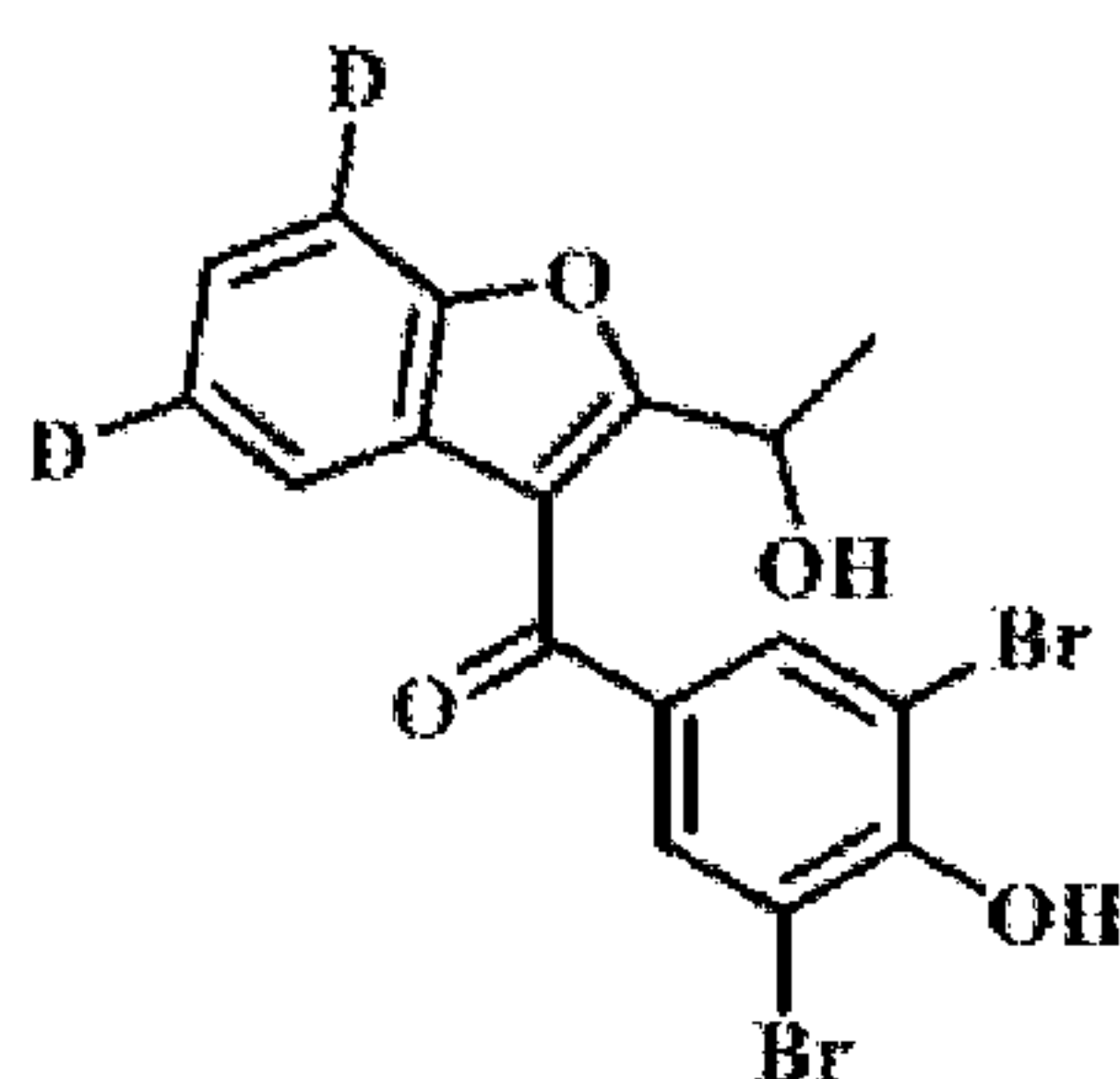


**Formula 44**

2,6-dibromo-4-[2-(1-chloroethyl)(6-<sup>2</sup>H)-1-benzofuran-3-carbonyl]phenol

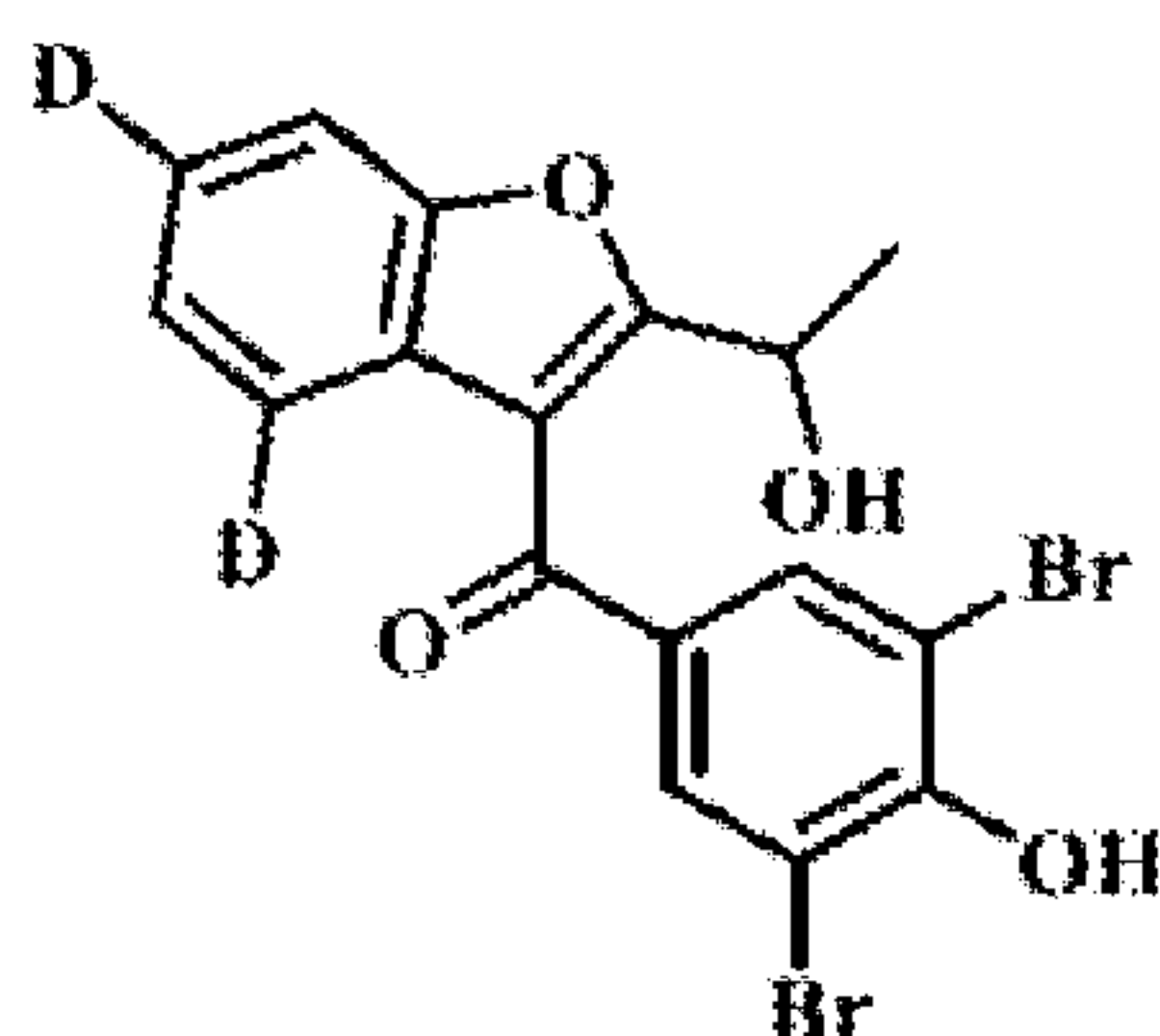
**Formula 45**

2,6-dibromo-4-[2-(1-chloroethyl)(<sup>2</sup>H<sub>4</sub>)-1-benzofuran-3-carbonyl]phenol



2,6-dibromo-4-[2-(1-hydroxyethyl)(5,6-<sup>2</sup>H<sub>2</sub>)-1-benzofuran-3-carbonyl]phenol

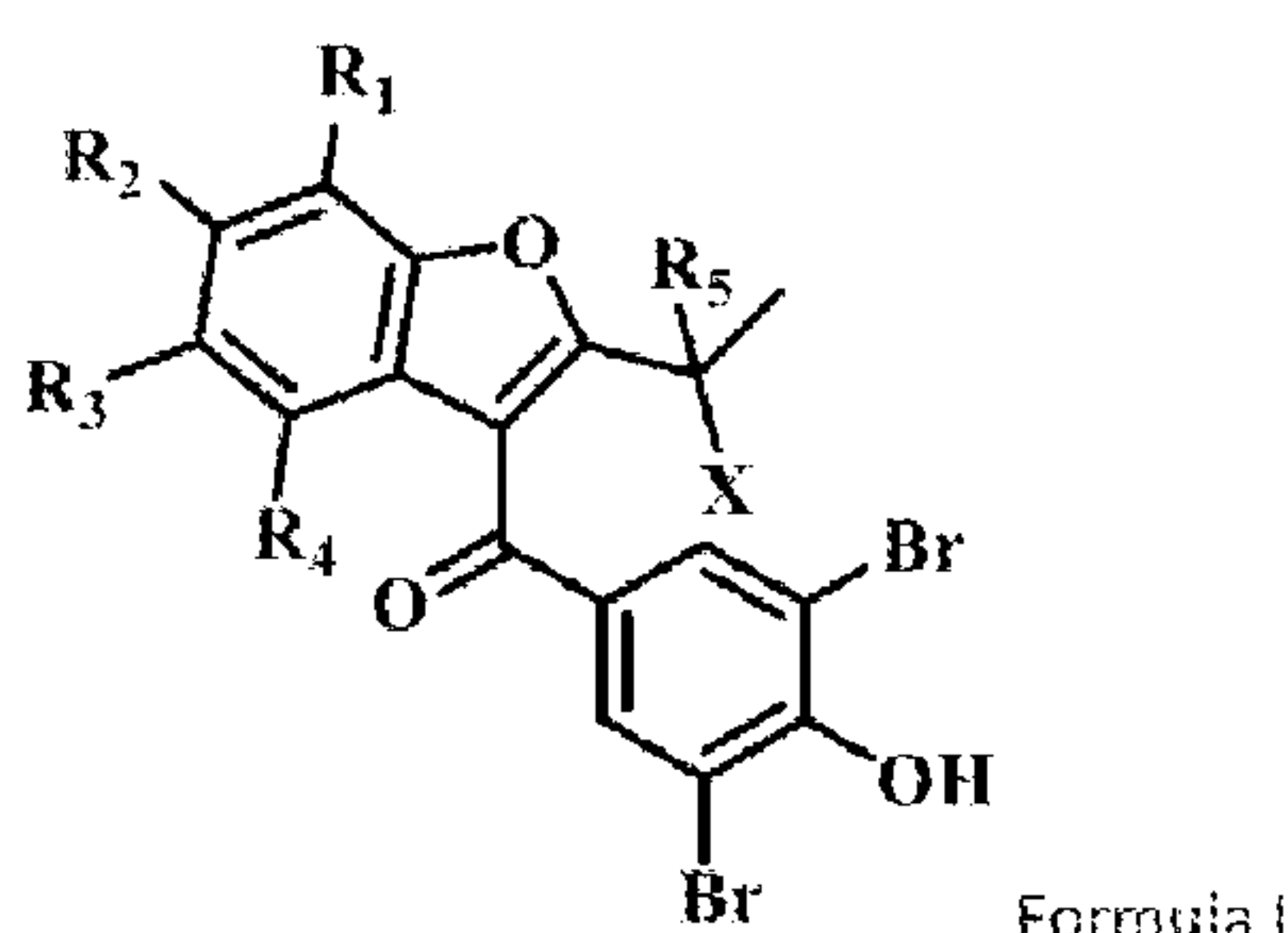
**Formula 46**

**Formula 47**

2,6-dibromo-4-[2-(1-hydroxyethyl)(4,6-<sup>2</sup>H<sub>2</sub>)-1-benzofuran-3-carbonyl]phenol

[0036] While the compounds of the inventive subject matter are thought to be useful for treating hyperuricemia or gout, treating conditions associated with hyperuricemia or gout, inhibiting one or more kidney transporters responsible for uric acid reabsorption in renal tubules, treating a condition, disorder or disease mediated by at least one kidney transporter responsible for uric acid reabsorption in renal tubules, and lowering serum uric acid through inhibition of purine catabolism, it should be appreciated that compounds of the inventive subject matter could be used in any commercially suitable manner now known or later discovered. It should therefore also be appreciated that compositions of the inventive subject matter could be used to treat or prevent any suitable condition, whether now known or later discovered.

[0037] The inventive subject matter also provides compounds, compositions and methods in which a composition for the treatment of a condition associated with hyperuricemia or gout is provided. The composition can include a pharmaceutically acceptable carrier, and a compound of Formula 1 or a pharmaceutically acceptable salt thereof:



Formula 1

**[0038]** In such a compound and/or formulation  $-X$  can be  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$ , or  $-I$ , where  $-R$  can be a  $-H$ ,  $-C_1-C_{10}$  alkyl or a  $-C_1-C_{10}$  substituted alkyl; where  $-R_2$  can be  $-deuterium$  or  $-H$ ; and where  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6$ -alkyl,  $C_6-C_{14}$ -aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$ -alkoxy,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6$ -alkylsulfonyl,  $-trifluoromethyl$ ,  $-C_1-C_6$ -alkanoyloxy,  $-C_1-C_6$ -alkylthio,  $-C_1-C_6$ -alkylsulfonyl,  $-C_2-C_6$ -alkoxycarbonyl,  $-C_2-C_6$ -alkanoylamino,  $-O-R_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NHSO_2R_6$ , and  $-NHCO_2R_6$ , where  $-R_6$  can be phenyl or naphthyl, and optionally substituted with one to three groups selected from  $-C_1-C_6$ -alkyl,  $-C_6-C_{10}$ -aryl,  $-C_1-C_6$ -alkoxy and halogen, and  $-C_4-C_{20}$ -hydroxyheteroaryl, and where the heteroatoms in  $-C_4-C_{20}$ -hydroxyheteroaryl are nitrogen or oxygen; and where the compound of Formula 1 is present in a therapeutically effective amount to treat a condition associated with hyperuricemia.

**[0039]** In some embodiments,  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  is  $-deuterium$  when  $X$  is a halogen,  $-OH$ , or one or more pharmaceutically acceptable pro-drugs. In some contemplated embodiments,  $-X$  can be  $-OH$  or  $-F$ ,  $R_3$  can be a halogen (e.g.  $-F$ ,  $-Cl$ ,  $-Br$  or  $-I$ ), and  $-R_1$ ,  $-R_2$ ,  $-R_4$ , and  $-R_5$  are each independently selected from  $-H$  or deuterium. In some other contemplated embodiments,  $-R_1$ ,  $-R_2$ ,  $-R_3$ , and  $-R_4$  are each deuterium,  $-X$  is  $-OH$ , and  $-R_5$  is hydrogen. In some contemplated embodiments,  $-R_1$ ,  $-R_2$ ,  $-R_3$ , and  $-R_4$  are each deuterium,  $-X$  is  $-F$ , and  $-R_5$  is hydrogen. In some contemplated embodiments,  $-R_1$ ,  $-R_2$ , and  $-R_4$  are each deuterium,  $-X$  is  $OH$ ,  $-R_3$  is  $-F$ , and  $-R_5$  is hydrogen. In some contemplated embodiments,  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$ . and  $-R_5$  are each independently selected from hydrogen and deuterium, and  $-X$  is  $-OH$ . In some contemplated embodiments,  $-R_1$ ,  $-R_2$ ,  $-R_3$ , and  $-R_4$  are each independently selected from hydrogen and deuterium,  $-X$  is a  $-F$  or  $-OH$ , and  $-R_5$  is hydrogen,  $-F$ , or deuterium. However, it is also contemplated that compounds of the inventive subject matter could include a halogen, for example fluorine at the 1' position, and comprise a hydrogen at each of the  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  positions.

**[0040]** For example, in some contemplated embodiments,  $X$  is  $-OH$ ,  $-R_1$ ,  $-R_2$ ,  $-R_3$ , and  $-R_4$  are each deuterium, and  $-R_5$  is  $-H$ . As another example, in some contemplated embodiments,  $X$  is  $-F$ ,  $-R_1$ ,  $-R_2$ ,  $-R_3$ , and  $-R_4$  are each deuterium, and  $-R_5$  is  $-H$ . In another example, in some contemplated embodiments,  $X$  and  $-R_3$  are each  $-F$ , and  $-R_1$ ,  $-R_2$ ,  $-R_4$ , and  $-R_5$  are each  $-H$ . As



yet another example, in some contemplated embodiments, X is -OH, -R<sub>3</sub> is -F, and -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>4</sub>, and -R<sub>5</sub> are each -H.

**[0041]** In some contemplated embodiments, -X is -F (fluorine). For example, some contemplated compounds include -deuterium at -R<sub>2</sub>, -F at -X, -H at each of -R<sub>1</sub>, -R<sub>3</sub>, and -R<sub>4</sub>, and -H at -R<sub>5</sub>. In some contemplated compounds, -X is -F, each of -R<sub>2</sub> and -R<sub>4</sub> is -deuterium, and each of -R<sub>1</sub>, -R<sub>3</sub>, and -R<sub>5</sub> is a -H. In some other contemplated compounds, -X is -F, each of -R<sub>2</sub> and -R<sub>3</sub> is -deuterium, and each of -R<sub>1</sub>, -R<sub>4</sub>, and -R<sub>5</sub> is a -H. In yet other contemplated embodiments, -X is -F, each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub> and -R<sub>4</sub>, is -deuterium, and -R<sub>5</sub> is a -H. Compounds wherein -X is -F, each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub> and -R<sub>4</sub> is -deuterium, and -R<sub>5</sub> is a -H are also contemplated.

**[0042]** In some contemplated embodiments, both the -X and -R<sub>5</sub> are fluorinated. For example, in some contemplated compounds, each of -X and -R<sub>5</sub> is -F, -R<sub>2</sub> is -deuterium, and each of -R<sub>1</sub>, -R<sub>3</sub> and -R<sub>4</sub>, is a -H. In some other contemplated embodiments, each of -X and -R<sub>5</sub> is -F, and each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub> and -R<sub>4</sub> is -deuterium.

**[0043]** In some contemplated embodiments, -X is -Cl (chlorine). For example, some contemplated compounds include -deuterium at -R<sub>2</sub>, -Cl at -X, -H at each of -R<sub>1</sub>, -R<sub>3</sub>, and -R<sub>4</sub>, and -H at -R<sub>5</sub>. In some contemplated compounds, -X is -Cl, each of -R<sub>2</sub> and -R<sub>4</sub> is -deuterium, and each of -R<sub>1</sub>, -R<sub>3</sub>, and -R<sub>5</sub> is a -H. In some other contemplated compounds, -X is -Cl, each of -R<sub>2</sub> and -R<sub>3</sub> is -deuterium, and each of -R<sub>1</sub>, -R<sub>4</sub>, and -R<sub>5</sub> is a -H. In yet other contemplated embodiments, -X is -Cl, each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub> and -R<sub>4</sub>, is -deuterium, and -R<sub>5</sub> is a -H. Compounds wherein -X is -Cl, each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub> and -R<sub>4</sub> is -deuterium, and -R<sub>5</sub> is a -H are also contemplated.

**[0044]** In some contemplated embodiments, both the -X and -R<sub>5</sub> are chlorinated. For example, in some contemplated compounds, each of -X and -R<sub>5</sub> is -Cl, -R<sub>2</sub> is -deuterium, and each of -R<sub>1</sub>, -R<sub>3</sub> and -R<sub>4</sub>, is a -H. In some other contemplated embodiments, each of -X and -R<sub>5</sub> is -Cl, and each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub> and -R<sub>4</sub> is -deuterium.

**[0045]** In some contemplated embodiments, both the -X and -R<sub>5</sub> are halogenated. For example, in some contemplated compounds, -X is -Cl, -Br, -I, or -F, -R<sub>5</sub> is -Cl, -Br, -I, or -F, -R<sub>2</sub> is -

deuterium, and each of  $-R_1$ ,  $-R_3$  and  $-R_4$ , is a  $-H$ . In some other contemplated embodiments,  $-X$  is  $-Cl$ ,  $-Br$ ,  $-I$ , or  $-F$ ,  $-R_5$  is  $-Cl$ ,  $-Br$ ,  $-I$ , or  $-F$ , and each of  $-R_1$ ,  $-R_2$ ,  $-R_3$  and  $-R_4$  is  $-H$ .

[0046] In some contemplated embodiments, the condition associated with hyperuricemia to be treated is at least one of gout, hypertension, hypothyroidism, renal insufficiency, obesity, and diabetes. In some contemplated embodiments, the compositions can be used to treat a condition other than hyperuricemia or one associated with hyperuricemia.

[0047] The compositions according to the inventive subject matter may be administered using various routes, including orally, parenterally, by inhalation, topically, via a mucus membrane (*e.g.* rectally, nasally, vaginally, etc.), and/or via an implanted reservoir, wherein the term "parenteral" as used herein includes subcutaneous, intravenous, intramuscular, intraarticular, intrasynovial, intrathecal, intrahepatic, intralesional, and intracranial administration (typically injection or infusion). Preferably, the compositions are administered orally, intraperitoneally, or intravenously.

[0048] The pharmaceutically acceptable compositions of this invention may be orally administered in any orally acceptable dosage form including, but not limited to, capsules, tablets, troches, elixirs, suspensions, syrups, wafers, chewing gums, suspensions, and/or solutions. The term "therapeutically effective amount" refers to the amount of the compound or pharmaceutical composition that will elicit a biological or medical response of a tissue, system, animal or human that is being sought by the researcher, veterinarian, medical doctor or other clinician, *e.g.*, reduction of sUA, reduction of occurrence or flare, pain, tophi, and reduction of morbidity.

[0049] With respect to the amount of contemplated compounds in the composition, it should be recognized that the particular quantity will typically depend on the specific formulation, active ingredient, and desired purpose. Therefore, it should be recognized that the amount of contemplated compounds will vary significantly. However, it is generally preferred that the compounds are present in a minimum amount effective to deliver a therapeutic effect or to be visualized *in vitro* or *in vivo*.

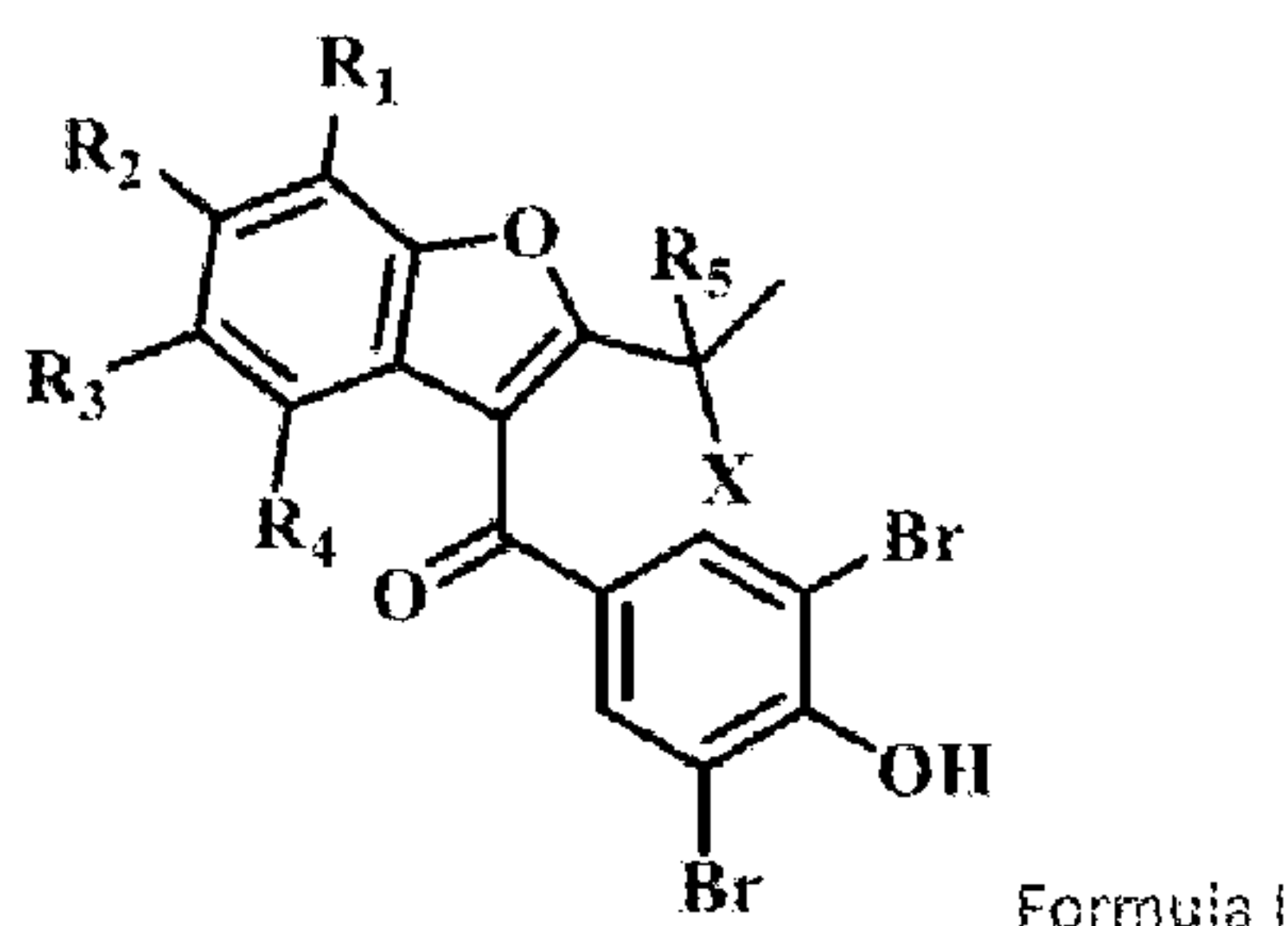


[0050] A dose of the composition according to the inventive subject matter may be selected appropriately depending on, among other things, one or more of the age, sex or weight of the person to be treated, the symptoms or severity of the condition, the route and frequency of administration, and the particular compound employed. Typically, the dose is normally from 0.01 to 500 mg/kg of body weight per day, more preferably from 0.1 to 100 mg, or from 0.1 to 50 mg/kg/day. In some contemplated embodiments, the composition is administered as a single dose. In some contemplated embodiments, the composition is administered in multiple doses. The administration of the suitable dose can be spread out over the course of a day, and can be administered, for example, 1-10 times per day, 1-5 times per day, 1-4 times per day, or 2-4 times per day. Viewed from another perspective, the dose of the composition administered to a person to be treated can be between 10-250 mg/day, between 10-100 mg/day, between 20-75 mg/day, 50-250 mg/day, 100-200 mg/day or any other suitable amount.

[0051] With respect to a dosage unit, it is generally contemplated that compounds are administered at a dosage effective to achieve a desired therapeutic effect or at a dosage effective to provide visualization *in vitro* or *in vivo*.

[0052] Depending on the particular use and structure, it is contemplated that the compounds according to the inventive subject matter are present in the composition in an amount between 1 microgram to 1000 milligram, more typically between 10 microgram to 500 milligram, and most typically between 10 mg to 250 mg per single dosage unit. Thus, concentrations of contemplated compounds *in vivo* or *in vitro* may be between 0.1 nM and 100 microM, more typically between 1 nM and 50 microM, and most typically between 10 nM and 10 microM.

[0053] The inventive subject matter also provides compounds, compositions and methods for treating a condition associated with hyperuricemia, diabetes or gout. Contemplated methods can include administering an effective amount of a composition comprising a pharmaceutically acceptable carrier and a compound of Formula 1, or a pharmaceutically acceptable salt thereof:



**[0054]** In such a compound  $-X$  can be  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$ , or  $-I$ , where  $-R$  can be  $-H$ ,  $-C_1-C_{10}$  alkyl, or a  $-C_1-C_{10}$  substituted alkyl; where  $-R_2$  is  $-deuterium$  or  $-H$ ; and where  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6$  alkyl,  $C_6-C_{14}$ -aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$  alkoxy,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6$  alkylsulfonyl,  $-trifluoromethyl$ ,  $-C_1-C_6$ -alkanoyloxy,  $-C_1-C_6$ -alkylthio,  $-C_1-C_6$  alkylsulfonyl,  $-C_2-C_6$ -alkoxycarbonyl,  $-C_2-C_6$ -alkanoylamino,  $-O-R_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NHCO_2R_6$ , and  $-NHCO_2R_6$ , where  $-R_6$  is phenyl or naphthyl, and optionally substituted with one to three groups selected from  $-C_1-C_6$ -alkyl,  $-C_6-C_{10}$ -aryl,  $-C_1-C_6$ -alkoxy and halogen, and  $-C_4-C_{20}$ -hydroxyheteroaryl, and where the heteroatoms in  $-C_4-C_{20}$ -hydroxyheteroaryl are nitrogen or oxygen.

**[0055]** In some contemplated embodiments,  $-X$  is a halogen or  $-OH$ . For example, some contemplated compounds include  $-deuterium$  or  $-H$  at  $-R_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$  or  $-OH$  at  $-X$ ,  $-H$  at each of  $-R_1$ ,  $-R_3$ , and  $-R_4$ , and  $-R_5$ . In some contemplated compounds,  $-X$  is  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$  or  $-OH$ , each of  $-R_2$  and  $-R_4$  is  $-deuterium$  or  $-H$ , and each of  $-R_1$ ,  $-R_3$ , and  $-R_5$  is a  $-H$ . In some other contemplated compounds,  $-X$  is  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$  or  $-OH$ , each of  $-R_2$  and  $-R_3$  is  $-deuterium$  or  $-H$ , and each of  $-R_1$ ,  $-R_4$ , and  $-R_5$  is a  $-H$ . In yet other contemplated embodiments,  $-X$  is  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$  or  $-OH$ , each of  $-R_1$ ,  $-R_2$ ,  $-R_3$  and  $-R_4$ , is  $-deuterium$  or  $-H$ , and  $-R_5$  is a  $-H$ . In some contemplated compounds, for example, wherein  $-X$  is  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$  or  $-OH$ , each of  $-R_1$ ,  $-R_2$ ,  $-R_3$  and  $-R_4$  is  $-deuterium$  or  $-H$ , and  $-R_5$  is a  $-H$ .

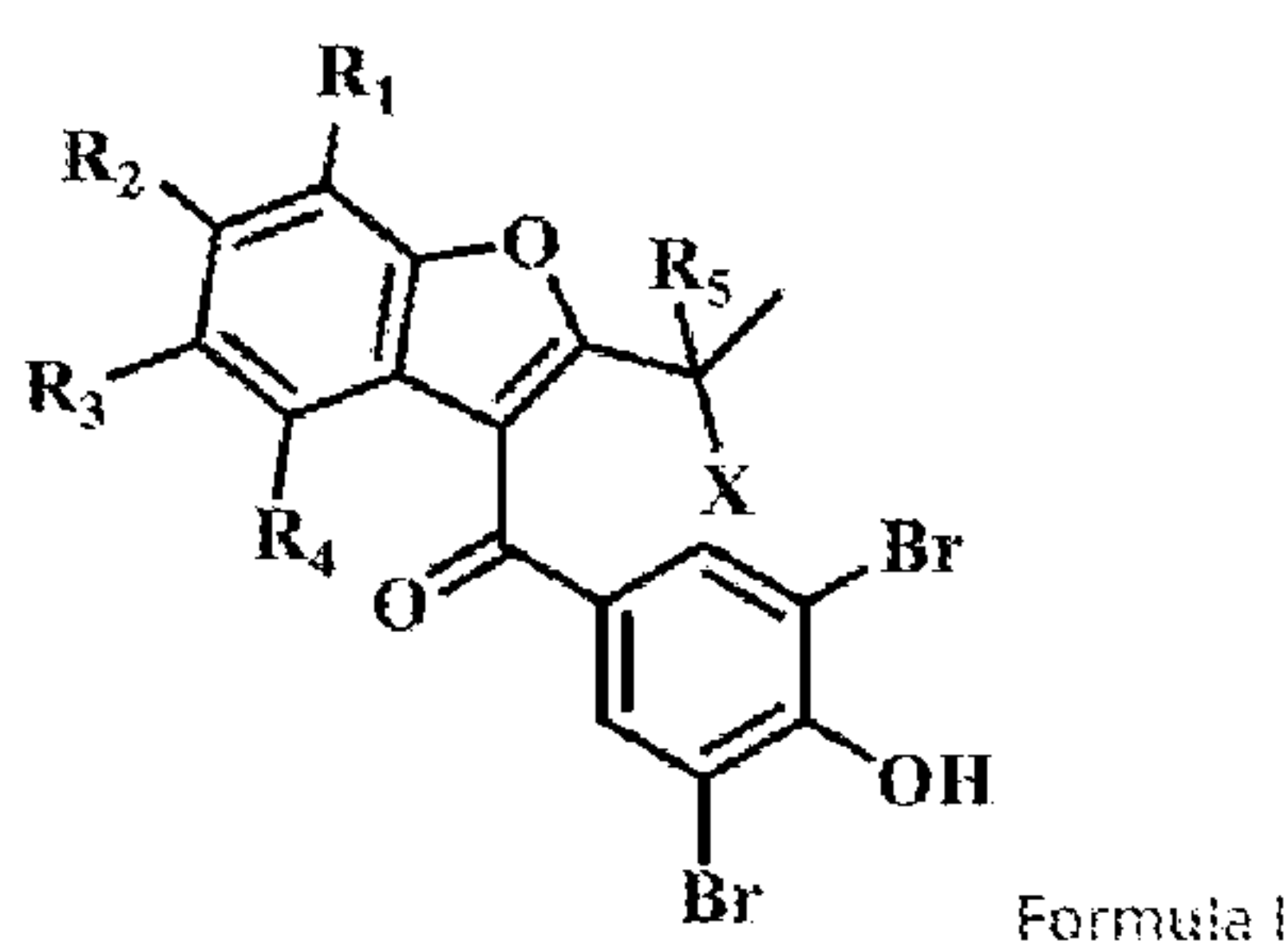
**[0056]** In some contemplated embodiments,  $-X$  is a halogen or  $-OH$ . For example, some contemplated compounds include  $-deuterium$  at  $-R_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$  or  $-OH$  at  $-X$ ,  $-H$  at each of  $-R_1$ ,  $-R_3$ , and  $-R_4$ , and  $-R_5$ . In some contemplated compounds,  $-X$  is  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$  or  $-OH$ ,



each of  $-R_2$  and  $-R_4$  is  $-deuterium$ , and each of  $-R_1$ ,  $-R_3$ , and  $-R_5$  is a  $-H$ . In some other contemplated compounds,  $-X$  is  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$  or  $-OH$ , each of  $-R_2$  and  $-R_3$  is  $-deuterium$ , and each of  $-R_1$ ,  $-R_4$ , and  $-R_5$  is a  $-H$ . In yet other contemplated embodiments,  $-X$  is  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$  or  $-OH$ , each of  $-R_1$ ,  $-R_2$ ,  $-R_3$  and  $-R_4$ , is  $-deuterium$ , and  $-R_5$  is a  $-H$ . In some contemplated compounds, for example, wherein  $-X$  is  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$  or  $-OH$ , each of  $-R_1$ ,  $-R_2$ ,  $-R_3$  and  $-R_4$  is  $-deuterium$ , and  $-R_5$  is a  $-H$ . In some contemplated compounds,  $-X$  is  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$  or  $-OH$ ,  $-R_3$  is  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$  or  $-OH$ , and  $-R_1$ ,  $-R_2$ ,  $-R_4$  and  $-R_5$  are  $-H$ .

**[0057]** In some contemplated embodiments, both the  $-X$  and  $-R_5$  are halogenated. For example, in some contemplated compounds, each of  $-X$  and  $-R_5$  is selected from  $-F$ ,  $-Cl$ ,  $-Br$  or  $-I$ ,  $-R_2$  is  $-deuterium$ , and each of  $-R_1$ ,  $-R_3$  and  $-R_4$ , is a  $-H$ . In some other contemplated embodiments, each of  $-X$  and  $-R_5$  is each selected from  $-F$ ,  $-Cl$ ,  $-Br$  or  $-I$ , and each of  $-R_1$ ,  $-R_2$ ,  $-R_3$  and  $-R_4$  is  $-deuterium$ .

**[0058]** The inventive subject matter also provides compounds, compositions and methods for treating a condition associated with hyperuricemia or gout including combination treatments with, for example, one or more xanthine oxidase inhibitors such as allopurinol, oxypurinol, febuxostat, topiroxostat, inositols and a compound of Formula 1. Contemplated compounds, compositions and methods can include administering an effective amount of a composition comprising a xanthine oxidase inhibitor, and a pharmaceutically acceptable carrier and a compound of Formula 1, or a pharmaceutically acceptable salt thereof:



**[0059]** In such a compound  $-X$  can be  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$ , or  $-I$ , where  $-R$  can be  $-H$ ,  $-C_1-C_{10}$  alkyl, or a  $-C_1-C_{10}$  substituted alkyl; where  $-R_2$  is  $-deuterium$  or  $-H$ ; and where  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6-$

alkyl, C<sub>6</sub>-C<sub>14</sub>-aryl, substituted -C<sub>6</sub>-C<sub>14</sub>-aryl, C<sub>1</sub>-C<sub>14</sub> alkoxy, -hydroxyl, -carboxyl, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -O-R<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub>, and -NHCO<sub>2</sub>R<sub>6</sub>, where -R<sub>6</sub> is phenyl or naphthyl, and optionally substituted with one to three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and where the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are nitrogen or oxygen.

**[0060]** In some contemplated embodiments, -X is a halogen or -OH. For example, some contemplated compounds include -deuterium or -H at -R<sub>2</sub>, -F, -Cl, -Br, -I or -OH at -X, -H at each of -R<sub>1</sub>, -R<sub>3</sub>, and -R<sub>4</sub>, and -R<sub>5</sub>. In some contemplated compounds, -X is -F, -Cl, -Br, -I or -OH, each of -R<sub>2</sub> and -R<sub>4</sub> is -deuterium or -H, and each of -R<sub>1</sub>, -R<sub>3</sub>, and -R<sub>5</sub> is a -H. In some other contemplated compounds, -X is -F, -Cl, -Br, -I or -OH, each of -R<sub>2</sub> and -R<sub>3</sub> is -deuterium or -H, and each of -R<sub>1</sub>, -R<sub>4</sub>, and -R<sub>5</sub> is a -H. In yet other contemplated embodiments, -X is -F, -Cl, -Br, -I or -OH, each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub> and -R<sub>4</sub>, is -deuterium or -H, and -R<sub>5</sub> is a -H. In some contemplated compounds, for example, wherein -X is -F, -Cl, -Br, -I or -OH, each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub> and -R<sub>4</sub> is -deuterium or -H, and -R<sub>5</sub> is a -H.

**[0061]** In some contemplated embodiments, -X is a halogen or -OH. For example, some contemplated compounds include -deuterium at -R<sub>2</sub>, -F, -Cl, -Br, -I or -OH at -X, -H at each of -R<sub>1</sub>, -R<sub>3</sub>, and -R<sub>4</sub>, and -R<sub>5</sub>. In some contemplated compounds, -X is -F, -Cl, -Br, -I or -OH, each of -R<sub>2</sub> and -R<sub>4</sub> is -deuterium, and each of -R<sub>1</sub>, -R<sub>3</sub>, and -R<sub>5</sub> is a -H. In some other contemplated compounds, -X is -F, -Cl, -Br, -I or -OH, each of -R<sub>2</sub> and -R<sub>3</sub> is -deuterium, and each of -R<sub>1</sub>, -R<sub>4</sub>, and -R<sub>5</sub> is a -H. In yet other contemplated embodiments, -X is -F, -Cl, -Br, -I or -OH, each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub> and -R<sub>4</sub>, is -deuterium, and -R<sub>5</sub> is a -H. In some contemplated compounds, for example, wherein -X is -F, -Cl, -Br, -I or -OH, each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub> and -R<sub>4</sub> is -deuterium, and -R<sub>5</sub> is a -H. In some contemplated compounds, -X is -F, -Cl, -Br, -I or -OH, -R<sub>3</sub> is -F, -Cl, -Br, -I or -OH, and -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>4</sub> and -R<sub>5</sub> are -H.

**[0062]** In some contemplated embodiments, both the -X and -R<sub>5</sub> are halogenated. For example, in some contemplated compounds, each of -X and -R<sub>5</sub> is selected from -F, -Cl, -Br or -I, -R<sub>2</sub> is -deuterium, and each of -R<sub>1</sub>, -R<sub>3</sub> and -R<sub>4</sub>, is a -H. In some other contemplated embodiments,



each of  $-X$  and  $-R_5$  is each selected from  $-F$ ,  $-Cl$ ,  $-Br$  or  $-I$ , and each of  $-R_1$ ,  $-R_2$ ,  $-R_3$  and  $-R_4$  is  $-deuterium$ .

**[0063]** In some contemplated embodiments, the condition to be treated is at least one of gout, hypertension and diabetes.

**[0064]** The term "pharmaceutically acceptable salt" of a compound recited herein is an acid or base salt that is suitable for use in contact with the tissues of human beings or animals without excessive toxicity or carcinogenicity, and preferably without irritation, allergic response, or other problem or complication. Such salts include mineral and organic acid salts of basic residues such as amines, as well as alkali or organic salts of acidic residues such as carboxylic acids. Specific pharmaceutical salts include, but are not limited to, salts of acids such as hydrochloric, phosphoric, hydrobromic, malic, glycolic, fumaric, sulfuric, sulfamic, sulfanilic, formic, toluenesulfonic, methanesulfonic, benzene sulfonic, ethane disulfonic, 2- hydroxyethylsulfonic, nitric, benzoic, 2-acetoxybenzoic, citric, tartaric, lactic, stearic, salicylic, glutamic, ascorbic, pamoic, succinic, fumaric, maleic, propionic, hydroxymaleic, hydroiodic, phenylacetic, alkanolic such as acetic,  $HOOC-(CH_2)_n-COOH$  where  $n$  is 0-4, and the like.

**[0065]** Similarly, pharmaceutically acceptable cations include, but are not limited to sodium, potassium, calcium, aluminum, lithium and ammonium. Those of ordinary skill in the art will recognize further pharmaceutically acceptable salts for the compounds provided herein. In general, a pharmaceutically acceptable acid or base salt can be synthesized from a parent compound that contains a basic or acidic moiety by any conventional chemical method. Briefly, such salts can be prepared by reacting the free acid or base forms of these compounds with a stoichiometric amount of the appropriate base or acid in water or in an organic solvent, or in a mixture of the two; generally, the use of nonaqueous media, such as ether, ethyl acetate, ethanol, isopropanol or acetonitrile, is preferred. Lists of suitable salts are found in at page 1418 of Remington's Pharmaceutical Sciences, 17th ed., Mack Publishing Company, Easton, Pa., 1985.

**[0066]** The term "solvate" refers to the compound formed by the interaction of a solvent and a compound. Suitable solvates are pharmaceutically acceptable solvates, such as hydrates, including monohydrates and hemi-hydrates.

[0067] The present invention provides compounds, as well as compositions of matter that are formulations of one or more active drugs and a pharmaceutically-acceptable carrier. In this regard, the invention provides a composition for administration to a mammalian subject, which may include one or more of the compounds presented herein, or its pharmaceutically acceptable salts, solvates, esters, chelates or pro-drugs thereof.

[0068] Pharmaceutically acceptable salts of the compounds of this invention include those derived from pharmaceutically acceptable inorganic and organic acids and bases. Examples of suitable acid salts include acetate, adipate, alginate, aspartate, benzoate, benzenesulfonate, bisulfate, butyrate, citrate, camphorate, camphorsulfonate, cyclopentanepropionate, digluconate, dodecylsulfate, ethanesulfonate, formate, fumarate, glucoheptanoate, glycerophosphate, glycolate, hemisulfate, heptanoate, hexanoate, hydrochloride, hydrobromide, hydroiodide, 2-hydroxyethanesulfonate, lactate, maleate, malonate, methanesulfonate, 2-naphthalenesulfonate, nicotinate, nitrate, oxalate, palmoate, pectinate, persulfate, 3-phenylpropionate, phosphate, picrate, pivalate, propionate, salicylate, succinate, sulfate, tartrate, thiocyanate, tosylate and undecanoate. Other acids, such as oxalic, while not in themselves pharmaceutically acceptable, may be employed in the preparation of salts useful as intermediates in obtaining the compounds of the invention and their pharmaceutically acceptable acid addition salts.

[0069] The term "pharmaceutically acceptable" refers to the fact that the carrier, diluent or excipient must be compatible with the other ingredients of the formulation and not deleterious to the recipient thereof.

[0070] The terms "administration of a compound" or "administering a compound" or "administering a composition" refer to the act of providing a compound of the invention or pharmaceutical composition to the subject in need of treatment. Where two or more compounds are administered, co-administration is typically preferred with the co-administration being either via a combination formulation, or via parallel or subsequent administration of the two compounds. Most typically sequential co-administration will be performed such that the first compound is present in the patient's body in measurable quantities when the second compound is administered.



[0071] Salts derived from appropriate bases include alkali metal (*e.g.*, sodium and potassium), alkaline earth metal (*e.g.*, magnesium, calcium), ammonium and  $N^+(C1-4 \text{ alkyl})_4$  salts. This invention also envisions the quaternization of any basic nitrogen-containing groups of the compounds disclosed herein. Water or oil-soluble or dispersible products may be obtained by such quaternization.

[0072] Any asymmetric atom of the compounds of the inventive subject matter can be present in racemic or enantiomerically enriched, for example the (*R*) or (*S*) configuration. Accordingly, as used herein a compound of the inventive subject matter can be in the form of one of the possible isomers, rotamers, or mixtures thereof, as substantially pure optical isomers, racemates or mixtures thereof. In some embodiments a formulation of the inventive concept can include a racemic mixture of enantiomers of one or more compounds of the inventive concept. In other embodiments a formulation of the inventive concept can include a majority (*i.e.* greater than about 50%) of a selected enantiomer of a compound of the inventive concept. In still other embodiments a formulation of the inventive concept can include only a single enantiomer of a compound of the inventive concept. Such enantiomer-enriched or single enantiomer formulations can provide effective treatment of conditions described herein, in some instances at reduced dosages and/or with fewer side effects relative to treatment with a formulation that includes a racemic mixture.

[0073] As used herein, the term "halo" or "halogen" refers to fluorine, chlorine, bromine or iodine.

[0074] The term "alkyl" herein alone or as part of another group refers to a monovalent alkane (hydrocarbon) derived radical containing from 1 to 12 carbon atoms unless otherwise defined. Alkyl groups may be substituted at any available point of attachment. An alkyl group substituted with another alkyl group is also referred to as a "branched alkyl group". Exemplary alkyl groups include methyl, ethyl, propyl, isopropyl, n-butyl, t-butyl, isobutyl, pentyl, hexyl, isohexyl, heptyl, dimethylpentyl, octyl, 2,2,4-trimethylpentyl, nonyl, decyl, undecyl, dodecyl, and the like.

[0075] Exemplary substituents for radicals designated as "optionally substituted" include one or more of the following groups: alkyl, aryl, halo (such as F, Cl, Br, I), haloalkyl (such as  $CCl_3$  or  $CF_3$ ), alkoxy, alkylthio, hydroxy, carboxy ( $-COOH$ ), alkyloxycarbonyl ( $-C(O)R$ ),

alkylcarbonyloxy (- OCOR), amino (-NH<sub>2</sub>), carbamoyl (-NHCOOR- or -OCONHR-), urea (-NHCONHR-) or thiol (-SH). In some embodiments of the present invention, alkyl groups are substituted with, for example, amino, or heterocycloalkyl, such as morpholine, piperazine, piperidine, azetidine, hydroxyl, methoxy, or a heteroaryl group, such as pyrrolidine.

**[0076]** The term "cycloalkyl" herein alone or as part of another group refers to fully saturated and partially unsaturated hydrocarbon rings of 3 to 9, preferably 3 to 7 carbon atoms. The examples include cyclopropyl, cyclobutyl, cyclopentyl and cyclohexyl, and like. Further, a cycloalkyl may be substituted. For example, a substituted cycloalkyl refers to such rings having one, two, or three substituents, selected from the group consisting of halo, alkyl, substituted alkyl, alkenyl, alkynyl, nitro, cyano, oxo (=O), hydroxy, alkoxy, thioalkyl, -CO<sub>2</sub>H, -C(=O)H, CO<sub>2</sub>-alkyl, -C(=O)alkyl, keto, =N-OH, =N-O-alkyl, aryl, heteroaryl, heterocyclo, -NR'R", -C(=O)NR'R", -CO<sub>2</sub>NR'R", -C(=O)NR'R", -NR'CO<sub>2</sub>R", -NR'C(=O)R", -SO<sub>2</sub>NR'R", and -NR'SO<sub>2</sub>R", wherein each of R' and R" are independently selected from hydrogen, alkyl, substituted alkyl, and cycloalkyl, or R' and R" together form a heterocyclo or heteroaryl ring.

**[0077]** The term 'alkenyl" herein alone or as part of another group refers to a hydrocarbon radical straight, branched or cyclic containing from 2 to 12 carbon atoms and at least one carbon to carbon double bond. Examples of such groups include the vinyl, allyl, 1-propenyl, isopropenyl, 2-methyl-1-propenyl, 1-butenyl, 2-butenyl, 3-butenyl, 1-pentenyl, 2-pentenyl, 3-pentenyl, 4-pentenyl, 1-hexenyl, 2-hexenyl, 3-hexenyl, 4-hexenyl, 5-hexenyl, 1-heptenyl, and like. Alkenyl groups may also be substituted at any available point of attachment. Exemplary substituents for alkenyl groups include those listed above for alkyl groups, and especially include C3 to C7 cycloalkyl groups such as cyclopropyl, cyclopentyl and cyclohexyl, which may be further substituted with, for example, amino, oxo, hydroxyl, etc.

**[0078]** The term "alkynyl" refers to straight or branched chain alkyne groups, which have one or more unsaturated carbon-carbon bonds, at least one of which is a triple bond. Alkynyl groups include C2-C8 alkynyl, C2-C6 alkynyl and C2-C4 alkynyl groups, which have from 2 to 8, 2 to 6 or 2 to 4 carbon atoms, respectively. Illustrative of the alkynyl group include ethenyl, propenyl, isopropenyl, butenyl, isobutenyl, pentenyl, and hexenyl. Alkynyl groups may also be substituted at any available point of attachment. Exemplary substituents for alkynyl groups include those



listed above for alkyl groups such as amino, alkylamino, etc. The numbers in the subscript after the symbol "C" define the number of carbon atoms a particular group can contain.

**[0079]** The term "alkoxy" alone or as part of another group denotes an alkyl group as described above bonded through an oxygen linkage (-O-). Preferred alkoxy groups have from 1 to 8 carbon atoms. Examples of such groups include the methoxy, ethoxy, n-propoxy, isopropoxy, n-butoxy, isobutoxy, sec-butoxy, tert-butoxy, n-pentyloxy, isopentyloxy, n-hexyloxy, cyclohexyloxy, n-heptyloxy, n-octyloxy and 2-ethylhexyloxy.

**[0080]** The term "alkylthio" refers to an alkyl group as described above attached via a sulfur bridge. Preferred alkoxy and alkylthio groups are those in which an alkyl group is attached via the heteroatom bridge. Preferred alkylthio groups have from 1 to 8 carbon atoms. Examples of such groups include the methylthio, ethylthio, n-propylthiol, n-butylthiol, and like.

**[0081]** The term "oxo," as used herein, refers to a keto (C=O) group. An oxo group that is a substituent of a nonaromatic carbon atom results in a conversion of -CH<sub>2</sub>- to -C(=O)-.

**[0082]** The term "alkoxycarbonyl" herein alone or as part of another group denotes an alkoxy group bonded through a carbonyl group. An alkoxy carbonyl radical is represented by the formula: -C(O)OR, where the R group is a straight or branched C1-C6 alkyl group, cycloalkyl, aryl, or heteroaryl.

**[0083]** The term "alkylcarbonyl" herein alone or as part of another group denotes an alkyl group bonded through a carbonyl group. An alkyl carbonyl radical is represented by the formula: -C(O)R, where the R group is a straight or branched C1-C6 alkyl group, cycloalkyl, aryl, or heteroaryl.

**[0084]** The term "alkanoyloxy" herein alone or as part of another group denotes an RCOO-group bonded through a single bond. An alkanoyloxy radical is represented by the formula RCOO-, where the R group is a straight or branched C1-C6 alkyl group, cycloalkyl, aryl, or heteroaryl.

**[0085]** The term "alkanoylamino" herein alone or as part of another group denotes an RCONH-group bonded through a single bond. An alkanoylamino radical is represented by the formula

RCONH-, where the R group is a straight or branched C1-C6 alkyl group, cycloalkyl, aryl, or heteroaryl.

**[0086]** The term "arylalkyl" herein alone or as part of another group denotes an aromatic ring bonded through an alkyl group (such as benzyl) as described above.

**[0087]** The term "aryl" herein alone or as part of another group refers to monocyclic or bicyclic aromatic rings, e.g. phenyl, substituted phenyl and the like, as well as groups which are fused, e.g., naphthyl, phenanthrenyl and the like. An aryl group thus contains at least one ring having at least 6 atoms, with up to five such rings being present, containing up to 20 atoms therein, with alternating (resonating) double bonds between adjacent carbon atoms or suitable heteroatoms. Aryl groups may optionally be substituted with one or more groups including, but not limited to halogen such as I, Br, F, or Cl; alkyl, such as methyl, ethyl, propyl, alkoxy, such as methoxy or ethoxy, hydroxy, carboxy, carbamoyl, alkyloxycarbonyl, nitro, alkenyloxy, trifluoromethyl, amino, cycloalkyl, aryl, heteroaryl, cyano, alkyl S(O)<sub>m</sub> (m=0, 1, 2), or thiol.

**[0088]** The term "aromatic" refers to a cyclically conjugated molecular entity with a stability, due to delocalization, significantly greater than that of a hypothetical localized structure, such as the Kekule structure.

**[0089]** The term "amino" herein alone or as part of another group refers to -NH<sub>2</sub>. An "amino" may optionally be substituted with one or two substituents, which may be the same or different, such as alkyl, aryl, arylalkyl, alkenyl, alkynyl, heteroaryl, heteroarylalkyl, cycloheteroalkyl, cycloheteroalkylalkyl, cycloalkyl, cycloalkylalkyl, haloalkyl, hydroxyalkyl, alkoxyalkyl, thioalkyl, carbonyl or carboxyl. These substituents may be further substituted with a carboxylic acid, any of the alkyl or aryl substituents set out herein. In some embodiments, the amino groups are substituted with carboxyl or carbonyl to form N-acyl or N-carbamoyl derivatives.

**[0090]** The term "alkylsulfonyl" refers to groups of the formula (SO<sub>2</sub>)-alkyl, in which the sulfur atom is the point of attachment. Preferably, alkylsulfonyl groups include C1-C6 alkylsulfonyl groups, which have from 1 to 6 carbon atoms. Methylsulfonyl is one representative alkylsulfonyl group.

**[0091]** The term "heteroatom" refers to any atom other than carbon, for example, N, O, or S.



**[0092]** The term "heteroaryl" herein alone or as part of another group refers to substituted and unsubstituted aromatic 5 or 6 membered monocyclic groups, 9 or 10 membered bicyclic groups, and 11 to 14 membered tricyclic groups which have at least one heteroatom (O, S or N) in at least one of the rings. Each ring of the heteroaryl group containing a heteroatom can contain one or two oxygen or sulfur atoms or from one to four nitrogen atoms provided that the total number of heteroatoms in each ring is four or less and each ring has at least one carbon atom.

**[0093]** The term "heterocyclic" or "heterocycloalkyl" herein alone or as part of another group refers to a cycloalkyl group (nonaromatic) in which one of the carbon atoms in the ring is replaced by a heteroatom selected from O, S or N. The "heterocycle" has from 1 to 3 fused, pendant or spiro rings, at least one of which is a heterocyclic ring (i.e., one or more ring atoms is a heteroatom, with the remaining ring atoms being carbon). The heterocyclic ring may be optionally substituted which means that the heterocyclic ring may be substituted at one or more substitutable ring positions by one or more groups independently selected from alkyl (preferably lower alkyl), heterocycloalkyl, heteroaryl, alkoxy (preferably lower alkoxy), nitro, monoalkylamino (preferably a lower alkylamino), dialkylamino (preferably a alkylamino), cyano, halo, haloalkyl (preferably trifluoromethyl), alkanoyl, aminocarbonyl, monoalkylaminocarbonyl, dialkylaminocarbonyl, alkyl amido (preferably lower alkyl amido), alkoxyalkyl (preferably a lower alkoxy; lower alkyl), alkoxy carbonyl (preferably a lower alkoxy carbonyl), alkylcarbonyloxy (preferably a lower alkylcarbonyloxy) and aryl (preferably phenyl), said aryl being optionally substituted by halo, lower alkyl and lower alkoxy groups. A heterocyclic group may generally be linked via any ring or substituent atom, provided that a stable compound results. N-linked heterocyclic groups are linked via a component nitrogen atom.

**[0094]** Typically, a heterocyclic ring comprises 1-4 heteroatoms; within certain embodiments each heterocyclic ring has 1 or 2 heteroatoms per ring. Each heterocyclic ring generally contains from 3 to 8 ring members (rings having from 7 to 8 ring members are recited in certain embodiments), and heterocycles comprising fused, pendant or spiro rings typically contain from 9 to 14 ring members which consists of carbon atoms and contains one, two, or three heteroatoms selected from nitrogen, oxygen or sulfur. Examples of "heterocyclic" or "heterocycloalkyl" groups include piperazine, piperidine, morpholine, thiomorpholine, pyrrolidine, imidazolidine and thiazolidine.

[0095] The term "substituent," as used herein, refers to a molecular moiety that is covalently bonded to an atom within a molecule of interest. For example, a "ring substituent" may be a moiety such as a halogen, alkyl group, haloalkyl group or other group discussed herein that is covalently bonded to an atom (preferably a carbon or nitrogen atom) that is a ring member.

[0096] The term "optionally substituted " as used herein means that the aryl, heterocyclyl, or other group may be substituted at one or more substitutable positions by one or more groups independently selected from alkyl (preferably lower alkyl), alkoxy (preferably lower alkoxy), nitro, monoalkylamino (preferably with one to six carbons), dialkylamino (preferably with one to six carbons), cyano, halo, haloalkyl (preferably trifluoromethyl), alkanoyl, aminocarbonyl, monoalkylaminocarbonyl, dialkylaminocarbonyl, alkyl amido (preferably lower alkyl amido), alkoxyalkyl (preferably a lower alkoxy and lower alkyl), alkoxy carbonyl (preferably a lower alkoxy carbonyl), alkylcarbonyloxy (preferably a lower alkylcarbonyloxy) and aryl (preferably phenyl), said aryl being optionally substituted by halo, lower alkyl and lower alkoxy groups. Optional substitution is also indicated by the phrase "substituted with from 0 to X substituents," where X is the maximum number of possible substituents. Certain optionally substituted groups are substituted with from 0 to 2, 3 or 4 independently selected substituents.

[0097] A dash ("-") that is not between two letters or symbols is used to indicate a point of the attachment for a substituent. For example, -CONH<sub>2</sub> is attached through the carbon atom. A dashed circle that locates inside of a heterocycle ring is used to indicate a conjugated system. The bonds between two atoms may be single bond or double bond.

[0098] The term "protected" refers that the group is in modified form to preclude undesired side reactions at the protected site. Suitable protecting groups for the compounds of the present invention will be recognized from the present application taking into account the level of skill in the art, and with reference to standard textbooks, such as Greene, T. W. et al., Protective Groups in Organic Synthesis, John Wiley & Sons, New York (1999).

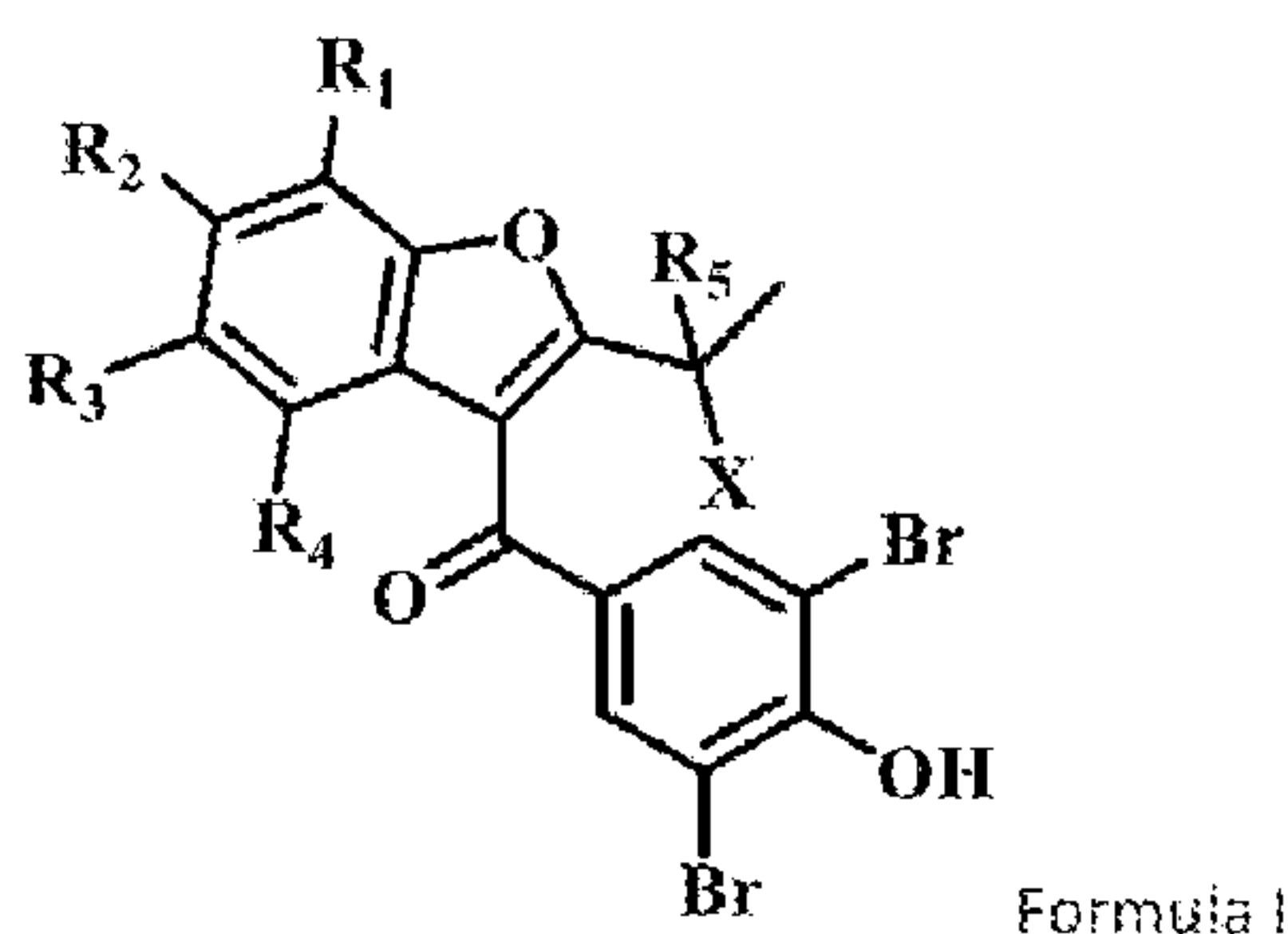
[0099] Depending on the particular purpose, it should also be recognized that contemplated compounds may be combined (*in vivo*, or in a pharmaceutical formulation or administration regimen) with at least one other pharmaceutically active agent to additively or synergistically provide a therapeutic or prophylactic effect. Concentrations of second pharmaceutically active



ingredients are typically at or preferably below those recommended for stand-alone administration, however, higher concentrations are also deemed suitable for use herein.

**[00100]** Therefore, contemplated pharmaceutical compositions will especially include those in which contemplated compounds (and optionally further pharmaceutically active ingredients) are provided with a suitable carrier, wherein contemplated compounds are preferably present at a concentration effective to treat or prevent a condition or disease associated with hyperuricemia.

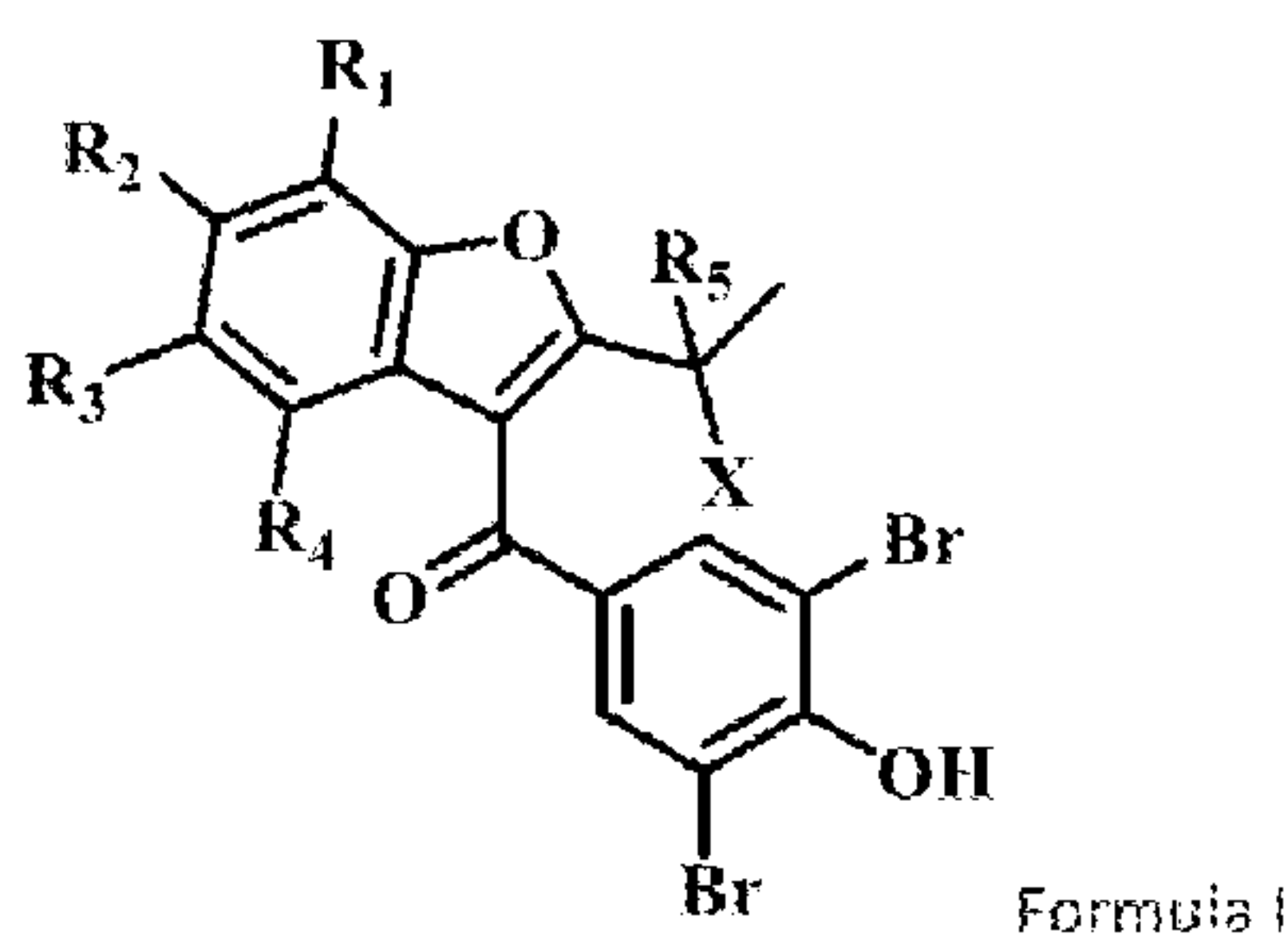
**[00101]** The inventive subject matter also provides compounds, compositions and methods for manufacturing a pharmaceutical composition for treating a condition associated with hyperuricemia or gout. Contemplated methods can include formulating a oral formulation that contains a pharmaceutically acceptable carrier and a compound of Formula 1 or a pharmaceutically acceptable salt thereof:



**[00102]** In such a compound or composition  $-X$  can be  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$ , or  $-I$ , where  $-R$  can be  $-H$ ,  $-C_1-C_{10}$  alkyl, or a  $-C_1-C_{10}$  substituted alkyl; where  $-R_2$  can be  $-deuterium$  or  $-H$ ; and where  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6$ -alkyl,  $C_6-C_{14}$ -aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$ -alkoxy,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6$ -alkylsulfonyl,  $-trifluoromethyl$ ,  $-C_1-C_6$ -alkanoyloxy,  $-C_1-C_6$ -alkylthio,  $-C_1-C_6$ -alkylsulfonyl,  $-C_2-C_6$ -alkoxycarbonyl,  $-C_2-C_6$ -alkanoylamino,  $-O-R_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NHSO_2R_6$ , and  $-NHCO_2R_6$ , where  $-R_6$  is phenyl or naphthyl, and can be optionally substituted with one to three groups selected from  $-C_1-C_6$ -alkyl,  $-C_6-C_{10}$ -aryl,  $-C_1-C_6$ -alkoxy and halogen, and  $-C_4-C_{20}$ -hydroxyheteroaryl, and where the heteroatoms in  $-C_4-C_{20}$ -hydroxyheteroaryl are nitrogen or oxygen.

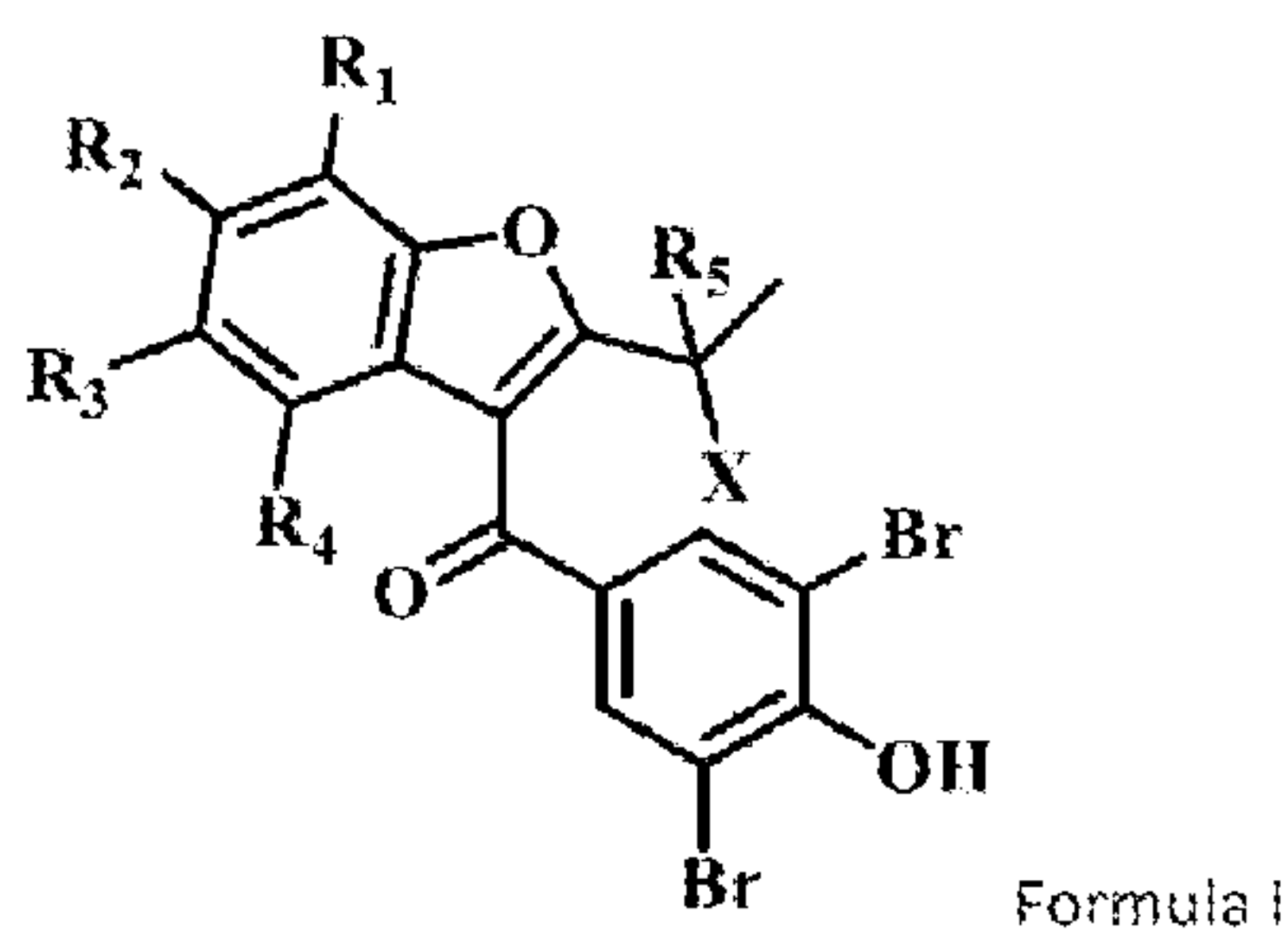


[00103] The inventive subject matter also provides compounds, compositions and methods for manufacturing a pharmaceutical composition for treating a condition associated with hyperuricemia or gout. Some contemplated methods can include the step of formulating a oral formulation that contains a pharmaceutically acceptable carrier and a compound of Formula 1 or a pharmaceutically acceptable salt thereof:



[00104] In such compounds or compositions  $-X$  can be  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$ , or  $-I$ , where  $-R$  can be  $-H$ ,  $-C_1-C_{10}$  alkyl or a  $-C_1-C_{10}$  substituted alkyl; where  $-R_2$  can be  $-deuterium$  or  $-H$ ; and where  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6$ -alkyl,  $C_6-C_{14}$ -aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$ -alkoxy,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6$ -alkylsulfonyl,  $-trifluoromethyl$ ,  $-C_1-C_6$ -alkanoyloxy,  $-C_1-C_6$ -alkylthio,  $-C_1-C_6$ -alkylsulfonyl,  $-C_2-C_6$ -alkoxycarbonyl,  $-C_2-C_6$ -alkanoylamino,  $-O-R_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NHSO_2R_6$ , and  $-NHCO_2R_6$ , where  $-R_6$  can be phenyl or naphthyl, and can be optionally substituted with one to three groups selected from  $-C_1-C_6$ -alkyl,  $-C_6-C_{10}$ -aryl,  $-C_1-C_6$ -alkoxy and halogen, and  $-C_4-C_{20}$ -hydroxyheteroaryl, and wherein the heteroatoms in  $-C_4-C_{20}$ -hydroxyheteroaryl are selected from  $t$  nitrogen or oxygen; and where the compound of Formula 1 is present in a therapeutically effective amount to treat a condition associated with hyperuricemia.

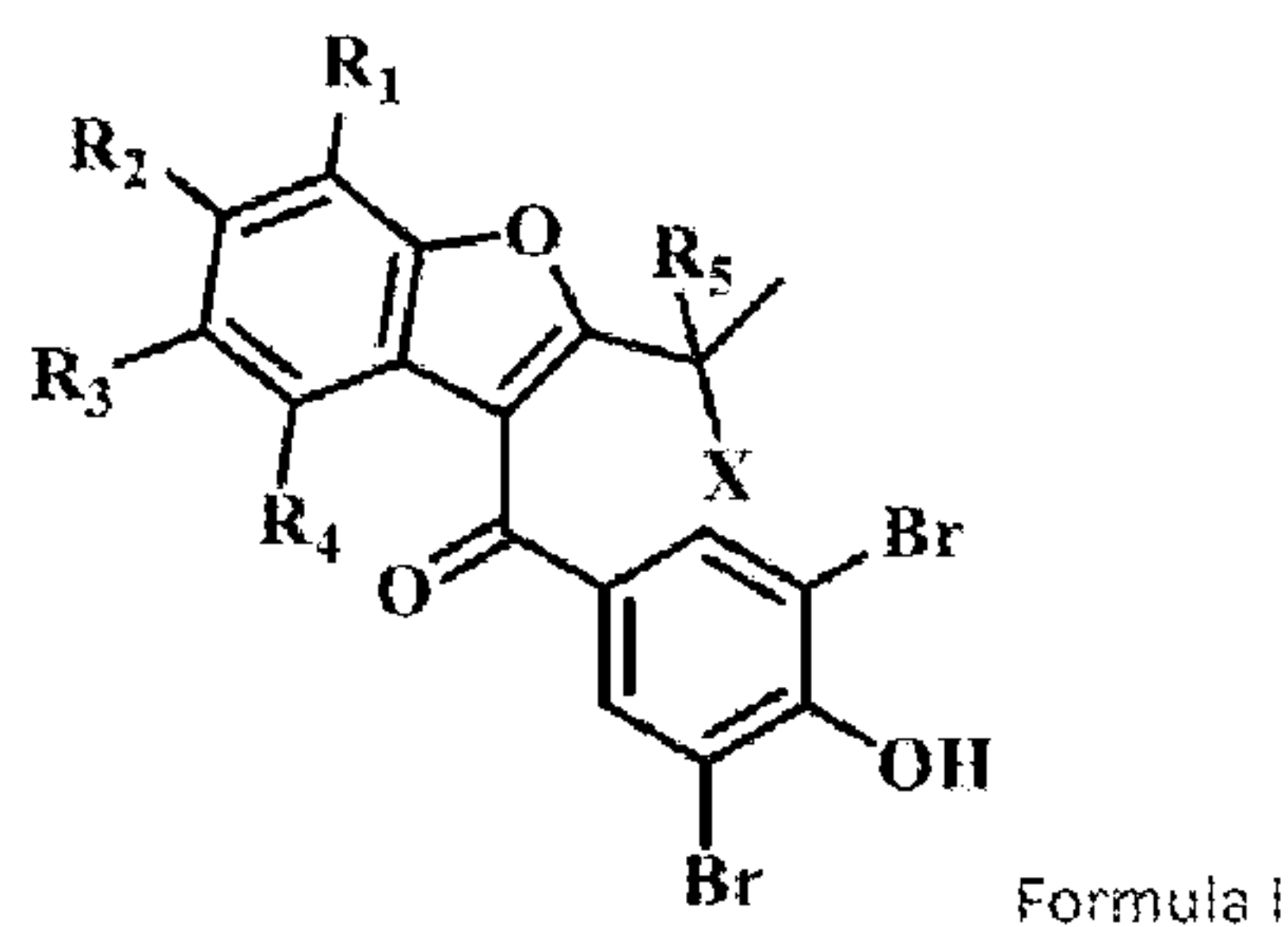
[00105] Still further, the inventive subject matter also provides compounds, compositions and methods for inhibiting at least one kidney transporter responsible for uric acid reabsorption in renal tubules. Contemplated methods can include the step of administering a therapeutically effective amount of a compound of Formula 1, or a pharmaceutically acceptable salt thereof:



[00106] Wherein  $-X$  is  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$  or  $-I$ , wherein  $-R$  is a  $-H$ ,  $-C_1-C_{10}$  alkyl or a  $-C_1-C_{10}$  substituted alkyl; wherein  $-R_2$  is  $-deuterium$  or  $-H$ ; and wherein  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from a group consisting of  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6$ -alkyl,  $C_6-C_{14}$ -aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$ -alkoxy,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6$ -alkylsulfonyl,  $-trifluoromethyl$ ,  $-C_1-C_6$ -alkanoyloxy,  $-C_1-C_6$ -alkylthio,  $-C_1-C_6$ -alkylsulfonyl,  $-C_2-C_6$ -alkoxycarbonyl,  $-C_2-C_6$ -alkanoylamino,  $-O-R_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NH-SO_2R_6$  and  $-NHCO_2R_6$ , wherein  $-R_6$  is phenyl or naphthyl, optionally substituted with one or three groups selected from  $-C_1-C_6$ -alkyl,  $-C_6-C_{10}$ -aryl,  $-C_1-C_6$ -alkoxy and halogen, and  $-C_4-C_{20}$ -hydroxyheteroaryl, and wherein the heteroatoms in  $-C_4-C_{20}$ -hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen.

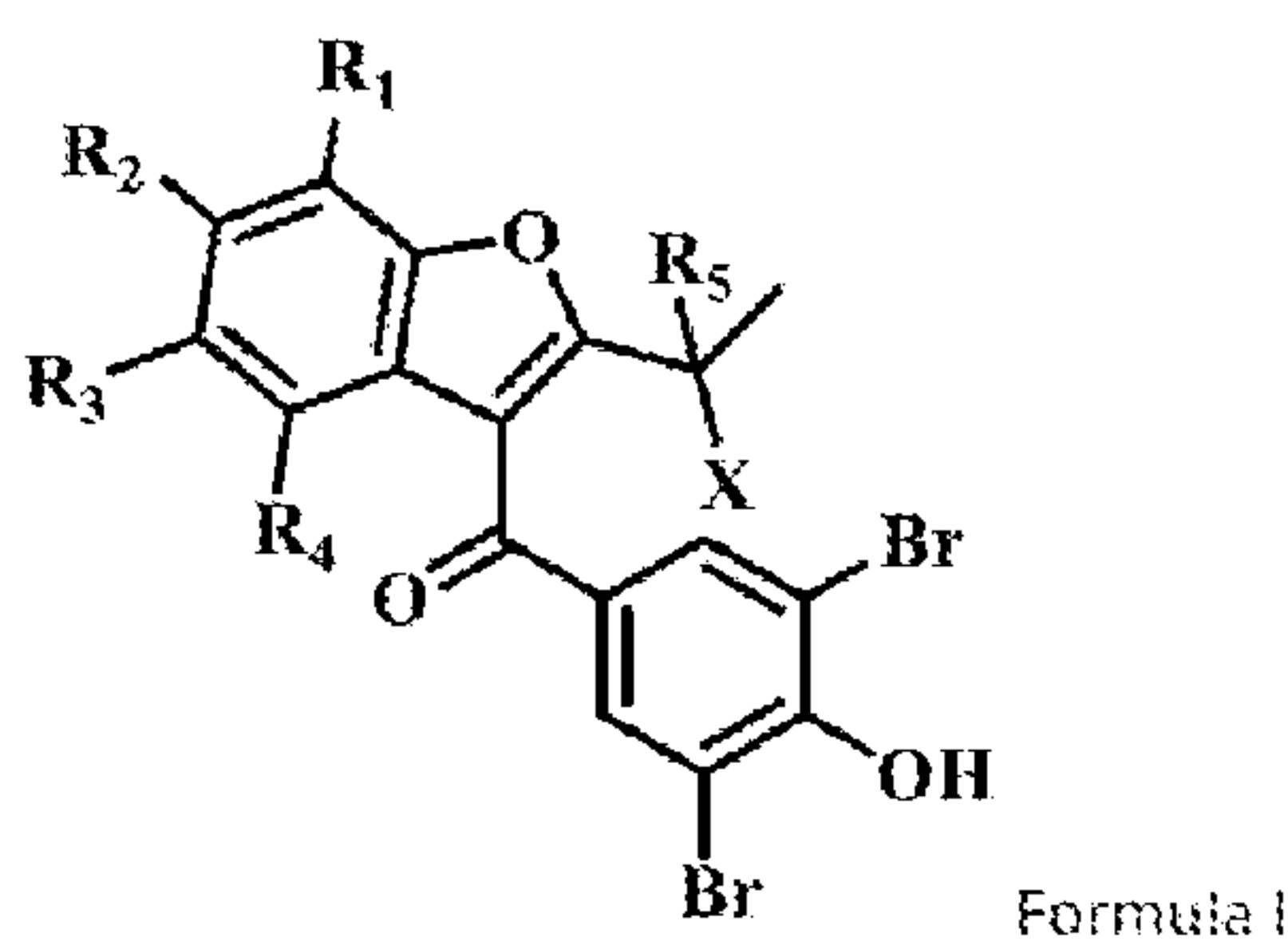
[00107] In some contemplated embodiments, mediating renal reabsorption of uric acid comprises modulating at least one of URAT1 activity, OAT4 activity, and SGLT2 activity. Similarly, Inventors contemplate that a combined formulation that incorporates a compound of the inventive concept and one or more compound(s) that modulate(s) URAT1 activity, one or more compound(s) that modulate(s) OAT4 activity, and/or one or more compound(s) that modulate(s) SGLT2 activity, and that such a combined formulation can have utility in treating conditions disclosed herein.

[00108] The inventive subject matter also provides compounds, compositions and methods for treating a condition, disorder or disease mediated by at least one kidney transporter responsible for uric acid reabsorption in renal tubules. Contemplated methods can include the step of administering an effective amount of a composition comprising a pharmaceutically acceptable carrier and a compound of formula 1 or a pharmaceutically acceptable salt thereof.



[00109] Wherein  $-X$  is  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$  or  $-I$ , wherein  $-R$  is a  $-H$ ,  $-C_1-C_{10}$  alkyl or a  $-C_1-C_{10}$  substituted alkyl; wherein  $-R_2$  is  $-deuterium$  or  $-H$ ; and wherein  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from a group consisting of  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6$ -alkyl,  $C_6-C_{14}$ -aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$ -alkoxy,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6$ -alkylsulfonyl,  $-trifluoromethyl$ ,  $-C_1-C_6$ -alkanoyloxy,  $-C_1-C_6$ -alkylthio,  $-C_1-C_6$ -alkylsulfonyl,  $-C_2-C_6$ -alkoxycarbonyl,  $-C_2-C_6$ -alkanoylamino,  $-O-R_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NH_2SO_2R_6$  and  $-NHCO_2R_6$ , wherein  $-R_6$  is phenyl or naphthyl, optionally substituted with one or three groups selected from  $-C_1-C_6$ -alkyl,  $-C_6-C_{10}$ -aryl,  $-C_1-C_6$ -alkoxy and halogen, and  $-C_4-C_{20}$ -hydroxyheteroaryl, and wherein the heteroatoms in  $-C_4-C_{20}$ -hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen.

[00110] The inventive subject matter also provides compounds of Formula 1, or a pharmaceutically acceptable salt thereof:



[00111] In such a compound  $-X$  can be  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$ , or  $-I$ , where  $-R$  can be  $-H$ ,  $-C_1-C_{10}$  alkyl or a  $-C_1-C_{10}$  substituted alkyl; where  $-R_2$  can be  $-deuterium$  or  $-H$ ; and where  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-$



C<sub>6</sub>-alkyl, C<sub>6</sub>-C<sub>14</sub>-aryl, substituted -C<sub>6</sub>-C<sub>14</sub>-aryl, C<sub>1</sub>-C<sub>14</sub> alkoxy, -hydroxyl, -carboxyl, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -O-R<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub>, and -NHCO<sub>2</sub>R<sub>6</sub>, where -R<sub>6</sub> can be phenyl or naphthyl, and can be optionally substituted with one to three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and where the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are nitrogen or oxygen.

**[00112]** The inventive subject matter also provides use of the compound set forth above in the manufacture of a drug. In some contemplated embodiments, the compound is present in an amount effective to treat a condition associated with hyperuricemia or gout. The compound set forth above can also be used to treat a condition associated with hyperuricemia. Alternatively or additionally, the compound set forth above can be used to modulate URAT1 activity in a person. Still further, it is also contemplated that the compound set forth above can be used to treat or prevent a disorder or disease mediated by URAT1 activity.

**[00113]** As used in the description herein and throughout the claims that follow, the meaning of “a,” “an,” and “the” includes plural reference unless the context clearly dictates otherwise. Also, as used in the description herein, the meaning of “in” includes “in” and “on” unless the context clearly dictates otherwise.

**[00114]** Also, as used herein, and unless the context dictates otherwise, the term "coupled to" is intended to include both direct coupling (in which two elements that are coupled to each other contact each other) and indirect coupling (in which at least one additional element is located between the two elements). Therefore, the terms "coupled to" and "coupled with" are used synonymously.

**[00115]** In some embodiments, the numbers expressing quantities of ingredients, properties such as concentration, reaction conditions, and so forth, used to describe and claim certain embodiments of the invention are to be understood as being modified in some instances by the term “about.” Accordingly, in some embodiments, the numerical parameters set forth in the written description and attached claims are approximations that can vary depending upon the desired properties sought to be obtained by a particular embodiment. In some embodiments, the

numerical parameters should be construed in light of the number of reported significant digits and by applying ordinary rounding techniques. Notwithstanding that the numerical ranges and parameters setting forth the broad scope of some embodiments of the invention are approximations, the numerical values set forth in the specific examples are reported as precisely as practicable. The numerical values presented in some embodiments of the invention may contain certain errors necessarily resulting from the standard deviation found in their respective testing measurements. Moreover, and unless the context dictates the contrary, all ranges set forth herein should be interpreted as being inclusive of their endpoints and open-ended ranges should be interpreted to include only commercially practical values. Similarly, all lists of values should be considered as inclusive of intermediate values unless the context indicates the contrary.

[00116] Thus, specific, compounds, compositions and methods for treating hyperuricemia or gout have been disclosed. It should be apparent, however, to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the disclosure. Moreover, in interpreting the disclosure all terms should be interpreted in the broadest possible manner consistent with the context. In particular the terms “comprises” and “comprising” should be interpreted as referring to the elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps can be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced.

Practitioner's Docket No. \*PCT

**IN THE INTERNATIONAL BUREAU (WIPO)**

International Application Number	International Filing Date	International Earliest Priority Date
PCT/US2017/041763	12 July 2017	18 July 2016

Title of Invention:       COMPOUNDS, COMPOSITIONS AND  
METHODS FOR TREATING OR PREVENTING  
A SYMPTOM ASSOCIATED WITH GOUT OR  
HYPERURICEMIA  
Applicant:               ARTHROSI THERAPEUTICS

International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20  
Switzerland

**LETTER FOR PCT ARTICLE 19  
(PCT SECTION 205)**

1. Applicant herewith submits replacement sheets numbered **39 to 48** to replace sheets numbered **39 to 48** originally filed for this application.

2. In respect of each claim appearing in the international application based on the replacement sheets submitted herewith, and in accordance with PCT Section 205, the following claim(s) is/are:

- (i) unchanged: claims 2, 4, 5, 7 to 9, 11 to 15, 17 to 20, 22, 24 to 30, and 34
- (ii) new: claim 44
- (iii) replacement of one or more claims as filed, as follows: 1, 3, 6, 10, 16, 21, 23, 31, 32, 33, 35, and 36

Basis for amendment: Support for the amended claims can be found in at least paragraphs [0013], [0025] to [0030], and [0036] of the application as filed.

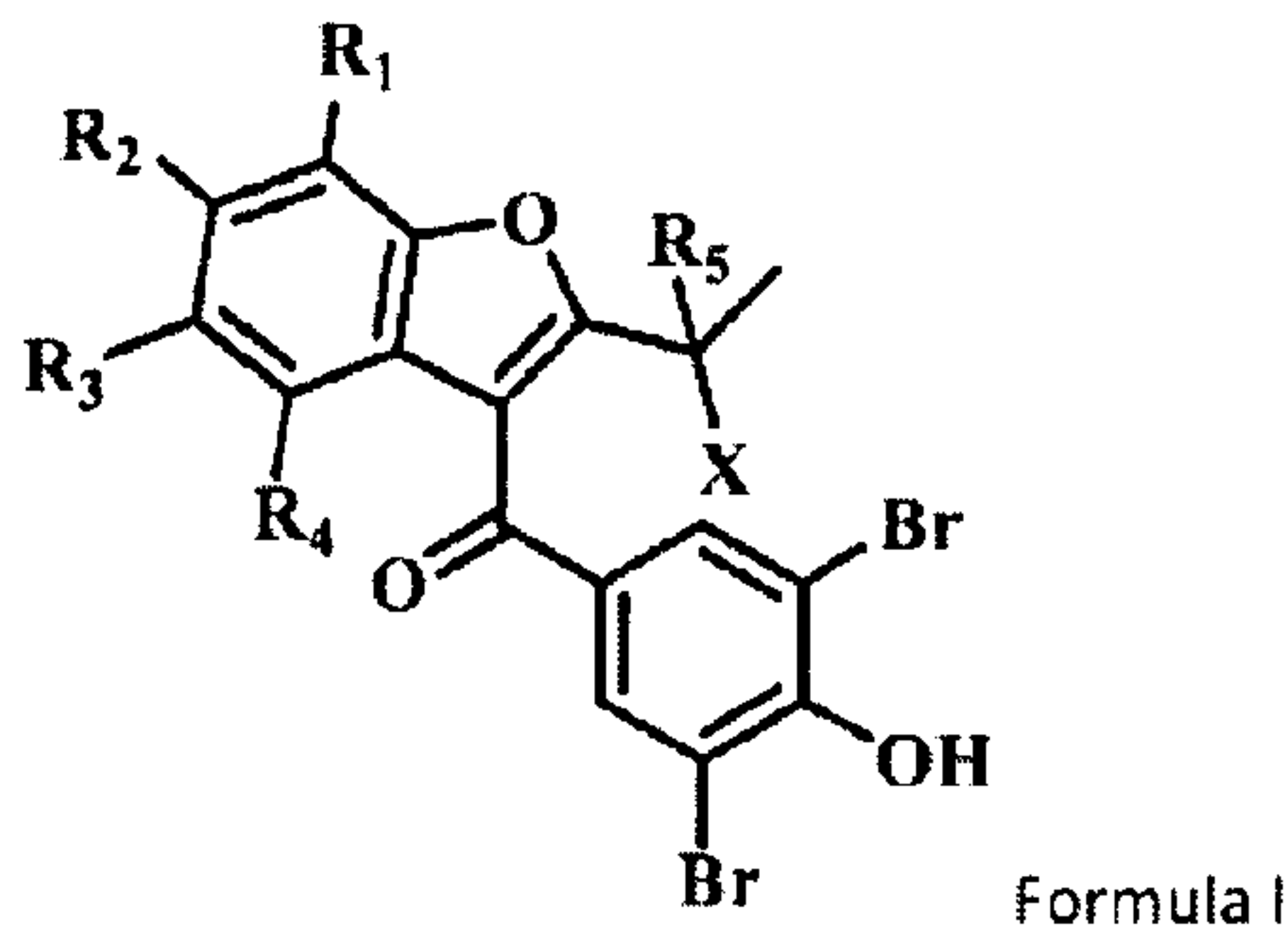
Dear Sir:

The Search Report dated **20 October 2017** designated only three references as being relevant to patentability. In response, claims 1, 3, 6, 10, 16, 21, 23, 31, 32, 33, 35, and 36 have been revised. The revised claims and references are addressed below.



**Revised Claims**

1. A compound of Formula 1, or a pharmaceutically acceptable salt thereof, wherein:



-X is -OH, -OR, -OC(O)R, -NH<sub>2</sub>, -NO<sub>2</sub>, -SO<sub>2</sub>R, -CN, -SO<sub>3</sub>H, -CHO, -COOH, -COCl, -CONH<sub>2</sub>, -F, -Cl, -Br or -I, wherein -R is a -H, -C<sub>1</sub>-C<sub>10</sub> alkyl or a -C<sub>1</sub>-C<sub>10</sub> substituted alkyl;

wherein -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> are each independently selected from a group consisting of -H, -deuterium, -F, -Cl, -Br, -I, -CN, -C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-C<sub>14</sub>-aryl, substituted -C<sub>6</sub>-C<sub>14</sub>-aryl, C<sub>1</sub>-C<sub>14</sub>-alkoxy, -hydroxyl, -carboxyl, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -OR<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub> and -NHCO<sub>2</sub>R<sub>6</sub>, wherein -R<sub>6</sub> is phenyl or naphthyl, optionally substituted with one or three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and wherein the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen; and

wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> are each selected from the group consisting of -deuterium or a halogen when X is OC(O)R a halogen, or -OH.

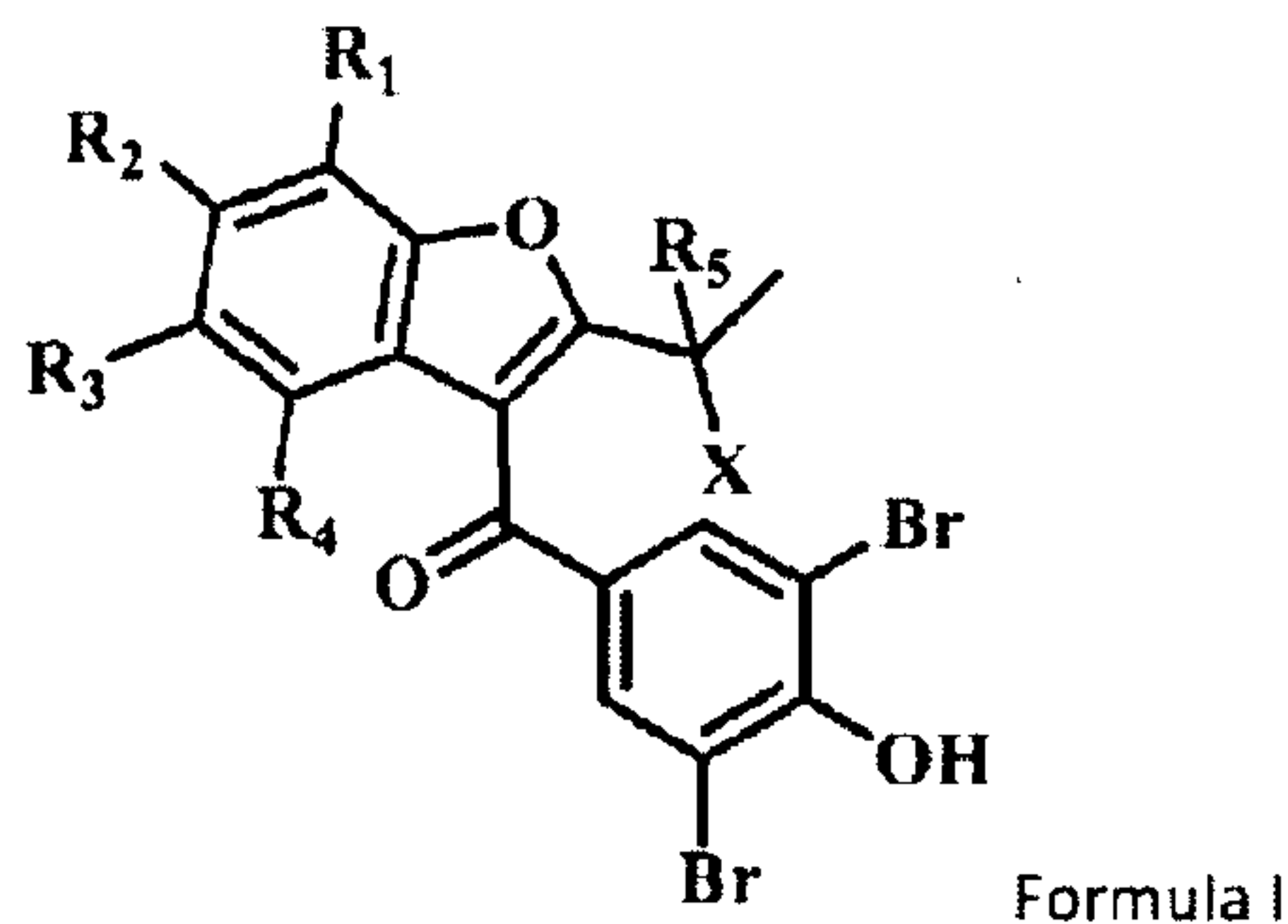
3. The compound of claim 1, wherein X is -OH, wherein each at least one of -R<sub>1</sub>, -R<sub>2</sub>, and -R<sub>4</sub> is -H-deuterium, wherein -R<sub>3</sub> is a halogen, and wherein -R<sub>5</sub> is -H.

6. The compound of claim 1, where X is -F, and wherein each of -R<sub>1</sub>, -R<sub>2</sub>, and -R<sub>4</sub> is -H, wherein -R<sub>3</sub> is a halogen, wherein at least two of -R<sub>1</sub>, -R<sub>2</sub>, and -R<sub>4</sub> are -H, wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, and -R<sub>4</sub> are -deuterium, and wherein -R<sub>5</sub> is -H.

10. A composition for the treatment of a condition associated with hyperuricemia or gout, comprising:

a pharmaceutically acceptable carrier;

a compound of Formula 1 or a pharmaceutically acceptable salt thereof;



wherein:

-X is -OH, -OR, -OC(O)R, -NH<sub>3</sub><sup>+</sup>, -NO<sub>2</sub>, -SO<sub>2</sub>R, -CN, -SO<sub>3</sub>H, -CHO, -COOH, -COCl, -CONH<sub>2</sub>, -F, -Cl, -Br or -I, wherein -R is a -H, -C<sub>1</sub>-C<sub>10</sub> alkyl or a -C<sub>1</sub>-C<sub>10</sub> substituted alkyl;

wherein -R<sub>2</sub> is -deuterium or -H; and

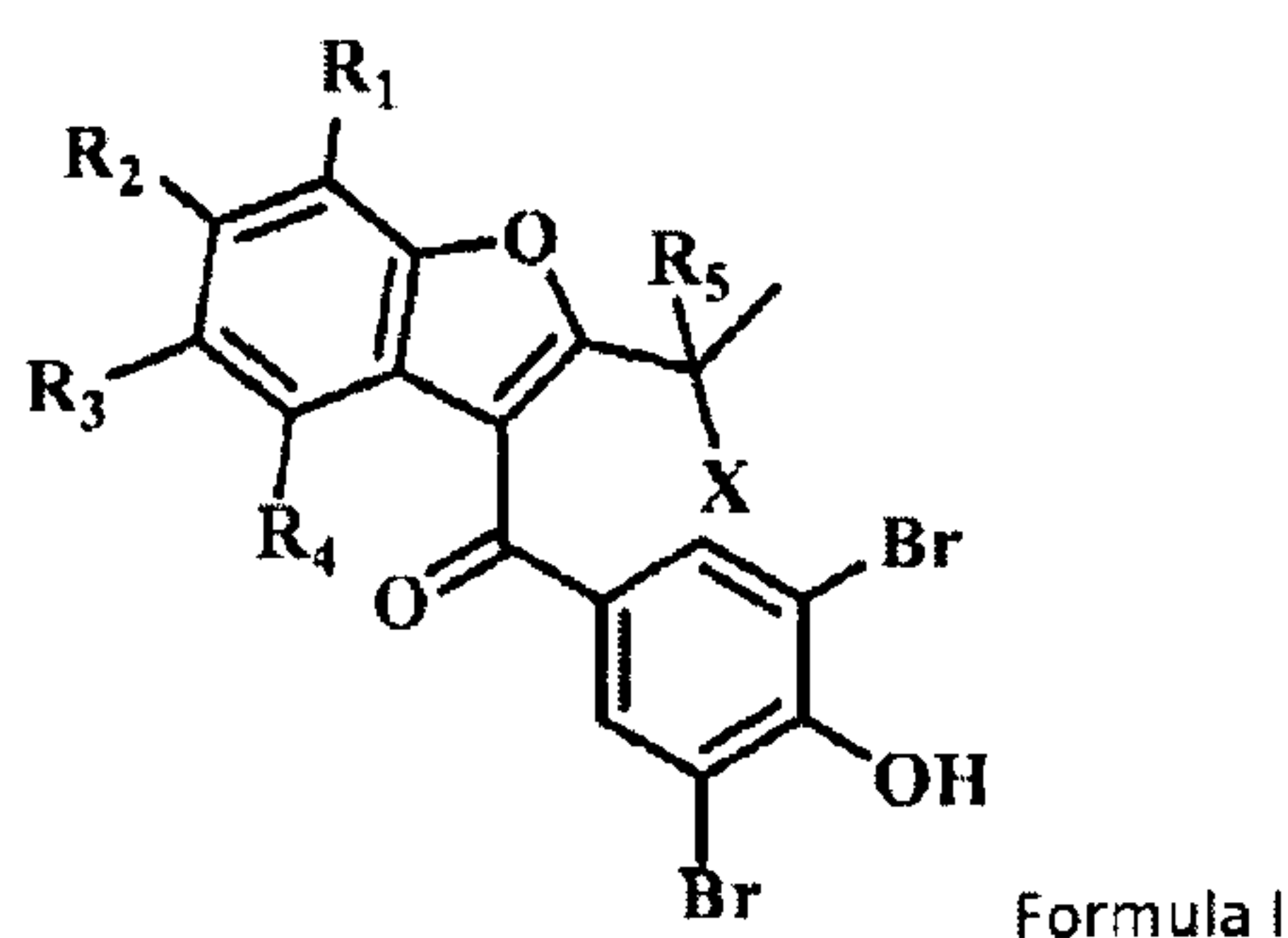
wherein -R<sub>1</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> are each independently selected from a group consisting of -H, -deuterium, -F, -Cl, -Br, -I, -CN, -C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-C<sub>14</sub>-aryl, substituted -C<sub>6</sub>-C<sub>14</sub>-aryl, C<sub>1</sub>-C<sub>14</sub>-alkoxy, -hydroxyl, -carboxyl, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -O-R<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub> and -NHCO<sub>2</sub>R<sub>6</sub>, wherein -R<sub>6</sub> is phenyl or naphthyl, optionally substituted with one or three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and wherein the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen;

wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> is deuterium, and

wherein the compound of Formula 1 is present in a therapeutically effective amount to treat a condition associated with hyperuricemia or gout.

16. The composition of claim 10, wherein  $-X$  is  $-F$  or  $-OH$ , and wherein each three or less of  $-R_1$ ,  $-R_2$ ,  $-R_4$ , and  $-R_5$  are  $-H$ , wherein at least one of  $-R_1$ ,  $-R_2$ ,  $-R_4$ , and  $-R_5$  is  $-deuterium$ , and wherein  $-R_3$  is a halogen.

21. A method of treating a condition associated with hyperuricemia or gout, comprising:  
administering an effective amount of a composition comprising a pharmaceutically acceptable carrier and a compound of Formula 1, or a pharmaceutically acceptable salt thereof;



wherein:

$-X$  is  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$  or  $-I$ , wherein  $-R$  is a  $-H$ ,  $-C_1-C_{10}$  alkyl or a  $-C_1-C_{10}$  substituted alkyl;

wherein  $-R_2$  is  $-deuterium$  or  $-H$ ; and

wherein  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from a group consisting of  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6$ -alkyl,  $C_6-C_{14}$ -aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$ -alkoxy,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6$ -alkylsulfonyl,  $-trifluoromethyl$ ,  $-C_1-C_6$ -alkanoyloxy,  $-C_1-C_6$ -alkylthio,  $-C_1-C_6$ -alkylsulfonyl,  $-C_2-C_6$ -alkoxycarbonyl,  $-C_2-C_6$ -alkanoylamino,  $-OR_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NHSO_2R_6$  and  $-NHCO_2R_6$ , wherein  $-R_6$  is phenyl or naphthyl, optionally substituted with one or three groups selected from  $-C_1-C_6$ -alkyl,  $-C_6-C_{10}$ -aryl,  $-C_1-C_6$ -alkoxy and halogen, and  $-C_4-C_{20}$ -hydroxyheteroaryl, and wherein the heteroatoms in  $-C_4-C_{20}$ -hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen; and

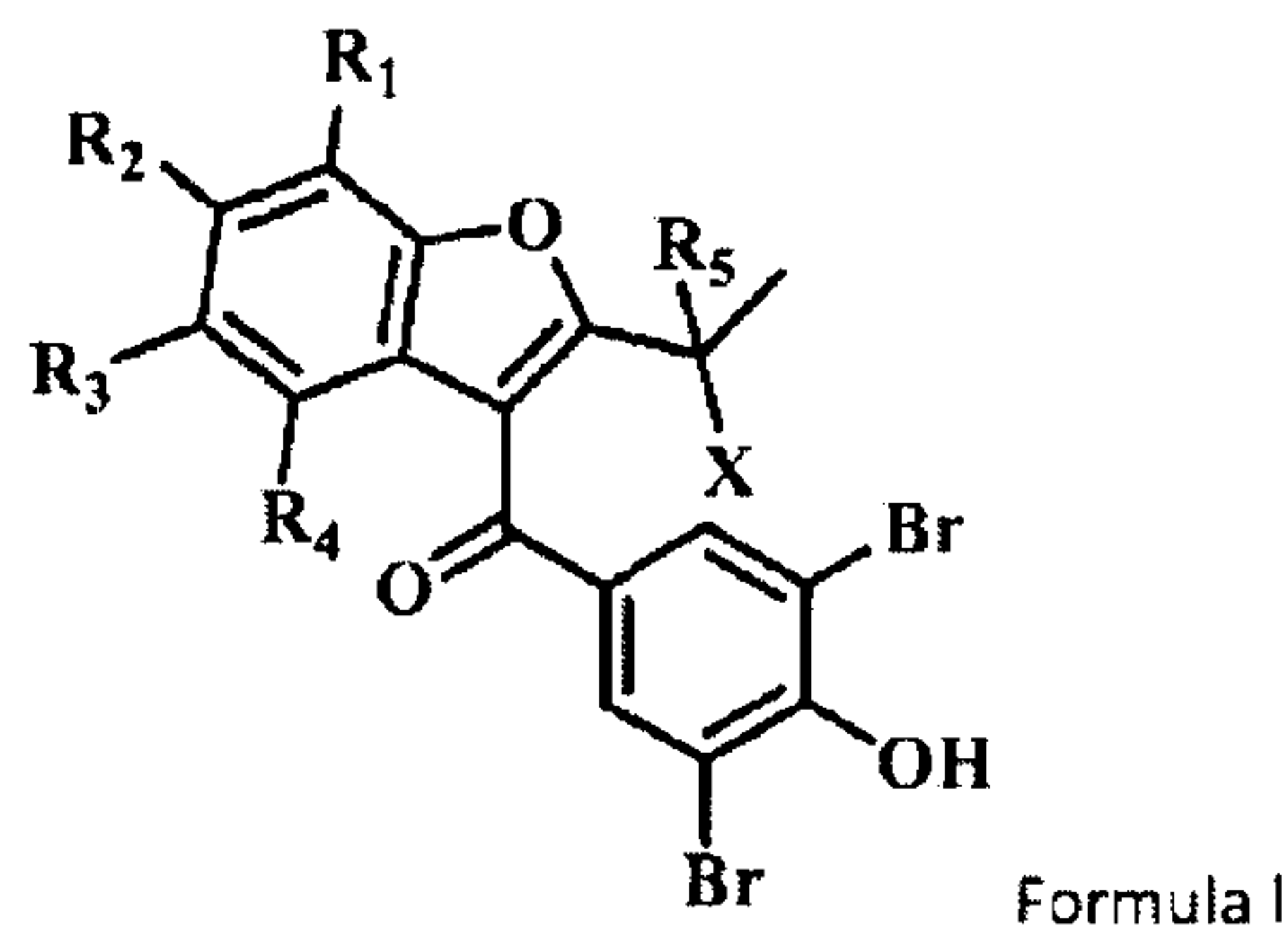
wherein at least one of  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  is deuterium.



23. The method of claim 21, wherein  $-X$  is  $-F$  or  $-OH$ , and wherein  $-R_3$  is a halogen, wherein each three or less of  $-R_1$ ,  $-R_2$ ,  $R_3$ , and  $-R_5$  is  $-H$ , and wherein at least one of  $-R_1$ ,  $-R_2$ ,  $R_3$ , and  $-R_5$  is deuterium.

31. A method of manufacturing a pharmaceutical composition for treating a condition associated with hyperuricemia or gout, comprising:

formulating a oral formulation that contains a pharmaceutically acceptable carrier and a compound of formula 1 or a pharmaceutically acceptable salt thereof;



wherein:

$-X$  is  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$  or  $-I$ , wherein  $-R$  is a  $-H$ ,  $-C_1-C_{10}$  alkyl or a  $-C_1-C_{10}$  substituted alkyl;

wherein  $-R_2$  is  $-deuterium$  or  $-H$ ; and

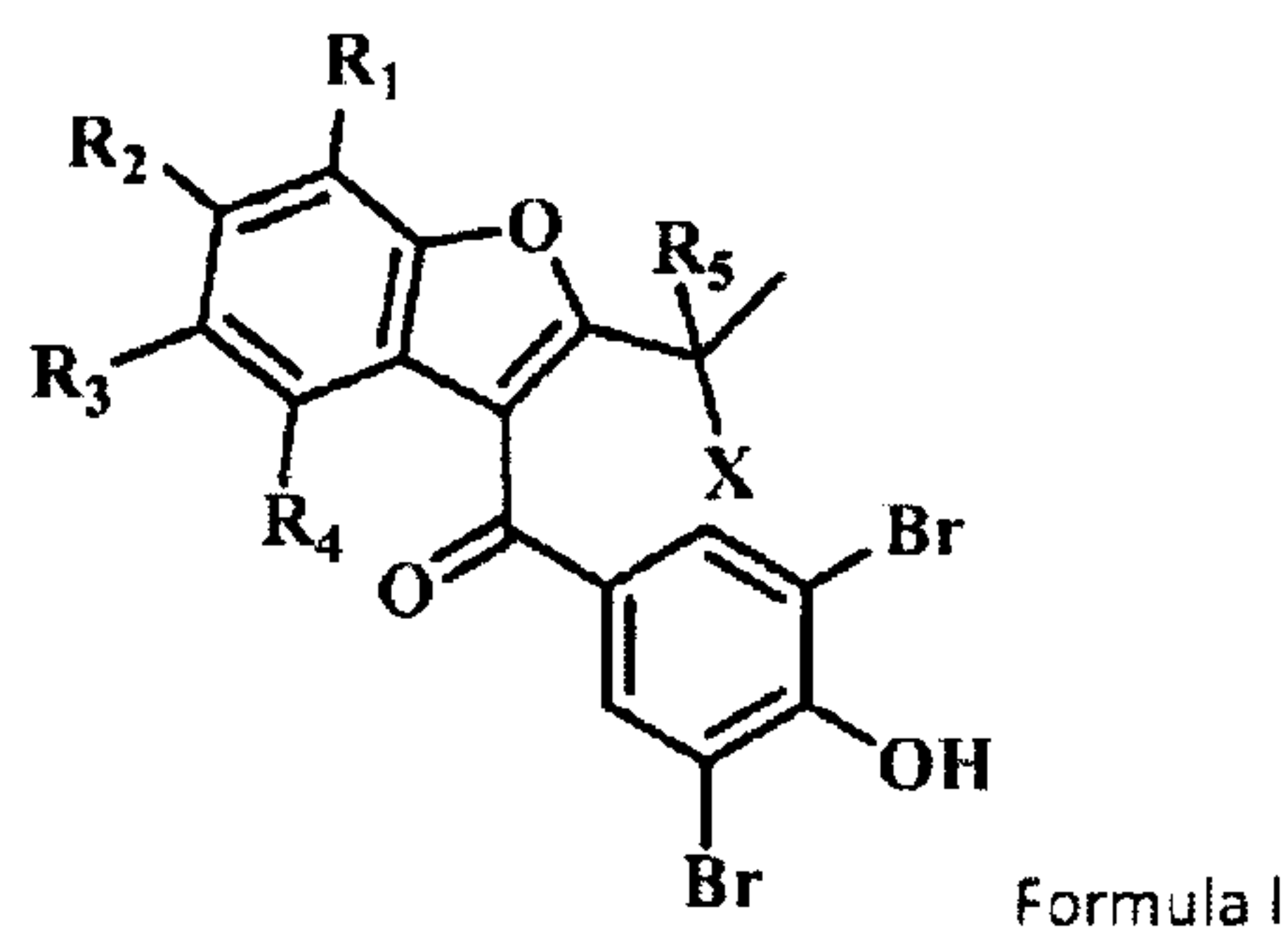
wherein  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from a group consisting of  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6$ -alkyl,  $C_6-C_{14}$ -aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$ -alkoxy,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6$ -alkylsulfonyl,  $-trifluoromethyl$ ,  $-C_1-C_6$ -alkanoyloxy,  $-C_1-C_6$ -alkylthio,  $-C_1-C_6$ -alkylsulfonyl,  $-C_2-C_6$ -alkoxycarbonyl,  $-C_2-C_6$ -alkanoylamino,  $-OR_6$ ,  $-S_2R_6$ ,  $-SO_2R_6$ ,  $-NHSO_2R_6$  and  $-NHCO_2R_6$ , wherein  $-R_6$  is phenyl or naphthyl, optionally substituted with one or three groups selected from  $-C_1-C_6$ -alkyl,  $-C_6-C_{10}$ -aryl,  $-C_1-C_6$ -alkoxy and halogen, and  $-C_4-C_{20}$ -hydroxyheteroaryl, and wherein the heteroatoms in  $-C_4-C_{20}$ -hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen;

wherein at least one of  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$ , and  $-R_5$  is deuterium; and

wherein the compound of Formula 1 is present in a therapeutically effective amount to treat a condition associated with hyperuricemia.

32. A method of manufacturing a liquid pharmaceutical composition for treating a condition associated with hyperuricemia or gout, comprising:

formulating a liquid formulation that contains a pharmaceutically acceptable carrier and a compound of formula 1 or a pharmaceutically acceptable salt thereof;



wherein:

-X is -OH, -OR, -OC(O)R, -NH<sub>3</sub><sup>+</sup>, -NO<sub>2</sub>, -SO<sub>2</sub>R, -CN, -SO<sub>3</sub>H, -CHO, -COOH, -COCl, -CONH<sub>2</sub>, -F, -Cl, -Br or -I, wherein -R is a -H, -C<sub>1</sub>-C<sub>10</sub> alkyl or a -C<sub>1</sub>-C<sub>10</sub> substituted alkyl;

wherein -R<sub>2</sub> is -deuterium or -H; and

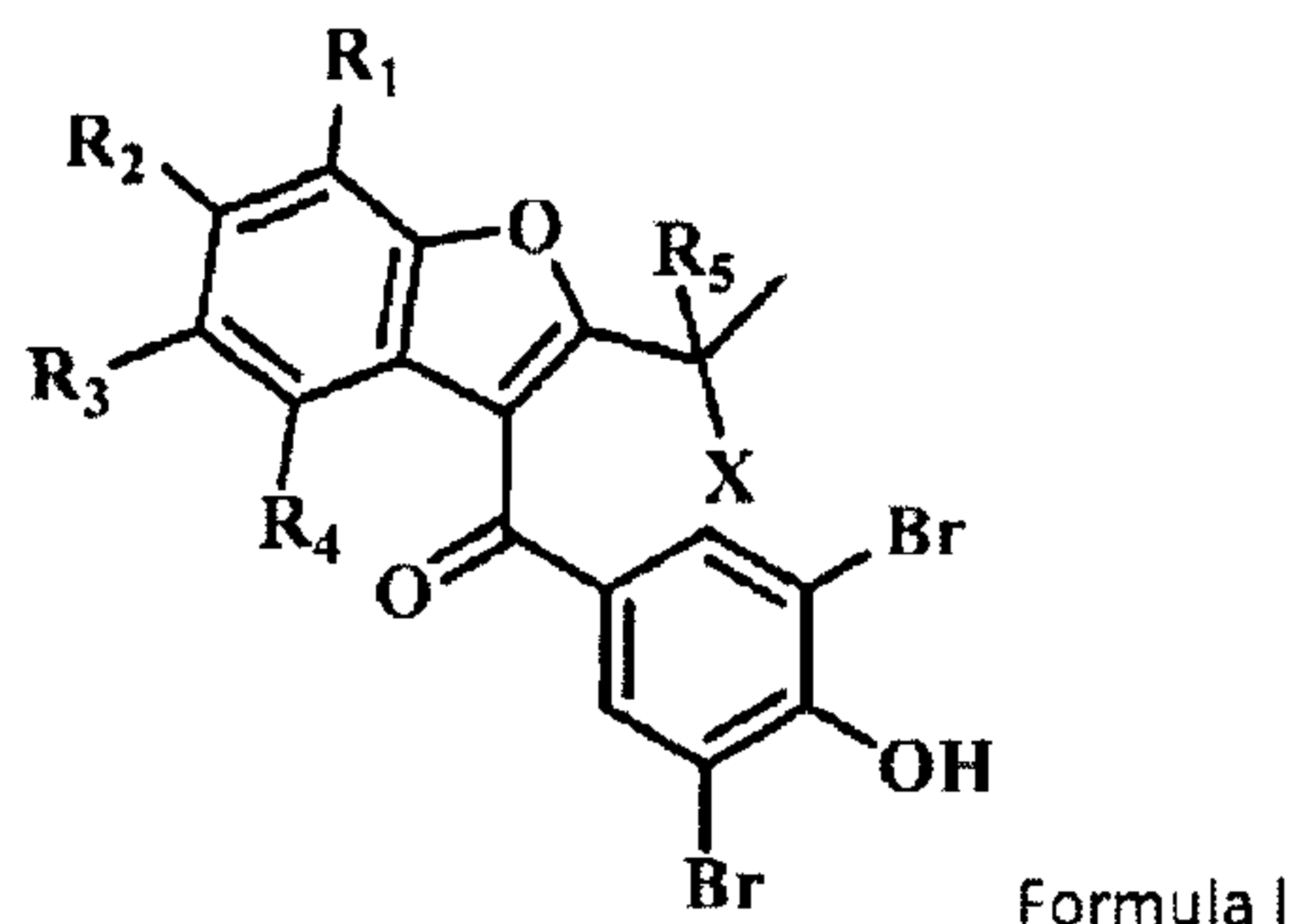
wherein -R<sub>1</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> are each independently selected from a group consisting of -H, -deuterium, -F, -Cl, -Br, -I, -CN, -C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-C<sub>14</sub>-aryl, substituted -C<sub>6</sub>-C<sub>14</sub>-aryl, C<sub>1</sub>-C<sub>14</sub>-alkoxy, -hydroxyl, -carboxyl, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -O-R<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub> and -NHCO<sub>2</sub>R<sub>6</sub>, wherein -R<sub>6</sub> is phenyl or naphthyl, optionally substituted with one or three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and wherein the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen;

wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub>, and -R<sub>5</sub> is deuterium; and

wherein the compound of Formula 1 is present in a therapeutically effective amount to treat a condition associated with hyperuricemia.

33. A method of inhibiting at least one kidney transporter responsible for uric acid reabsorption in renal tubules, comprising:

administering a therapeutically effective amount of a compound of formula 1, or a pharmaceutically acceptable salt thereof;



wherein:

-X is -OH, -OR, -OC(O)R, -NH<sub>3</sub><sup>+</sup>, -NO<sub>2</sub>, -SO<sub>2</sub>R, -CN, -SO<sub>3</sub>H, -CHO, -COOH, -COCl, -CONH<sub>2</sub>, -F, -Cl, -Br or -I, wherein -R is a -H, -C<sub>1</sub>-C<sub>10</sub> alkyl or a -C<sub>1</sub>-C<sub>10</sub> substituted alkyl;

wherein -R<sub>2</sub> is -deuterium or -H; and

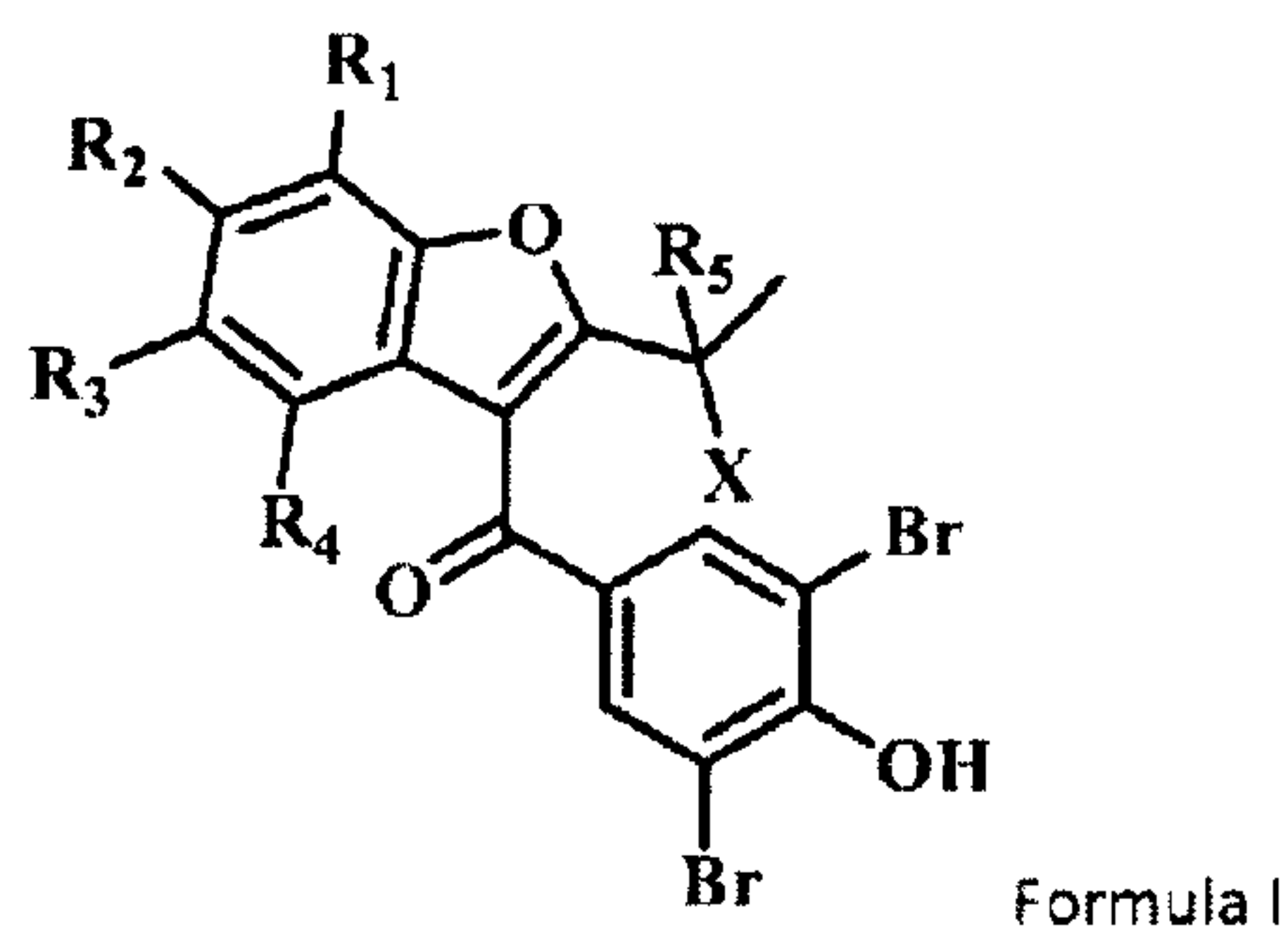
wherein -R<sub>1</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> are each independently selected from a group consisting of -H, -deuterium, -F, -Cl, -Br, -I, -CN, -C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-C<sub>14</sub>-aryl, substituted -C<sub>6</sub>-C<sub>14</sub>-aryl, C<sub>1</sub>-C<sub>14</sub>-alkoxy, -hydroxyl, -carboxyl, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -OR<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub> and -NHCO<sub>2</sub>R<sub>6</sub>, wherein -R<sub>6</sub> is phenyl or naphthyl, optionally substituted with one or three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and wherein the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen;

wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub>, and -R<sub>5</sub> is deuterium.

35. A method of treating a condition, disorder or disease mediated by at least one kidney transporter responsible for uric acid reabsorption in renal tubules, comprising:

administering an effective amount of a composition comprising a pharmaceutically acceptable carrier and a compound of formula 1 or a pharmaceutically acceptable salt thereof;





wherein:

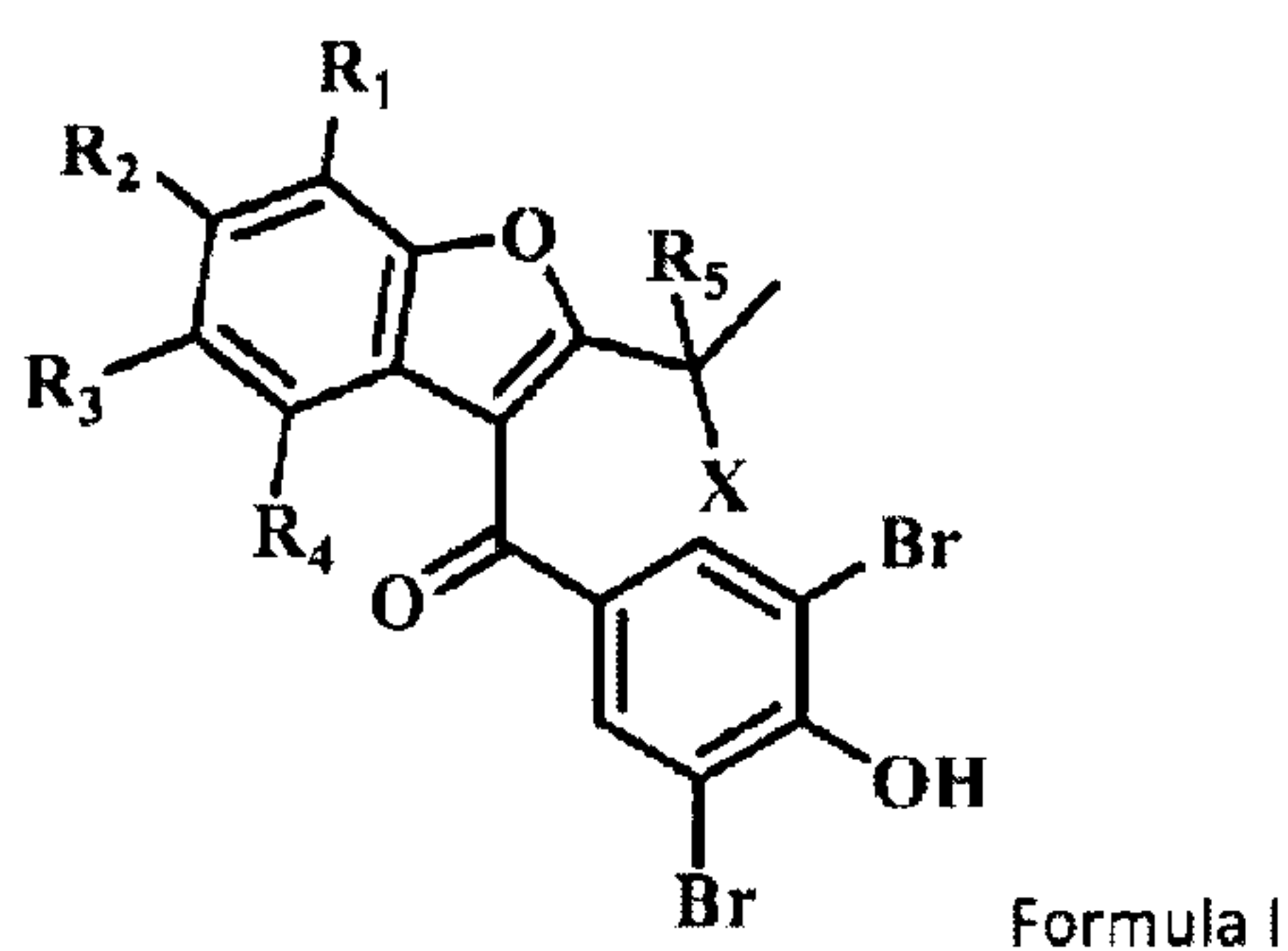
-X is -OH, -OR, -OC(O)R, -NH<sub>3</sub><sup>+</sup>, -NO<sub>2</sub>, -SO<sub>2</sub>R, -CN, -SO<sub>3</sub>H, -CHO, -COOH, -COCl, -CONH<sub>2</sub>, -F, -Cl, -Br or -I, wherein -R is a -H, -C<sub>1</sub>-C<sub>10</sub> alkyl or a -C<sub>1</sub>-C<sub>10</sub> substituted alkyl;

wherein -R<sub>2</sub> is -deuterium or -H; and

wherein -R<sub>1</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> are each independently selected from a group consisting of -H, -deuterium, -F, -Cl, -Br, -I, -CN, -C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-C<sub>14</sub>-aryl, substituted -C<sub>6</sub>-C<sub>14</sub>-aryl, C<sub>1</sub>-C<sub>14</sub>-alkoxy, -hydroxyl, -carboxyl, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -OR<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub> and -NHCO<sub>2</sub>R<sub>6</sub>, wherein -R<sub>6</sub> is phenyl or naphthyl, optionally substituted with one or three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and wherein the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen; and

wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub>, and -R<sub>5</sub> is deuterium.

36. A compound of Formula 1, or a pharmaceutically acceptable salt thereof;



wherein:

-X is -OH, -OR, -F, -Cl, -Br or -I, wherein -R is a -H, -C<sub>1</sub>-C<sub>10</sub> alkyl or a -C<sub>1</sub>-C<sub>10</sub> substituted alkyl;

wherein ~~-R<sub>3</sub>-R<sub>2</sub>~~ is ~~-deuterium or -F~~;

wherein R<sub>3</sub> is -F; and

wherein each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>4</sub>, and -R<sub>5</sub> are selected from the group consisting of each -H and, or -deuterium.

**STATEMENT UNDER ARTICLE 34**

The Office considers claim 1 to be anticipated by DE 19624292A1, to Merckle GMBH, hereafter referred to as D1), and to lack inventive step over Drug Safety 31(8):643-665 (2008) (to Lee, hereafter referred to as D2). The Office further states that claims 2 to 9 are novel, but lack inventive step over D1 in view of D2 and knowledge known to a person of ordinary skill in the art. The Office further states that claims 10, 31, 32, and 36 to 40 are novel but lack inventive step over D2. The Office similarly states that claim 11 to 18, 42, and 43 are novel but lack inventive step over D2. In regards to claims 19 and 20, the Office admits that D2 fails to teach a xanthine oxidase inhibitor, but finds that these claims lack inventive step over D2 in view of United States Patent Application Publication No. 2014-0357683 (to Takeda Pharmaceuticals, hereafter referred to as D3). Similar arguments are provided in finding that claim 41 lacks inventive step over D2 in view of D3.

In regards to claim 1, the Office states that D1 teaches a compound of formula 1 wherein X is OC(O)R, R is a methyl group, and R<sub>1</sub> to R<sub>5</sub> are hydrogen. The Applicant notes that claim 1 is amended in the instant response such that at least one of R<sub>1</sub> to R<sub>5</sub> is deuterium when X is OC(O)R, which represents a subset of compounds specified in claim 1 of the application as filed. As such, claim 1 as currently amended is novel over D1. The Office further states that D2 teaches benzbromarone as a uricosuric drug and inhibitor of CYP2C9, and further teaches generation of a metabolite corresponding to formula 1 of claim 1 when X is OH and R<sub>1</sub> to R<sub>5</sub> are H. The Office admits that at least one of R<sub>1</sub> to R<sub>5</sub> is deuterium or a halogen when X is OH in the claimed subject matter. The Office provides reasoning that such substitution falls within the scope of activities of a person of ordinary skill in the art.

The tools available to organic chemists make a nearly infinite number of variations possible as something that a person of ordinary skill could potentially generate. The Applicant notes, however, that the test of inventive step is not simply that a person of ordinary skill could perform such a step, but rather that they would do so.

The Applicant notes that for a pharmaceutical compound to be of use it must demonstrate both activity and a lack of toxicity. Benzbromarone has been known for some time, but the compound is not in wide use due to concerns over idiosyncratic toxicity. The specification of the instant application makes it clear that compounds of formula 1 provide the technical effect of providing benzbromarone activity while having relatively reduced toxicity relative



to benzbromarone (see paragraph [0013] of the application as filed). A review of D2 shows no teaching or suggestion that such reduction is possible, and there is no apparent teaching in general chemical knowledge available to a person of ordinary skill in the chemical arts to suggest that modifications to benzbromarone to derive the claimed compound would provide such. Claim 1, therefore, provides an inventive step over D2. Claims 2 to 9, in depending from claim 1, similarly demonstrate an inventive step over D2.

In regards to claim 10, the Office states that D2 teaches that benzbromarone is useful in the treatment of hyperuricemia or gout, and that a hydroxylated metabolite is present in substantial amounts following administration of this drug. The Office states that the metabolite corresponds to formula 1 of the claim when X is OH and R1 to R5 are H, and that the claim differs by specifying the inclusion of a carrier. The Office states that a person of ordinary skill would readily derive the subject matter of claim 10 based on the activity of benzbromarone and knowledge of the presence of the hydroxylated metabolite. A review of D2 shows that it teaches benzbromarone has a significant risk of severe hepatotoxicity and that metabolism of the hydroxylated metabolite varies between individuals. The Applicant notes that claim 10 is amended to specify that at least one of R1 to R5 is deuterium. As noted above, there is no teaching or suggestion of the technical effect of reduced toxicity relative to benzbromarone while retaining activity in D2 or general chemical knowledge. A person of ordinary skill, therefore, would not derive a compound of formula 1 as so defined. As such claim 10 has an inventive step over D2. Claims 11 to 18, 42, and 43 depend from claim 10 and similarly demonstrate an inventive step over D2. The Office cites D3 as teaching coadministration of a xanthine oxidase inhibitor, and found that claims 19 and 20 (which depend from claim 10) lack an inventive step over D2 in view of D3. A review of D3, however, shows that it fails to cure the deficiencies of D2. Claims 19 and 20, therefore, demonstrate an inventive step over D2 and D3.

The Office states that the features of claims 31 and 32 are substantially similar to those of claim 10, but are directed towards methods of manufacturing specified pharmaceutical compositions. The Applicant notes that claims 31 and 32 are amended in a fashion similar to claim 10, and therefore show an inventive step over D2 for reasons as stated above.

In regards to claim 36, the Office states that D2 teaches benzbromarone and a hydroxylated metabolite that corresponds to formula 1 when X is OH and R1 to R5 are hydrogen. The Office admits that the claimed subject matter differs in that R3 can be deuterium or fluorine,

but finds that such substitutions would be within the scope of ordinary experimentation by a person of ordinary skill. As noted above, however, such reasoning fails to recognize the technical effect of reduced toxicity relative to benzbromarone while retaining benzbromarone activity and the lack of teaching or suggestion of such effects in D2 or in general chemical knowledge. As such while a person of ordinary skill could attempt a nearly infinite number of variations, this line of reasoning fails to provide the requisite "would". In addition, claim 36 has been amended to stipulate that at least one of R1 to R5 is deuterium, which is not taught or suggested in D2 or within the scope of ordinary experimentation without previous knowledge of the heretofore unknown technical effect. As such claim 36 shows an inventive step over D2. Claims 37 to 40 depend from claim 36 and similar demonstrate the requisite inventive step. The Applicant also notes that D3 fails to cure the deficiencies of D2 in regards to claim 41, which by virtue of dependence of claim 36 also shows an inventive step.

### **Conclusion**

Claims 1 to 43 are pending in this application. The Applicants request withdrawal of the rejections of all pending claims.

Respectfully submitted,  
Fish IP Law, LLP

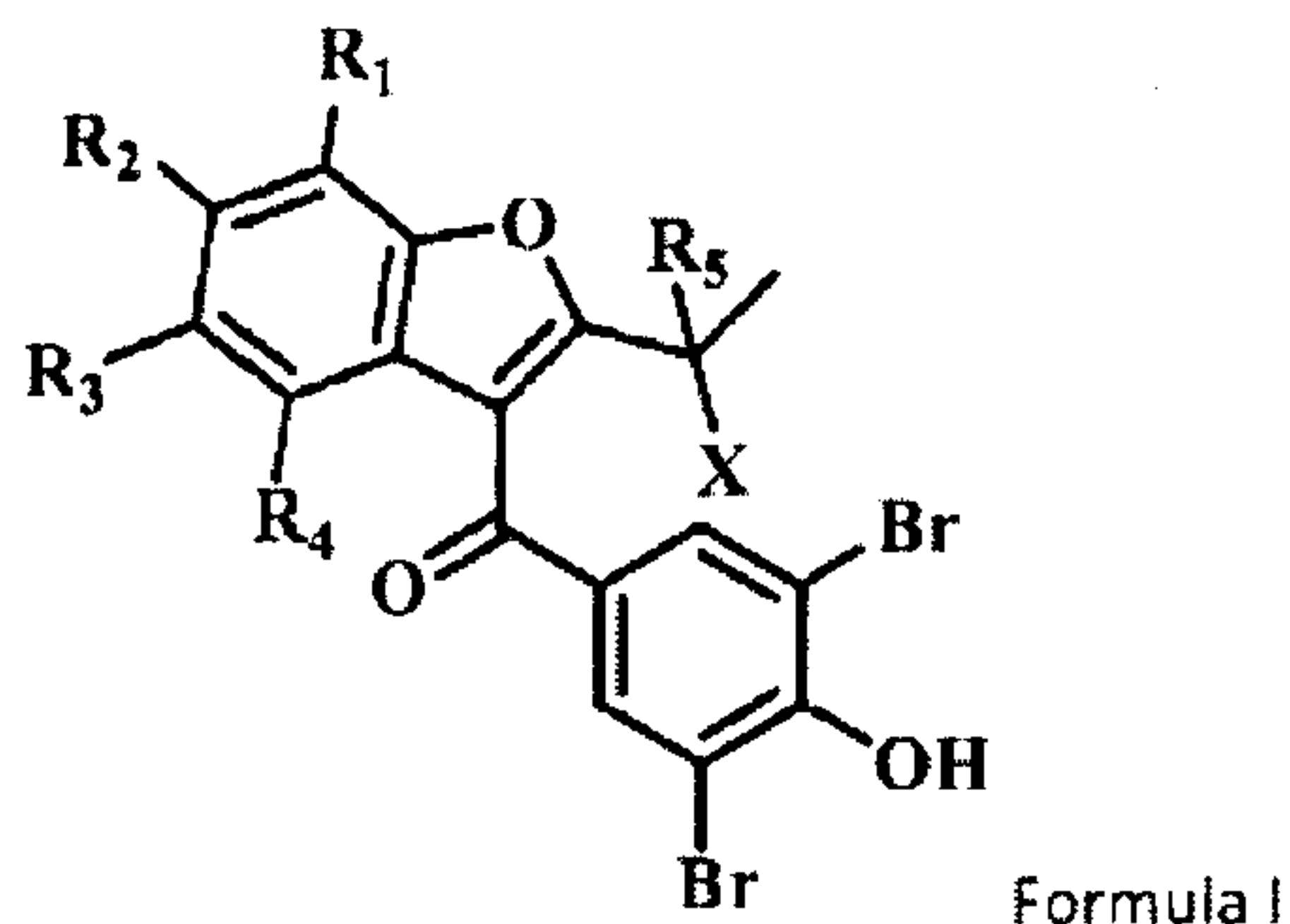
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## CLAIMS

What is claimed is:

1. A compound of Formula 1, or a pharmaceutically acceptable salt thereof, wherein:



-X is -OH, -OR, -OC(O)R, -NH<sub>2</sub>, -NO<sub>2</sub>, -SO<sub>2</sub>R, -CN, -SO<sub>3</sub>H, -CHO, -COOH, -COCl, -CONH<sub>2</sub>, -F, -Cl, -Br or -I, wherein -R is a -H, -C<sub>1</sub>-C<sub>10</sub> alkyl or a -C<sub>1</sub>-C<sub>10</sub> substituted alkyl;

wherein -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> are each independently selected from a group consisting of -H, -deuterium, -F, -Cl, -Br, -I, -CN, -C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-C<sub>14</sub>-aryl, substituted -C<sub>6</sub>-C<sub>14</sub>-aryl, C<sub>1</sub>-C<sub>14</sub>-alkoxy, -hydroxyl, -carboxyl, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -O-R<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub> and -NHCO<sub>2</sub>R<sub>6</sub>, wherein -R<sub>6</sub> is phenyl or naphthyl, optionally substituted with one or three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and wherein the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen; and

wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> is -deuterium when X is OC(O)R a halogen, or -OH.

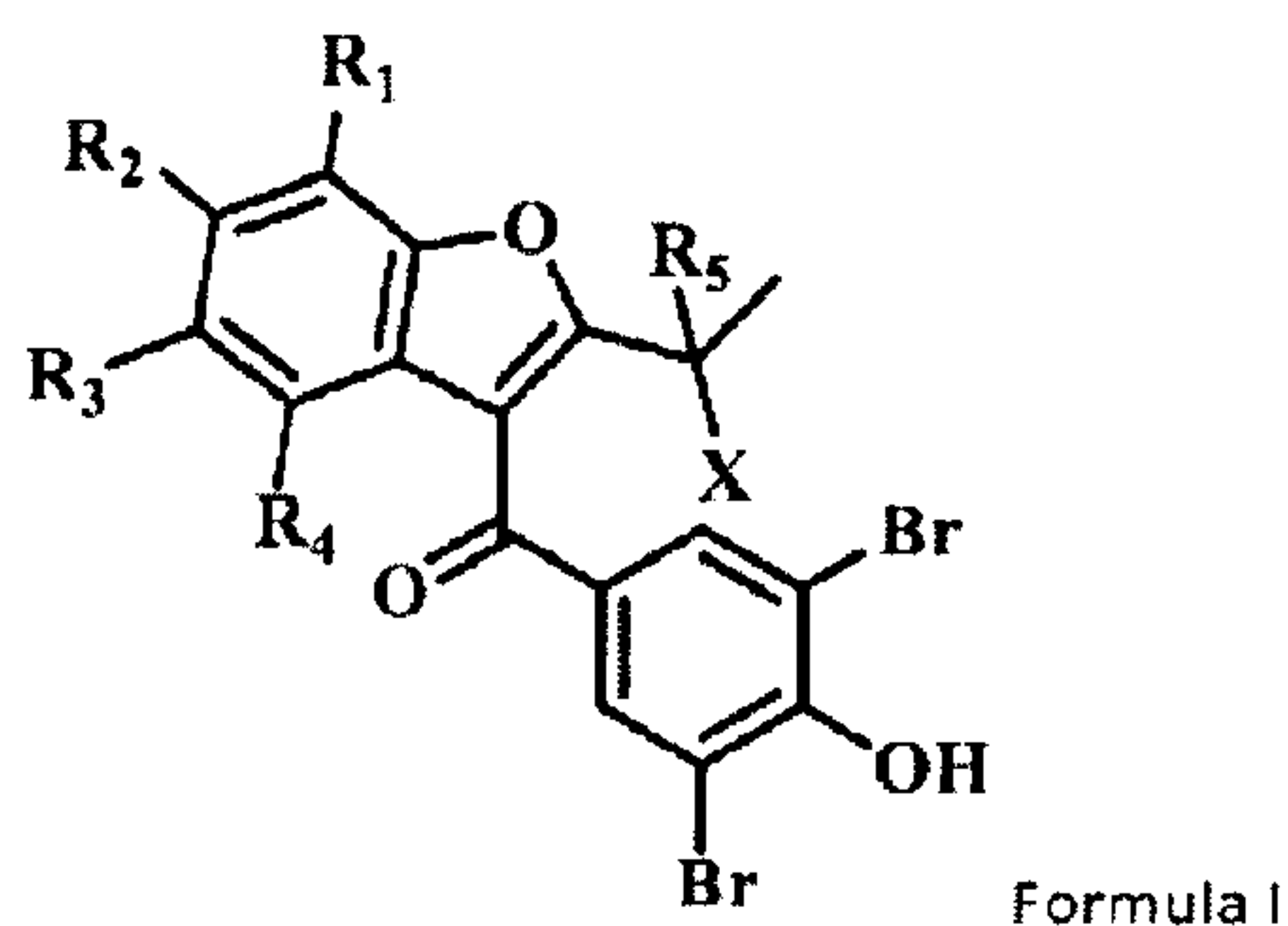
2. The compound of claim 1, wherein X is -OH, and wherein each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, and -R<sub>4</sub> is -deuterium, and R<sub>5</sub> is -H.
3. The compound of claim 1, wherein X is -OH, wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, and -R<sub>4</sub> is -deuterium, wherein -R<sub>3</sub> is a halogen, and wherein -R<sub>5</sub> is -H.
4. The compound of claim 3, wherein -R<sub>3</sub> is -F.



5. The compound of claim 1, wherein X is -F, wherein each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, and -R<sub>4</sub> is -deuterium, and wherein R<sub>5</sub> is -H.
6. The compound of claim 1, where X is -F, wherein -R<sub>3</sub> is a halogen, wherein at least two of -R<sub>1</sub>, -R<sub>2</sub>, and -R<sub>4</sub> are -H, wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, and -R<sub>4</sub> are -deuterium, and wherein -R<sub>5</sub> is -H.
7. The compound of claim 6, where -R<sub>3</sub> is -F.
8. The compound of claim 1, wherein -X is -F or -OH, wherein each of -R<sub>2</sub> and -R<sub>4</sub> is -deuterium, and wherein each of -R<sub>1</sub>, -R<sub>3</sub>, and -R<sub>5</sub> is -H.
9. The compound of claim 1, wherein -X is -F or -OH, wherein each of -R<sub>2</sub> and -R<sub>3</sub> is -deuterium, and wherein each of -R<sub>1</sub>, -R<sub>4</sub>, and -R<sub>5</sub> is -H.
10. A composition for the treatment of a condition associated with hyperuricemia or gout, comprising:

a pharmaceutically acceptable carrier;

a compound of Formula 1 or a pharmaceutically acceptable salt thereof;



wherein:

-X is -OH, -OR, -OC(O)R, -NH<sub>3</sub><sup>+</sup>, -NO<sub>2</sub>, -SO<sub>2</sub>R, -CN, -SO<sub>3</sub>H, -CHO, -COOH, -COCl, -CONH<sub>2</sub>, -F, -Cl, -Br or -I, wherein -R is a -H, -C<sub>1</sub>-C<sub>10</sub> alkyl or a -C<sub>1</sub>-C<sub>10</sub> substituted alkyl;

wherein -R<sub>2</sub> is -deuterium or -H; and

wherein -R<sub>1</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> are each independently selected from a group consisting of -H, -deuterium, -F, -Cl, -Br, -I, -CN, -C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-C<sub>14</sub>-aryl, substituted -C<sub>6</sub>-C<sub>14</sub>-aryl, C<sub>1</sub>-C<sub>14</sub>-alkoxy, -hydroxyl, -carboxyl, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -

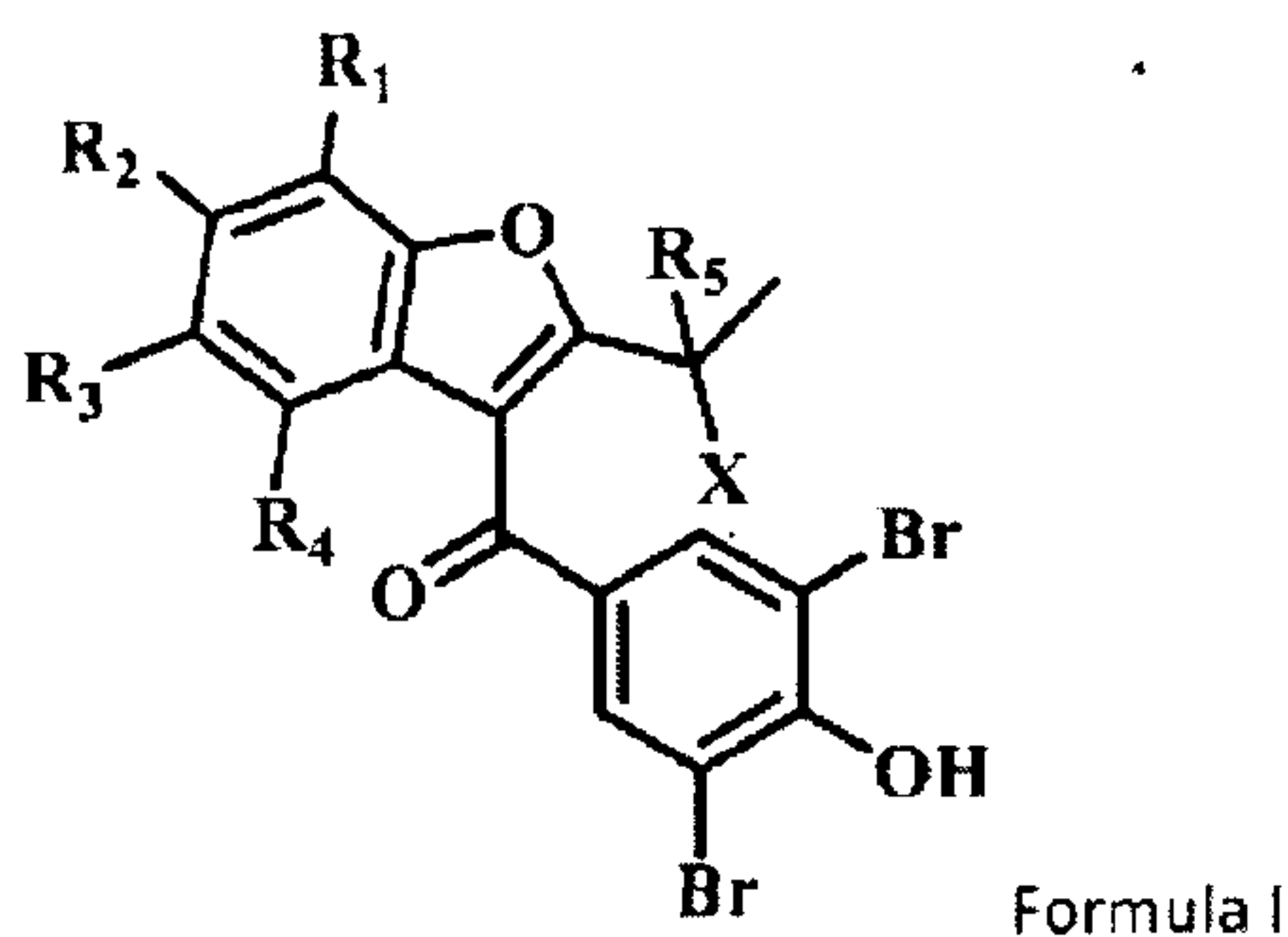
C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -O-R<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub> and -NHCO<sub>2</sub>R<sub>6</sub>, wherein -R<sub>6</sub> is phenyl or naphthyl, optionally substituted with one or three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and wherein the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen;

wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> is deuterium, and

wherein the compound of Formula 1 is present in a therapeutically effective amount to treat a condition associated with hyperuricemia or gout.

11. The composition of claim 10, wherein -R<sub>2</sub> is deuterium.
12. The composition of claim 11, wherein -X is -F or -OH, wherein -R<sub>1</sub>, -R<sub>2</sub>, and -R<sub>4</sub> is deuterium, and -R<sub>5</sub> is -H.
13. The composition of claim 12, wherein -R<sub>3</sub> is -deuterium.
14. The composition of claim 10, wherein -X is -F, wherein each of -R<sub>2</sub> and -R<sub>3</sub> is deuterium, and wherein each of -R<sub>1</sub>, -R<sub>4</sub>, and -R<sub>5</sub> is -H.
15. The composition of claim 10, wherein each of -X and -R<sub>5</sub> is -F, and wherein each of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub> and -R<sub>4</sub> is deuterium.
16. The composition of claim 10, wherein -X is -F or -OH, wherein three or less of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>4</sub>, and -R<sub>5</sub> are -H, wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>4</sub>, and -R<sub>5</sub> is -deuterium, and wherein -R<sub>3</sub> is a halogen.
17. The composition of claim 16, where -R<sub>3</sub> is -F.
18. The composition of claim 10, wherein the condition is at least one of hyperuricemia, gout, hypertension, and diabetes.
19. The composition of claim 10, further comprising a xanthine oxidase inhibitor.
20. The composition of claim 19, wherein the xanthine oxidase inhibitor is allopurinol, oxypurinol, febuxostat, topiroxostat, or inositol.

21. A method of treating a condition associated with hyperuricemia or gout, comprising:  
 administering an effective amount of a composition comprising a pharmaceutically acceptable carrier and a compound of Formula 1, or a pharmaceutically acceptable salt thereof;



wherein:

-X is -OH, -OR, -OC(O)R, -NH<sub>3</sub><sup>+</sup>, -NO<sub>2</sub>, -SO<sub>2</sub>R, -CN, -SO<sub>3</sub>H, -CHO, -COOH, -COCl, -CONH<sub>2</sub>, -F, -Cl, -Br or -I, wherein -R is a -H, -C<sub>1</sub>-C<sub>10</sub> alkyl or a -C<sub>1</sub>-C<sub>10</sub> substituted alkyl;

wherein -R<sub>2</sub> is -deuterium or -H; and

wherein -R<sub>1</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> are each independently selected from a group consisting of -H, -deuterium, -F, -Cl, -Br, -I, -CN, -C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-C<sub>14</sub>-aryl, substituted -C<sub>6</sub>-C<sub>14</sub>-aryl, C<sub>1</sub>-C<sub>14</sub>-alkoxy, -hydroxyl, -carboxyl, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -OR<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub> and -NHCO<sub>2</sub>R<sub>6</sub>, wherein -R<sub>6</sub> is phenyl or naphthyl, optionally substituted with one or three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and wherein the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen; and

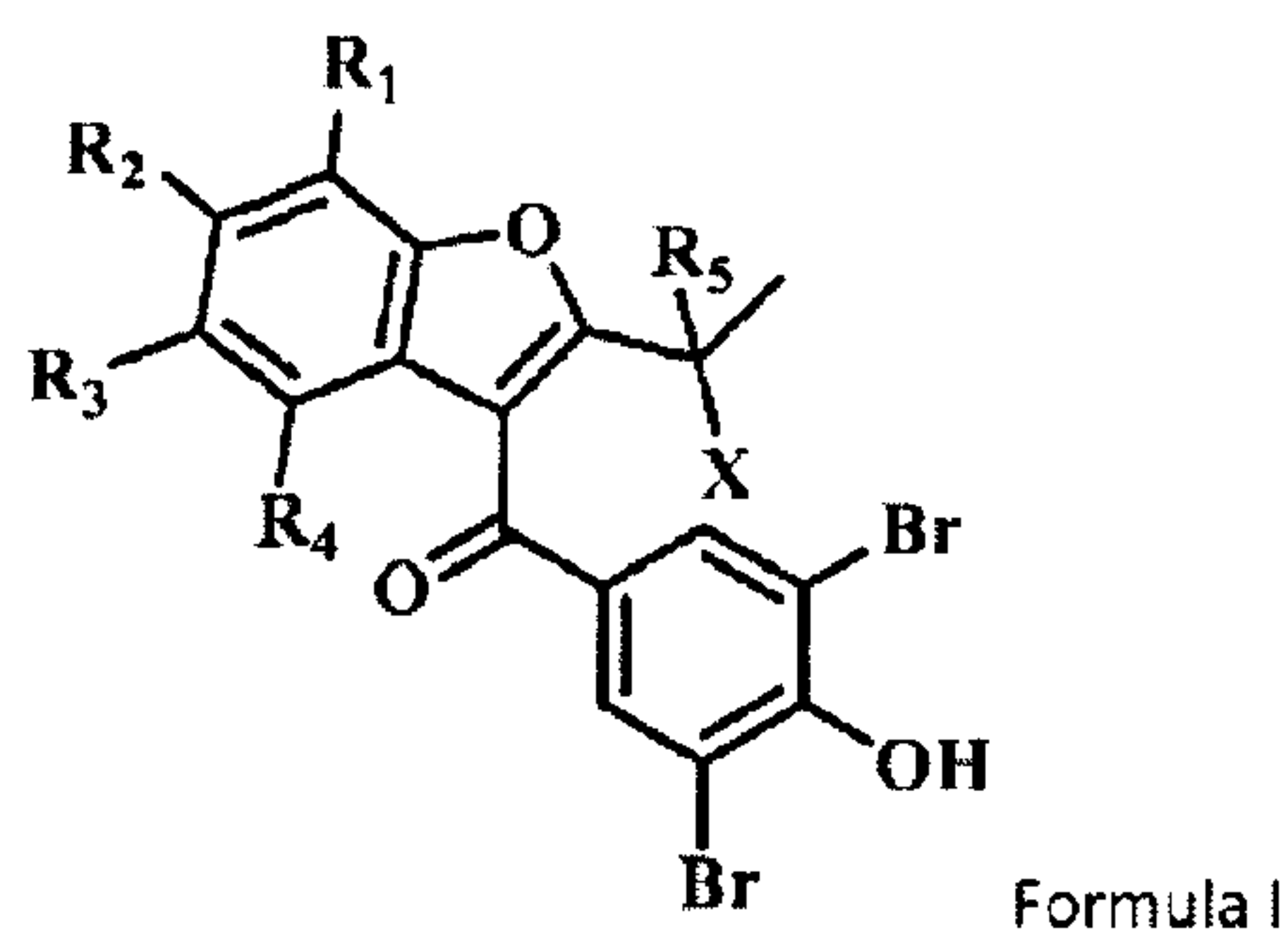
wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> is deuterium.

22. The method of claim 21, wherein -X is -F or -OH, wherein each of -R<sub>1</sub>, -R<sub>2</sub>, R<sub>3</sub>, and -R<sub>4</sub> is a deuterium, and wherein -R<sub>5</sub> is -H.



23. The method of claim 21, wherein  $-X$  is  $-F$  or  $-OH$ , wherein  $-R_3$  is a halogen, wherein three or less of  $-R_1$ ,  $-R_2$ ,  $R_3$ , and  $-R_5$  are  $-H$ , and wherein at least one of  $-R_1$ ,  $-R_2$ ,  $R_3$ , and  $-R_5$  is deuterium.
24. The compound of claim 23, where  $-R_3$  is  $-F$ .
25. The method of claim 21, wherein each of  $-X$  and  $-R_5$  is  $-F$ , wherein  $-R_2$ , is deuterium, and wherein each of  $-R_1$ ,  $-R_3$  and  $-R_4$ , is  $-H$ .
26. The method of claim 21, wherein each of  $-X$  and  $-R_5$  is  $-F$ , and wherein each of  $-R_1$ ,  $-R_2$ ,  $-R_3$  and  $-R_4$  is deuterium.
27. The method of claim 21, wherein between 50-300 mg of the compound of formula 1 is present in the composition, and wherein the composition is administered as a single dose.
28. The method of claim 21, wherein the condition is at least one of hyperuricemia, gout, hypertension and diabetes.
29. The method of claim 21, wherein the composition further comprises a xanthine oxidase inhibitor.
30. The method of claim 29, wherein the xanthine oxidase inhibitor is allopurinol oxypurinol, febuxostat, topiroxostat, or inositols.
31. A method of manufacturing a pharmaceutical composition for treating a condition associated with hyperuricemia or gout, comprising:

formulating a oral formulation that contains a pharmaceutically acceptable carrier and a compound of formula 1 or a pharmaceutically acceptable salt thereof;



wherein:

-X is -OH, -OR, -OC(O)R, -NH<sub>3</sub><sup>+</sup>, -NO<sub>2</sub>, -SO<sub>2</sub>R, -CN, -SO<sub>3</sub>H, -CHO, -COOH, -COCl, -CONH<sub>2</sub>, -F, -Cl, -Br or -I, wherein -R is a -H, -C<sub>1</sub>-C<sub>10</sub> alkyl or a -C<sub>1</sub>-C<sub>10</sub> substituted alkyl;

wherein -R<sub>2</sub> is -deuterium or -H; and

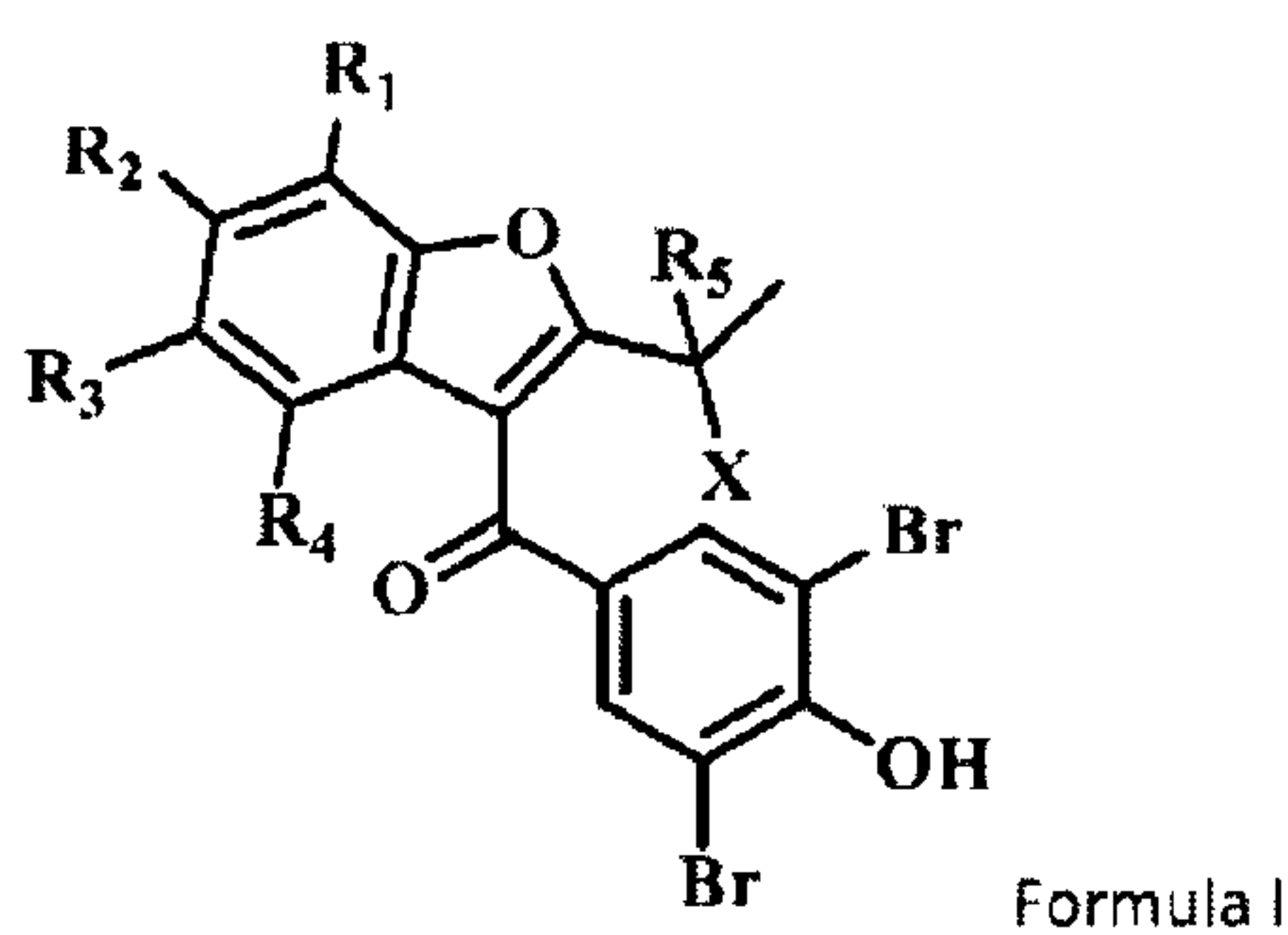
wherein -R<sub>1</sub>, -R<sub>3</sub>, -R<sub>4</sub> and -R<sub>5</sub> are each independently selected from a group consisting of -H, -deuterium, -F, -Cl, -Br, -I, -CN, -C<sub>1</sub>-C<sub>6</sub>-alkyl, C<sub>6</sub>-C<sub>14</sub>-aryl, substituted -C<sub>6</sub>-C<sub>14</sub>-aryl, C<sub>1</sub>-C<sub>14</sub>-alkoxy, -hydroxyl, -carboxyl, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -OR<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub> and -NHCO<sub>2</sub>R<sub>6</sub>, wherein -R<sub>6</sub> is phenyl or naphthyl, optionally substituted with one or three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and wherein the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen;

wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub>, and -R<sub>5</sub> is deuterium; and

wherein the compound of Formula 1 is present in a therapeutically effective amount to treat a condition associated with hyperuricemia.

32. A method of manufacturing a liquid pharmaceutical composition for treating a condition associated with hyperuricemia or gout, comprising:

formulating a liquid formulation that contains a pharmaceutically acceptable carrier and a compound of formula 1 or a pharmaceutically acceptable salt thereof;



wherein:

-X is -OH, -OR, -OC(O)R, -NH<sub>3</sub><sup>+</sup>, -NO<sub>2</sub>, -SO<sub>2</sub>R, -CN, -SO<sub>3</sub>H, -CHO, -COOH, -COCl, -CONH<sub>2</sub>, -F, -Cl, -Br or -I, wherein -R is a -H, -C<sub>1</sub>-C<sub>10</sub> alkyl or a -C<sub>1</sub>-C<sub>10</sub> substituted alkyl;

wherein  $-R_2$  is  $-deuterium$  or  $-H$ ; and

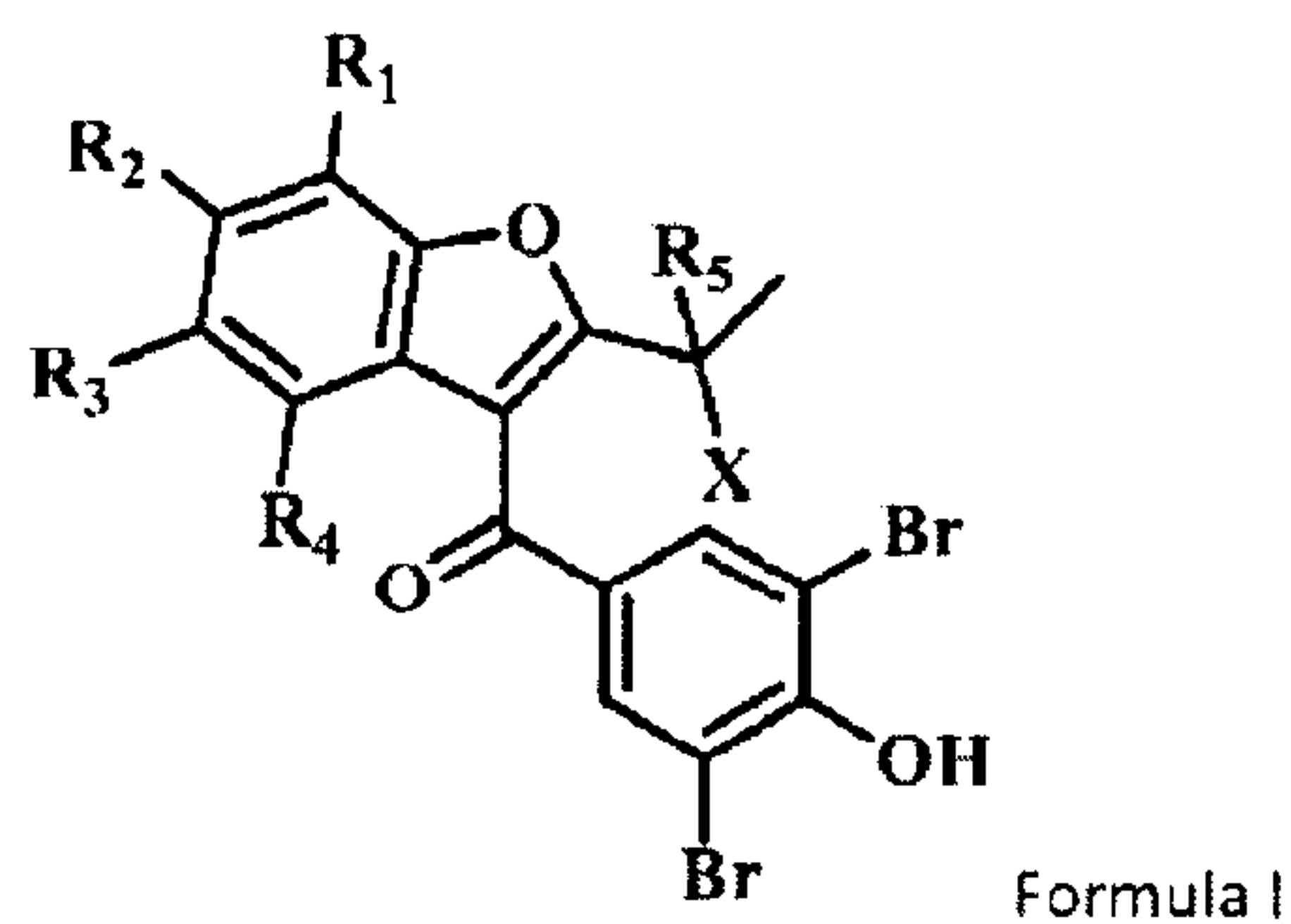
wherein  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from a group consisting of  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6-alkyl$ ,  $C_6-C_{14}-aryl$ , substituted  $-C_6-C_{14}-aryl$ ,  $C_1-C_{14}-alkoxy$ ,  $-hydroxyl$ ,  $-carboxyl$ ,  $-C_1-C_6-alkylsulfonyl$ ,  $-trifluoromethyl$ ,  $-C_1-C_6-alkanoyloxy$ ,  $-C_1-C_6-alkylthio$ ,  $-C_1-C_6-alkylsulfonyl$ ,  $-C_2-C_6-alkoxycarbonyl$ ,  $-C_2-C_6-alkanoylamino$ ,  $-O-R_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NHSO_2R_6$  and  $-NHCO_2R_6$ , wherein  $-R_6$  is phenyl or naphthyl, optionally substituted with one or three groups selected from  $-C_1-C_6-alkyl$ ,  $-C_6-C_{10}-aryl$ ,  $-C_1-C_6-alkoxy$  and halogen, and  $-C_4-C_{20}-hydroxyheteroaryl$ , and wherein the heteroatoms in  $-C_4-C_{20}-hydroxyheteroaryl$  are selected from the group consisting of nitrogen and oxygen;

wherein at least one of  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$ , and  $-R_5$  is deuterium; and

wherein the compound of Formula 1 is present in a therapeutically effective amount to treat a condition associated with hyperuricemia.

33. A method of inhibiting at least one kidney transporter responsible for uric acid reabsorption in renal tubules, comprising:

administering a therapeutically effective amount of a compound of formula 1, or a pharmaceutically acceptable salt thereof;



wherein:

$-X$  is  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$  or  $-I$ , wherein  $-R$  is a  $-H$ ,  $-C_1-C_{10}$  alkyl or a  $-C_1-C_{10}$  substituted alkyl;

wherein  $-R_2$  is  $-deuterium$  or  $-H$ ; and

wherein  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from a group consisting of  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6-alkyl$ ,  $C_6-C_{14}-$



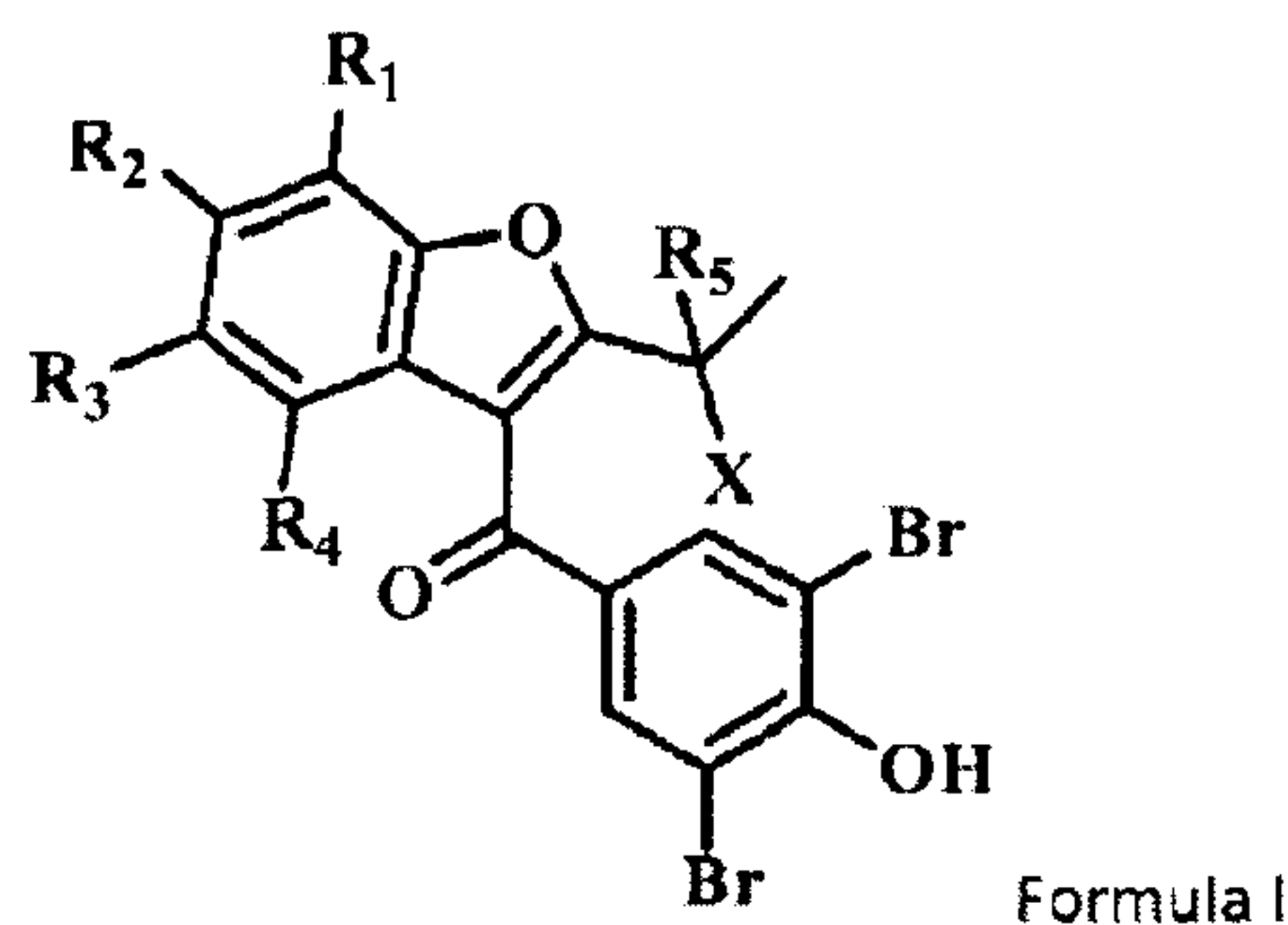
aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$ -alkoxy, -hydroxyl, -carboxyl,  $-C_1-C_6$ -alkylsulfonyl, -trifluoromethyl,  $-C_1-C_6$ -alkanoyloxy,  $-C_1-C_6$ -alkylthio,  $-C_1-C_6$ -alkylsulfonyl,  $-C_2-C_6$ -alkoxycarbonyl,  $-C_2-C_6$ -alkanoylamino,  $-O-R_6$ ,  $-S_2R_6$ ,  $-SO_2-R_6$ ,  $-NHSO_2R_6$  and  $-NHCO_2R_6$ , wherein  $-R_6$  is phenyl or naphthyl, optionally substituted with one or three groups selected from  $-C_1-C_6$ -alkyl,  $-C_6-C_{10}$ -aryl,  $-C_1-C_6$ -alkoxy and halogen, and  $-C_4-C_{20}$ -hydroxyheteroaryl, and wherein the heteroatoms in  $-C_4-C_{20}$ -hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen;

wherein at least one of  $-R_1$ ,  $-R_2$ ,  $-R_3$ ,  $-R_4$ , and  $-R_5$  is deuterium.

34. The method of claim 33, wherein mediating renal reabsorption of uric acid comprises modulating URAT1 activity.

35. A method of treating a condition, disorder or disease mediated by at least one kidney transporter responsible for uric acid reabsorption in renal tubules, comprising:

administering an effective amount of a composition comprising a pharmaceutically acceptable carrier and a compound of formula 1 or a pharmaceutically acceptable salt thereof;



wherein:

$-X$  is  $-OH$ ,  $-OR$ ,  $-OC(O)R$ ,  $-NH_3^+$ ,  $-NO_2$ ,  $-SO_2R$ ,  $-CN$ ,  $-SO_3H$ ,  $-CHO$ ,  $-COOH$ ,  $-COCl$ ,  $-CONH_2$ ,  $-F$ ,  $-Cl$ ,  $-Br$  or  $-I$ , wherein  $-R$  is a  $-H$ ,  $-C_1-C_{10}$  alkyl or a  $-C_1-C_{10}$  substituted alkyl;

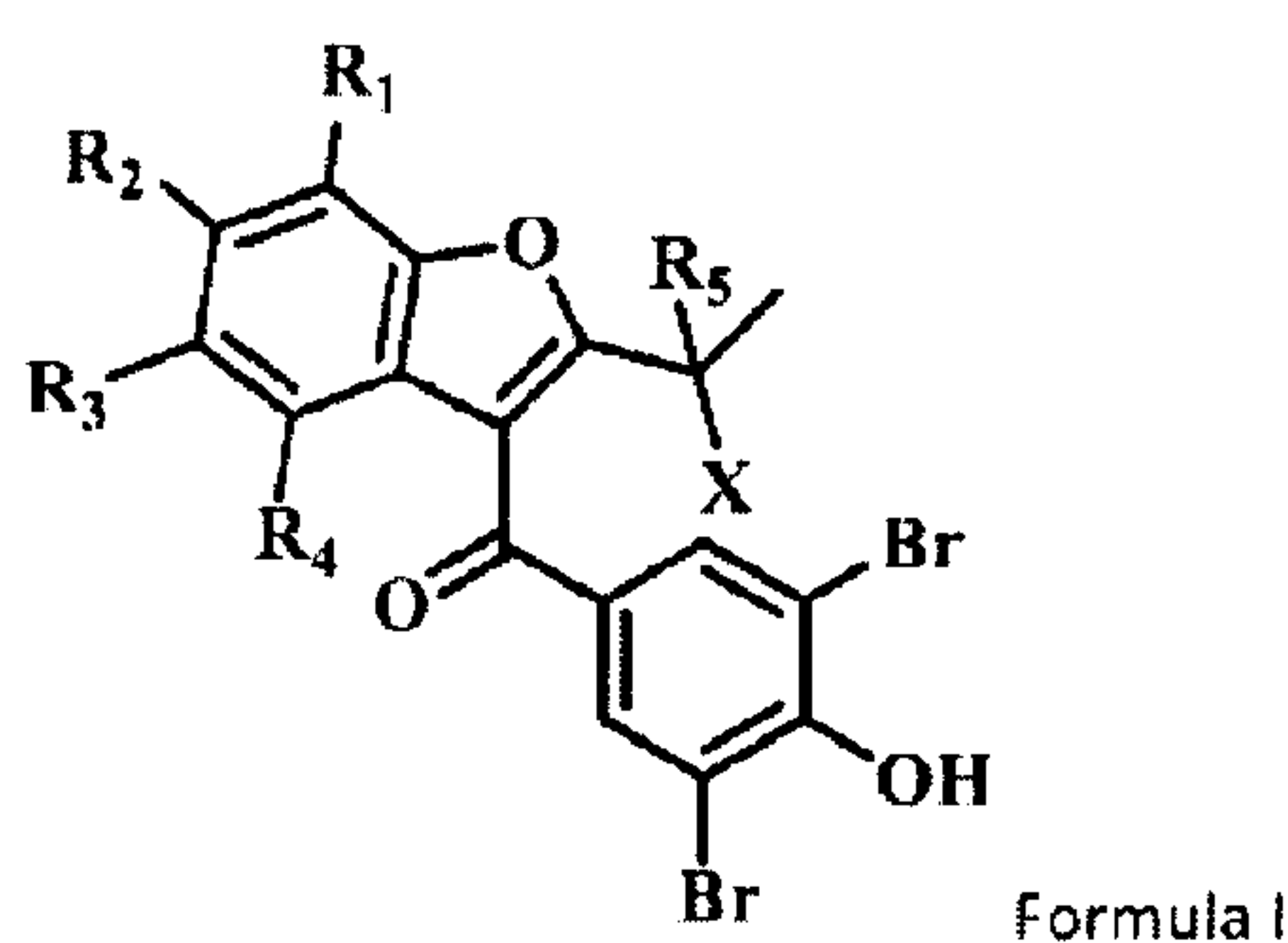
wherein  $-R_2$  is  $-deuterium$  or  $-H$ ; and

wherein  $-R_1$ ,  $-R_3$ ,  $-R_4$  and  $-R_5$  are each independently selected from a group consisting of  $-H$ ,  $-deuterium$ ,  $-F$ ,  $-Cl$ ,  $-Br$ ,  $-I$ ,  $-CN$ ,  $-C_1-C_6$ -alkyl,  $C_6-C_{14}$ -aryl, substituted  $-C_6-C_{14}$ -aryl,  $C_1-C_{14}$ -alkoxy, -hydroxyl, -carboxyl,  $-C_1-$

C<sub>6</sub>-alkylsulfonyl, -trifluoromethyl, -C<sub>1</sub>-C<sub>6</sub>-alkanoyloxy, -C<sub>1</sub>-C<sub>6</sub>-alkylthio, -C<sub>1</sub>-C<sub>6</sub>-alkylsulfonyl, -C<sub>2</sub>-C<sub>6</sub>-alkoxycarbonyl, -C<sub>2</sub>-C<sub>6</sub>-alkanoylamino, -O-R<sub>6</sub>, -S<sub>2</sub>R<sub>6</sub>, -SO<sub>2</sub>-R<sub>6</sub>, -NHSO<sub>2</sub>R<sub>6</sub> and -NHCO<sub>2</sub>R<sub>6</sub>, wherein -R<sub>6</sub> is phenyl or naphthyl, optionally substituted with one or three groups selected from -C<sub>1</sub>-C<sub>6</sub>-alkyl, -C<sub>6</sub>-C<sub>10</sub>-aryl, -C<sub>1</sub>-C<sub>6</sub>-alkoxy and halogen, and -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl, and wherein the heteroatoms in -C<sub>4</sub>-C<sub>20</sub>-hydroxyheteroaryl are selected from the group consisting of nitrogen and oxygen; and

wherein at least one of -R<sub>1</sub>, -R<sub>2</sub>, -R<sub>3</sub>, -R<sub>4</sub>, and -R<sub>5</sub> is deuterium.

36. A compound of Formula 1, or a pharmaceutically acceptable salt thereof;



wherein:

-X is -OH, -OR, -F, -Cl, -Br or -I, wherein -R is a -H, -C<sub>1</sub>-C<sub>10</sub> alkyl or a -C<sub>1</sub>-C<sub>10</sub> substituted alkyl;

wherein -R<sub>2</sub> is -deuterium;

wherein R<sub>3</sub> is -F; and

wherein each of -R<sub>1</sub>, -R<sub>4</sub>, and -R<sub>5</sub> are selected from the group consisting of -H and -deuterium .

37. Use of the compound of claim 36 in the manufacture of a drug.

38. Use of the compound of claim 36 to treat a condition associated with hyperuricemia or gout.

39. Use of the compound of claim 36 to modulate URAT1 activity in a person.

40. Use of the compound of claim 36 to treat or prevent a disorder or disease mediated by URAT1 activity.

41. Use of the compound of claim 36 in combination with a xanthine oxidase inhibitor to treat a condition associated with hyperuricemia, gout or diabetes.

42. The composition of claim 10, wherein the composition is an enantiomer-enriched composition.

43. The composition of claim 10, wherein the composition is a single enantiomer composition.

44. The compound of claim 1, wherein the compound shows improved stability relative to benzbromarone while retaining activity of benzbromarone against a URAT1 transporter.