Title of the Invention: C5 or C6 monosaccharide (E)-3(Furan-2-YL)Maconoacrylates, their preparation methods and uses thereof

Abstract Title: C5 or C6 monosaccharide (E)-3(Furan-2-YL)Maconoacrylates, their preparation methods and uses thereof

Disclosed are C5 or C6 monosaccharide-(E)-3-(furan-2-yI)monoacrylates of formula (1), their preparation methods and uses thereof, wherein R represents C5 or C6 monosaccharide residue. Said compounds are prepared by reacting (E)-3-(furan-2-yI) acrylic acid with C5 or C6 monosaccharide. Said compounds can be used as tobacco humectants.

![Chemical Structure](image)

This international application has entered the national phase early.
C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates, their preparation methods and uses thereof

FIELD OF THE INVENTION

The present invention belongs to the field of tobacco technology, and relates to tobacco humectants which is a compound of monosaccharide and monoester, specifically the present invention is directed to C5 or C6 monosaccharide -(E)-3-(furan-2-yl)monoacrylates, their preparation methods and uses thereof.

BACKGROUND OF THE INVENTION

The moisturizing performance of the cigarette is closely related to the quality of cigarette, the study of increasing aroma and keeping moisture is one of the main directions of scientific and technological research and technological innovation in the next few years of China’s tobacco industry. Currently, humectants used in cigarette production in China are mainly polyhydroxy substances such as glycerin, propylene glycol, xylitol, etc., which rely mainly on the moisture absorption from environment to keep the tobacco moist and lubricated and play the role of the moisturizing and lubricating, so that is of unidirectional humectants. Although such humectants may maintain the moisture content of the tobacco during processing to improve the workability of the tobacco, its ability in maintaining moisture content of the finished cigarette and in improving smoking comfort is not entirely satisfactory. Further, since such multi-hydroxyl humectants have no dehumidifying effect, the moisture content of the tobacco processed with such humectants is more influenced by the ambient temperature and humidity. That is to say, the tobacco tends to lose moisture in a dry environment, causing an increase in its dryness and irritant properties, while the tobacco tends to absorb moisture in a warm humid environment causing it to go moldy. Therefore, research and development for new bidirectional or composite humectants with the effect of maintaining moisture, dehumidifying as well as sustained-release of aroma, has important practical significance to improve the moisture maintenance and the international competitiveness of the cigarette products in China.

SUMMARY OF THE INVENTION

The purpose of the present invention is to provide C5 or C6
monosaccharide-(E)-3-(furan-2-yl)monoacrylates.

A second purpose of the present invention is to disclose preparation methods of the C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates.

A third purpose of the present invention is to disclose uses of the C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates.

The purpose of the present invention is realized by a C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylate (hereinafter referred to: monoeaster derivatives of a C5 or C6 monosaccharide) with the following formula, the chemical structural formula is:

![Chemical structural formula]

Wherein, R represents a residue of C5 or C6 monosaccharide, the C5 monosaccharide is selected from the group consisting of: xylose, ribose, arabinose, lyxose, ribulose or xylulose; the C6 monosaccharide is selected from: glucose, galactose, mannose, fructose, sorbose, gulose, mannitol, sorbitol, 1,4 - anhydroinositol or 3,6 - anhydroinositol.

The second purpose of the present invention is realized like this: a method for preparing a compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates, wherein the method comprises the step of :

![Chemical reaction diagram]

After the initial materials, including the (E)-3-(furan-2-yl) acrylic acid and the C5 monosaccharide or C6 monosaccharid, were added to the solvent, a condensing agent was also added for condensation reaction in the presence of a catalyst; after reacting for a period of time, then through processing, to obtain the corresponding mixture of C5 or C6 monosaccharide-(E)-3-(furan-2-yl) acrylic monoester and polyester; the resulting mixture of monoesters and polyesters is purified by recrystallization or column chromatography and the corresponding mixture of C5 or C6 monosaccharide-(E)-3-(furan-2-yl) monoacrylates is obtained.
The specific preparation methods are described below:

The feed ratio in molar of (E)-3-(furan-2-yl) acrylic acid and the C5 monosaccharide or C6 monosaccharide during condensation reaction is 1.0:0.2 ~ 10.0; the preferred feed ratio in molar is 1.0:1.0 ~ 3.0.

The solvent used in the condensation reaction is as follows: ether solvent (diethyl ether, isopropyl ether or methyl tert-butyl ether), petroleum ether, n-heptane, tetrahydrofuran, N,N-dimethyl formamide, N-methyl pyrrolidone, dimethylsulfoxide, water, ethyl acetate, isopropyl acetate, dichloromethane, chloroform, C3 ~ C8 aliphatic ketone, benzene, toluene or pyridine; the solvent is preferably selected from the group consisting of tetrahydrofuran, N,N-dimethyl formamide, methylene chloride, ethyl acetate or pyridine.

The condensing agent used in the reaction is as follows: chloro formic acid esters (methylchloroformate, ethyl chloroformate, isopropyl chloroformate), dicyclohexylcarbodiimide (DCC), 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide hydrochloride (EDCI), carbonyldiimidazole imidazole (CDI), N-Ethoxycarbonyl-2-ethoxy-1,2-dihydroquinoline (EEDQ), diethyl cyanophosphonate (DEFC), 2-chloro-4,6-dimethoxy-1,3,5-triazine (CDMT) or chlorinated 4-(4,6-dimethoxy-1,3,5-triazin-2-yl)-4-methyl morpholine salt (DMTMM).

The feed ratio in molar of the condensing agent and (E)-3-(furan-2-yl) acrylic acid is 1.0 ~ 5.0:1.0, and the preferred feed ratio in molar is 1.0 ~ 2.0:1.0.

The catalyst used in the reaction is 4-dimethylaminopyridine (DMAP); The feed ratio in molar of the catalyst and (E)-3-(furan-2-yl) acrylic acid is 0.01 ~ 1.0:1.0, and the preferred feed ratio in molar is 0.05 ~ 0.3:1.0.

The condensation reaction temperature is -10°C ~ 130°C, and the reaction temperature is preferably 0 ~ 50°C; the condensation reaction time is 20 minutes ~ 48 hours, and the preferred reaction time is 1 ~ 24 hours.

The third purpose of the present invention is realized by: the present invention disclosed the compounds C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates which can be used as tobacco humectants; since such humectants are both water-soluble and lipo-soluble to some extent, the bilayer protection film where the oil and water are separated can be formed on the tobacco surface to stabilize the moisture content of cigarettes, to achieve the effect of maintaining lubrication, dehumidifying and slow-release of aroma.

Compared with the current technology, the beneficial effect of the invention is as
follows:

1. The present invention disclosed the tobacco humectants of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates by which the bilayer protection film where the oil and water are separated can be formed on the tobacco surface, thus they have dual effect of maintaining moisture and dehumidifying; the tobacco treated with such humectants loses moisture extremely slowly in dry climates, while also absorbs moisture extremely slowly in humid climates, that effectively reduces the changes in tobacco moisture content due to environmental conditions.

2. The present invention discloses the tobacco humectants of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates by which the bilayer protection film where the oil and water are separated can be formed on the tobacco surface, thus they can slow down significantly the volatilization of the aroma constituents in the tobacco, so they have the effect of slow-release of aroma.

3. The tobacco humectants of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates disclosed in the present invention are themselves unscented, however they can produce aromatic properties by thermal cracking or degradation during suction so as to improve the aroma of the cigarette. These aromatic properties exist inherently in the tobacco, but only at a low level. Accordingly, such tobacco humectants disclosed in the present invention themselves have no odor, and have good compatibility with tobacco.

4. Compared with propylene glycol or glycerol that are widely used in the current tobacco industry, the end product of the tobacco humectants of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates disclosed in the present invention after combustion are non-toxic and safe for use, which is advantageous to improving safety of tobacco smoking, and is applicable and practical to use.

**DETAILED DESCRIPTION OF THE INVENTION**

The present invention will be further described in the following examples, however, the scope of the present invention is not limited to the following examples. Persons skilled in the art can understand that various changes and modifications of the present invention can be made without departing from the spirit and scope of the invention as claimed.

Example 1:
Preparation of the 6-[(2E)-3-furan-2-yl-2-acrylic acid]-D- glucopyranose ester (Compound
I):

D-glucose 18.0 g (0.1 mol), (E)-3-(furan-2-yl) acrylic acid 16.58 g (0.12 mol) and 200 ml N, N-dimethylformamide, were sequentially added to the reaction flask at room temperature, stir them until the solid was dissolved; add 4-dimethylamino 1.23 g (0.01 mol) of pyridine; and after the reaction solution was cooled to 0 ~ 5 °C, add 24.76g (0.12 mol) of dicyclohexyl carbodiimide; continue to stirring for reaction for 1 hour at 0 ~ 5°C, then the temperature rises naturally to room temperature, and the reaction mixture was stirred for 20 hours for reaction; the precipitated solid was filtered after the reaction ended, and the solvent was distilled off under reduced pressure from the filtrate; the residue liquid was dissolved in 200 ml of methylene chloride, and washed sequentially with 40 ml of 10% aqueous hydrochloric acid, 50 ml of saturated sodium carbonate aqueous solution and 50 ml of saturated brine; the resulting dichloromethane solution was dried over using anhydrous Na₂SO₄, then filtered, and dichloromethane was distilled off under reduced pressure, obtaining (E) -3 - (furan -2 -yl) acrylic acid monoester and multi-ester mixture of glucose; the mixture was purified by silica gel column chromatography (eluent: chloroform: methanol = 5:1), obtaining 13.87 g of 6 - [(2E) -3 - furans -2 - yl) -2 - acrylic acid]-D- glucopyranose ester, the harvest rate of 46.2%; HR-TOFMS (+Q) m/z: 301.0930 ([C₁₃H₁₆O₈+H]⁺ Calculated value: 301.0923).

Example 2:

Preparation of the 6- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D- galactosyl pyranose ester (Compound II):

The procedure was same as in Example 1, except for that D-glucose was replaced with D-galactose, dicyclohexyl carbodiimide was replaced with 1-ethyl-1-3-(3-dimethylaminopropyl) carbodiimide hydrochloride, N, N-dimethylformamide is replaced with tetrahydro furans, obtaining 6 - [(2E) -3 - furans -2 - yl) -2 - acrylic acid]-D - galactosyl pyranose ester, the harvest rate of 50.7%; HR-TOFMS (+ Q) m/z: 301.0928 ([C₁₃H₁₆O₈+H]⁺ Calculated value: 301.0923).

Example 3:

Preparation of the 6- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D-mannose pyranose ester (Compound III):

The procedure was same as in Example 1, except for that D-glucose is replaced with D-mannose, dicyclohexyl carbodiimide is replaced with N-ethoxycarbonyl-2-ethoxy-1 ,2 - dihydroquinoline, N, N-dimethyl formamide is replaced with pyridine, obtaining 6 - [(2E) -3
-(furans -2 - yl) -2-acrylic acid]-D- mannose pyranose ester, the harvest rate of 42.5%;
HR-TOFMS (+ Q) m/z: 301.0912 ([C_{13}H_{16}O_{8}+H]^+ Calculated value: 301.0923).

Example 4:
Preparation of the 1- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D-sorbitol pyranose ester
(Compound IV):

The procedure was same as in Example 1, except for D-glucose is replaced with
d-sorbitol, dicyclohexyl carbodiimide is replaced with Carbonyldimidazole, N, N-dimethyl
formamide is replaced with Dichloromethane, obtaining 1- [(2E) -3- (furan-2-yl) -2-acrylic
acid]-D- sorbitol pyranose ester, the harvest rate of 40.0%; HR-TOFMS (+ Q) m/z: 323.0740
([C_{13}H_{16}O_{8}+Na]^+ Calculated value: 323.0743).

Example 5:
Preparation of the 1- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D- fructose pyranose ester
(Compound V):

The procedure was same as in Example 1, except for D-glucose is replaced with
D-fructose, dicyclohexyl carbodiimide is replaced with Methyl chloroformate, N,
N-dimethyl formamide is replaced with Pyridine, obtaining 1- [(2E) -3- (furan-2-yl)
-2-acrylic acid]-D- fructose pyranose ester, the harvest rate of 52.0%; HR-TOFMS (+ Q) m/z:
323.0735 ([C_{13}H_{16}O_{8}+Na]^+ Calculated value: 323.0743).

Example 6:
Preparation of the 1- [(2E) -3- (furan-2-yl) -2-acrylic acid]-mannitol ester (Compound
VI):

The procedure was same as in Example 1, except for D-glucose is replaced with
mannitol, obtaining 1- [(2E) -3- (furan-2-yl) -2-acrylic acid]- mannitol ester, the harvest rate
of 58.0%; HR-TOFMS (+ Q) m/z: 303.1088 ([C_{13}H_{16}O_{8}+H]^+ Calculated value: 303.1080).

Example 7:
Preparation of the 1- [(2E) -3- (furan-2-yl) -2-acrylic acid]-sorbitol ester (Compound
VII):

The procedure was same as in Example 1, except for D-glucose is replaced with
sorbitol, obtaining 1- [(2E) -3- (furan-2-yl) -2-acrylic acid]- sorbitol ester, the harvest rate of
62.0%; HR-TOFMS (+ Q) m/z: 303.1086 ([C_{13}H_{16}O_{8}+H]^+ Calculated value: 303.1080).

Example 8:
Preparation of the 6-[(2E)-3-(furan-2-yl)-2-acrylic acid]-1,4- anhydroxyfaffitol ester
(Compound VIII):
The procedure was same as in Example 1, except for D-glucose is replaced with 1,4-anhydrosoorbitol, obtaining 6-[(2E)-3- (furan-2-yl) -2-acrylic acid]- 1,4- anhydrosoorbitol ester, the harvest rate of 76.6%; HR-TOFMS (+ Q) m/z: 285.0980 ([C_{13}H_{16}O_{7}+H]^{+} Calculated value: 285.0974).

Example 9:

Preparation of the 1-[(2E)-3-(furan-2-yl)-2-acrylic acid]-3,6- anhydrosoorbitol ester (Compound IX):

The procedure was same as in Example 1, except for D-glucose is replaced with 3,6-Sorbitan, obtaining 1- [(2E) -3- (furan-2-yl)-2-acrylic acid]- 3,6- anhydrosoorbitol ester, the harvest rate of 83.2%; HR-TOFMS (+ Q) m/z: 285.0978 ([C_{13}H_{16}O_{7}+H]^{+} Calculated value: 285.0974).

Example 10:

Preparation of the 5- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D- xylose furanose ester (Compound X):

The procedure was same as in Example 1, except for D-glucose is replaced with D-xylose, dicyclohexyl carbodiimide is replaced with Ethyl chloroformate, N, N-dimethyl formamide is replaced with Dimethyl sulfoxide, obtaining 5- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D- xylose furanose ester, the harvest rate of 52.7%; HR-TOFMS (+Q) m/z: 270.0748 ([C_{12}H_{13}O_{7}+H]^{+} Calculated value: 270.0740).

Example 11:

Preparation of the 5- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D- ribose furanose ester (Compound XI):

The procedure was same as in Example 1, except for D-glucose is replaced with D-ribose, dicyclohexyl carbodiimide is replaced with Isopropyl chloroformate, N, N-dimethyl formamide is replaced with Isopropyl acetate, obtaining 5- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D- ribose furanose ester, the harvest rate of 61.3%; HR-TOFMS (+Q) m/z: 270.0743 ([C_{13}H_{13}O_{7}+H]^{+} Calculated value: 270.0740).

Example 12:

Preparation of the 5- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D- arabinose furanose ester (Compound XII):

The procedure was same as in Example 1, except for D-glucose is replaced with D-arabinose, dicyclohexyl carbodiimide is replaced with Hydrogen diethylphosphite, N, N-dimethyl formamide is replaced with Chloroform, obtaining 5- [(2E) -3- (furan-2-yl)
-2-acrylic acid]-D- arabinose furanose ester, the harvest rate of 55.8%; HR-TOFMS (+Q) m/z: 270.0733 ([C\textsubscript{12}H\textsubscript{13}O\textsubscript{7}+H] \textsuperscript{+} Calculated value: 270.0740).

Example 13:
Preparation of the 5- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D-lyxose furanose ester (Compound XIII):

The procedure was same as in Example 1, except for D-glucose is replaced with D-lyxose, dicyclohexyl carbodiimide is replaced with 2 - chloro -4.6 - dimethoxy -1 ,3.5 - triazine, N, N-dimethyl formamide is replaced with Pyridine, obtaining 5- [(2E) -3- furan-2-yl)-2-acrylic acid]-D-lyxose furanose ester ; the harvest rate of 52.8%; HR-TOFMS (+Q) m/z: 270.0730 ([C\textsubscript{12}H\textsubscript{13}O\textsubscript{7}+H] \textsuperscript{+} Calculated value: 270.0740).

Example 14:
Preparation of the 1- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D-ribulose ester (Compound XIV):

The procedure was same as in Example 1, except for D-glucose is replaced with D-ribulose, dicyclohexyl carbodiimide is replaced with Chloride 4-(4,6-dimethoxy-1,3,5-triazin-2-yl) -4-methyl-morpholine, N, N-dimethyl formamide is replaced with Pyridine, obtaining 1- [(2E) -3-(furan-2-yl) -2-acrylic acid]-D-ribulose ester, the harvest rate of 50.5%; HR-TOFMS (+Q) m/z: 270.0725 ([C\textsubscript{12}H\textsubscript{13}O\textsubscript{7}+H] \textsuperscript{+} Calculated value: 270.0740).

Example 15:
Preparation of the 1- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D- ketoxylose ester (Compound XV):

The procedure was same as in Example 1, except for D-glucose is replaced with D-xylulose, N, N-dimethyl formamide is replaced with Pyridine, obtaining 1- [(2E) -3-(furan-2-yl) -2-acrylic acid]-D- ketoxylose ester ; the harvest rate of 49.7%; HR-TOFMS (+Q) m/z: 270.0725 ([C\textsubscript{12}H\textsubscript{13}O\textsubscript{7}+H] \textsuperscript{+} Calculated value: 270.0740).

Example 16:
Preparation of the 6- [(2E) -3- (furan-2-yl) -2-acrylic acid]-D-gulose pyranose ester (Compound XVI):

The procedure was same as in Example 1, except for D-glucose is replaced with D-gulose, obtaining 6-[(2E) -3- (furan-2-yl) -2-acrylic acid]-D-gulose pyranose esters ; the harvest rate of 44.5%; HR-TOFMS (+Q) m/z: 301.09120 ([C\textsubscript{13}H\textsubscript{15}O\textsubscript{8}+H] \textsuperscript{+} Calculated value:
Example 17:

Tested the effects of the moisturizing, dehumidifying, and the sustained-release material incense:

For the compounds C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylate (Compound I to XVI) disclosed herein, evaluate its moisturizing, dehumidifying, and the effect of the sustained-release material incense by the following method.

(1) Tested the effects of the moisturizing, dehumidifying:

Added the cut tobacco samples of propylene glycol as controls, the comparative experiment of moisturizing effect between the cut tobacco of the above compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylate (Compound I to XVI) was made. The solution of propylene glycol and said monosaccharide-monoester compound is added to the cut tobacco, respectively (the Humectants in an amount of 0.05 ~ 1.0% of the tobacco weight); then the processed tobacco samples were placed in four temperature humidity chambers of different conditions (said four conditions were: temperature of 10°C and relative humidity of 40%, temperature of 30°C and relative humidity of 40%, temperature of 10°C and relative humidity of 80%, temperature of 30°C and relative humidity of 80%, respectively); weigh that once every 24 hours, a total of 6 times, and calculate the rate of the water content of the cut tobacco, respectively.

The test results demonstrates that the above compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylate (Compound I to XVI) have different degree effects of moisturizing and dehumidifying, the effect is better than that of propylene glycol control group.

(2) Tested the effects of the sustained-release material incense:

Added the cut tobacco samples of propylene glycol as controls, the comparative experiment of the effect to sustained-release material incense between the cut tobacco of the above compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylate (Compound I to XVI) was made. The solution of propylene glycol and said monosaccharide-monoester compound is added to the cut tobacco, respectively (the Humectants used in an amount of 0.05 ~ 1.0% of the tobacco weight); after the various cut tobacco samples are placed for a period of time, sample each of 0.5 g, respectively, and then using dichloromethane as the
solvent was subjected to ultrasonic extraction; after the extracted dichloromethane solution was filtrated through the millipore filter, the content of the aroma substances in the filtrate was analysed by using gas chromatography-mass spectrometry analysis.

The test result shows that the content of the typically aroma substance in the cut tobacco samples, which is treated with the above monosaccharide-monoesters compound, is higher than that treated with the propylene glycol with different degrees, indicating that the compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylate disclosed in the present invention have the efficacy of slowing-down the volatilization of flavor substances in the tobacco.
Claims

1. A compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylate with the following formula:

![Chemical Structure](image)

wherein, R represents a residue of C5 or C6 monosaccharide; the C5 monosaccharide is selected from the group consisting of: xylose, ribose, arabinose, lyxose, ribulose or xylulose; the C6 monosaccharide is selected from the group consisting of: glucose, galactose, mannose, fructose, sorbose, gulose, mannitol, sorbitol, 1,4 - anhydrosorbitol or 3,6 - anhydrosorbitol.

2. A method for preparing a compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates with the following formula, wherein the method comprises the step of:

![Chemical Reaction](image)

adding the initial material, including the (E)-3-(furan-2-yl) acrylic acid and the C5 monosaccharide or C6 monosaccharid to the solvent, and adding a condensing agent to conduct condensation reaction in the presence of a catalyst after reacting for a period of time, then through processing, obtaining the corresponding mixture of C5 or C6 monosaccharide-(E)-3-(furan-2-yl) acrylic monoester and polyester; purifying the resulting mixture of monoesters and polyesters by recrystallization or column chromatography and the corresponding mixture of C5 or C6 monosaccharide-(E)-3-(furan-2-yl) monoacrylates are obtained;

the condensing agent used in the reaction is as follows; chloro formic acid esters, dicyclohexylcarbodiimide, 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide hydrochloride, carbonyldiimidazole imidazole, N-Ethoxycarbonyl-2-ethoxy-1,2-dihydroquinoline, diethyl
cyanophosphonate, 2-chloro-4,6-dimethoxy-1,3,5-triazine or chlorinated 4-(4,6-dimethoxy-1,3,5-triazin-2-yl)-4-methyl morpholine salt; the catalyst used in the reaction is 4-dimethylaminopyridine.

3. A method for preparing a compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates according to claim 2, characterized in that: said solvent is preferably selected from the group consisting of tetrahydrofuran, N,N-dimethyl formamide, methylene chloride, ethyl acetate or pyridine.

4. A method for preparing a compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates according to claim 2, characterized in that: the feed ratio in molar of (E)-3-(furan-2-yl) acrylic acid and the C5 monosaccharide or C6 monosaccharid during condensation reaction is 1.0:0.2 ~ 10.0.

5. A method for preparing a compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates according to claim 4, characterized in that: the feed ratio in molar of (E)-3-(furan-2-yl) acrylic acid and the C5 monosaccharide or C6 monosaccharid during condensation reaction is preferably 1.0:1.0 ~ 3.0.

6. A method for preparing a compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates according to claim 2, characterized in that: the feed ratio in molar of the condensing agent and (E)-3-(furan-2-yl) acrylic acid is 1.0 ~5.0:1.0.

7. A method for preparing a compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates according to claim 6, characterized in that: (E)-3-(furan-2-yl)monoacrylates according to claim 2, characterized in that: the feed ratio in molar of the condensing agent and (E)-3-(furan-2-yl) acrylic acid is preferably 1.0~2.0:1.0.

8. A method for preparing a compound of C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates according to claim 2, characterized in that: the feed ratio
in molar of the catalyst and (E)-3-(furan-2-y1) acrylic acid is 0.01~1.0:1.0; the condensation reaction temperature is -10°C~130°C; the condensation reaction time is 20 minutes ~ 48 hours.

9. A method for preparing a compound of C5 or C6 monosaccharide-(E)-3-(furan-2-y1) monoacrylates according to claim 8, characterized in that: the feed ratio in molar of the catalyst and (E)-3-(furan-2-y1) acrylic acid is preferably 0.05~0.3:1.0; the condensation reaction temperature is preferably 0~50°C; the condensation reaction time is preferably 1~24 hours.

10. A compound of C5 or C6 monosaccharide-(E)-3-(furan-2-y1) monoacrylate according to claim 1 used as tobacco humectants.
PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT
(PCT Article 18 and Rules 43 and 44)

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<tr>
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<th>FOR FURTHER ACTION</th>
<th>see Form PCT/ISA/220 as well as, where applicable, item 5 below.</th>
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Applicant

CHINA TOBACCO CHUANYU INDUSTRIAL CORPORATION et al.

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 6 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report
   a. With regard to the language, the international search was carried out on the basis of:
      ☑ the international application in the language in which it was filed
      ☐ a translation of the international application into _____________________, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 43.6bis(a)).
   c. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, see Box No. I.

2. ☐ Certain claims were found unsearchable (see Box No. II)

3. ☐ Unity of invention is lacking (see Box No. III)

4. With regard to the title,
   ☑ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,
   ☐ the text is approved as submitted by the applicant.
   ☑ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the drawings,
   a. The figure of the drawings to be published with the abstract is Figure No. __________________
      ☐ as suggested by the applicant
      ☐ as selected by this Authority, because the applicant failed to suggest a figure
      ☐ as selected by this Authority, because this figure better characterizes the invention
   b. ☐ none of the figures is to be published with the abstract

Form PCT/ISA/210(first sheet)(July 2009)
Disclosed are C5 or C6 monosaccharide-(E)-3-(furan-2-yl)monoacrylates of formula (1), their preparation methods and uses thereof, wherein R represents C5 or C6 monosaccharide residue. Said compounds are prepared by reacting (E)-3-(furan-2-yl) acrylic acid with C5 or C6 monosaccharide. Said compounds can be used as tobacco humectants.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: C07H13/04, C07H1/00, A24B15/40

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

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

WPI, Sipoabs, CNPAT, CNKI, REG, Caplus,
humectant, furanyl, glycoside or glycosides, structure search according to the general formula in claim 1

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Relevant to claim No.</th>
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* Further documents are listed in the continuation of Box C.  See patent family annex.

Special categories of cited documents:

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search: 27 July 2011 (27.07.2011)

Date of mailing of the international search report: 11 Aug. 2011 (11.08.2011)

Name and mailing address of the ISA/CN

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Authorized officer

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Telephone No. (86-10)62086343

Form PCT/ISA/210 (second sheet) (July 2009)
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| A        | CN1204482 A (LU Chichang) 13 Jan. 1999 (13.01.1999)  
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Form PCT/ISA/210 (patent family annex) (July 2009)
INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2011/000777

A. CLASSIFICATION OF SUBJECT MATTER

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

C07H13/04 (2006.01)i
C07H1/00 (2006.01)i
A24B15/40 (2006.01)i