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PAPER

The multicomponent reaction of imidazo[1,5-*a*]pyridine carbenes with phthalaldehydes and dimethyl acetylenedicarboxylate: a facile construction of benzo[*d*]furo[3,2-*b*]azepines†

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A study on the multicomponent reaction comprising both N-heterocyclic carbenes and substituted phthalaldehydes is reported. The imidazo[1,5-*a*]pyridine carbenes, namely imidazo[1,5-*a*]pyridine-3-ylidenes, reacted with phthalaldehydes and DMAD under very mild conditions to produce novel fused tricyclic benzo[*d*]furo[3,2-*b*]azepine derivatives. The resulting fused heterocyclic compounds are fluorescent and they give an emission around 500 nm with quantum yields (Φ_F) being up to 0.81. This study provides not only a unique approach to fused azepine derivatives that are not easily accessible by other methods, but also opens a new avenue to complicated molecular skeletons. The fluorescence properties of long emission wavelength and high fluorescence quantum yields of some products predict their potential applications as optical sensors.

Introduction

Multicomponent reactions (MCRs) have been attracting continued interest owing to their high synthetic efficiency and their use in the facile construction of complex organic compounds.[1] Although various multicomponent reactions have been documented, multicomponent reactions involving carbenes remained largely unexplored until recent years.[2] In 2001, Nair and co-workers reported the first three-component reaction of a nucleophilic dimethoxycarbene with dimethyl acetylenedicarboxylate and aldehydes or quinones.[3] Since then, a number of multicomponent reactions involving nucleophilic carbenes, mainly N-heterocyclic carbenes, have been emerging in organic synthesis.[4,5] It is important to note that most of the known carbene-involved MCRs comprise of a nucleophilic carbene, an activated alkyne and a carbonyl compound such as aldehyde, ketone, anhydride, or ketene.[3,4] These three-component reactions generally lead to the formation of polysubstituted furans or furanones,[3,4] only the reaction of thiazole or benzothiazole carbenes with ketenes and DMAD was found to produce heterocycle-fused furan derivatives.[4] To our surprise, although different carbonyl compounds have been employed in the multicomponent reactions of N-heterocyclic carbenes, phthalaldehydes have never been used.

Our interests in nucleophilic carbenes and their applications in organic synthesis[6] have led us to investigate multicomponent reactions of N-heterocyclic carbenes.[5] Our attention had been drawn to imidazo[1,5-*a*]pyridine-1-ylidenes and imidazo[1,5-*a*]pyridine-3-ylidenes, the *C*,*N*-substituted and *N*,*N*-substituted imidazo[1,5-*a*]pyridine carbenes reported in 2005 by Lassaletta *et al.*[7] and Glorius *et al.*[8] Both types of imidazo[1,5-*a*]pyridine carbenes have been shown to be strong C-ligands to Ag, Rh, Ir, Pd cations and elemental Se;[7,8] however, their reactions and applications as organic intermediates remain largely unexplored. Very recently, we developed a method for the syntheses of highly functionalized pyrroles or thiophenes from the reaction of dipolar adducts, which were derived from imidazo[1,5-*a*]pyridine-1-ylidenes and isothiocyanates, with different alkynes.[9] We also provided a straightforward approach to fully substituted furans *via* the three-component reactions of imidazo[1,5-*a*]pyridine-3-ylidenes with aldehydes and DMAD or allenoates.[10] After that, our attention was then turned to the multicomponent reaction comprised of N-heterocyclic carbenes and substituted phthalaldehydes. We envisioned that the three-component reaction of N-heterocyclic carbenes with phthalaldehydes might offer an opportunity to produce novel and complex fused heterocyclic compounds. We report herein our investigation on the three-component reaction of imidazo[1,5-*a*]pyridine-3-ylidenes with phthalaldehydes and dimethyl acetylenedicarboxylate. The reaction provides a unique and straightforward synthetic route to benzo[*d*]furo[3,2-*b*]azepines, novel fused tricyclic heterocycles.

Results and discussion

We initiated our study with the examination of the reaction of 2-phenylimidazo[1,5-*a*]pyridine-3-ylidene **2a** with phthalaldehyde **3a** and dimethyl acetylenedicarboxylate **4**. The imidazo[1,5-*a*]pyridine carbene **2a** was generated *in situ* from its precursor,

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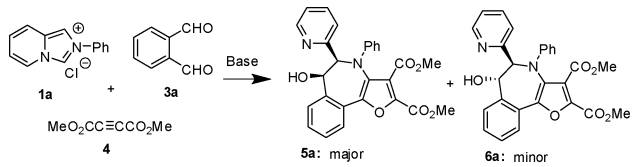
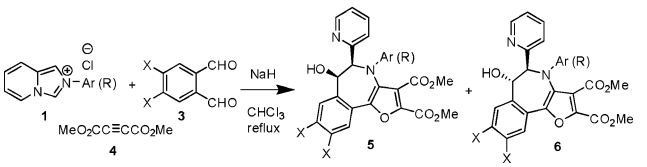
Table 1 The reaction of 2-phenylimidazo[1,5-*a*]pyridinium salt **1a** with phthalaldehyde **3a** and dimethyl acetylenedicarboxylate **4** in the presence of a base under different conditions



	Reaction conditions[a]				Yield[b]	
Entry	Base	Solvent	Temp.	Time (h)	**5a**	**6a**
1	NaH	CH_2Cl_2	–20 °C	12	22	16
2	NaH	CH_2Cl_2	r.t	2	39	9
3	NaH	CH_2Cl_2	reflux	2	43	16
4	NaH	$CHCl_3$	reflux	2	44	24
5	NaH	CH_2ClCH_2Cl	reflux	2	37	12
6	NaH	THF	reflux	2	33	8
7	NaH	CH_3COCH_3	reflux	2	24	15
8	NaH	C_6H_6	60 °C	2	17	11
9	NaH	CH_3CN	60 °C	2	32	12
10	DBU	$CHCl_3$	reflux	2	19	18
11	$EtN(i\text{-}Pr)_2$	$CHCl_3$	reflux	2	32	14
12	*t*-BuOK	$CHCl_3$	reflux	2	30	18

[a] **1a** : **3** : **4**:base = 1.2 : 1 : 1.2 : 1.8; [b] Isolated yields.

Table 2 The three-component reaction of imidazo[1,5-*a*]pyridinium salts **1** with phthalaldehydes **3** and dimethyl acetylenedicarboxylate **4** in the presence of NaH under optimized conditions



						Yield (%)[a]	
Entry	**1**	Ar or R	**3**	X	Time (h)	**5**	**6**
1	**1a**	Ph	**3a**	H	2	**5a**: 44	**6a**: 24
2	**1b**	*p*-MePh	**3a**	H	3	**5b**: 47	**6b**: 22
3	**1c**	*p*-MeOPh	**3a**	H	3	**5c**: 58	**6c**: 24
4	**1d**	*p*-ClPh	**3a**	H	2	**5d**: 44	**6d**: 15
5	**1e**	*p*-BrPh	**3a**	H	3	**5e**: 45	**6e**: 27
6	**1f**	*p*-CF_3Ph	**3a**	H	3	**5f**: 51	**6f**: 12
7	**1g**	Bz	**3a**	H	3	**5g**: 48	**6g**: 22
8	**1h**	*n*-Bu	**3a**	H	3	**5h**: 42	**6h**: 39
9	**1i**	*i*-Pr	**3a**	H	3	**5i**: 59	**6i**: 30
10	**1i**	*i*-Pr	**3b**	Me	4	**5j**: 41	**6j**: 15
11	**1i**	*i*-Pr	**3c**	OMe	4	**5k**: 52	**6k**: 17
12	**1i**	*i*-Pr	**3d**	Br	4	**5l**: 37	**6l**: 22

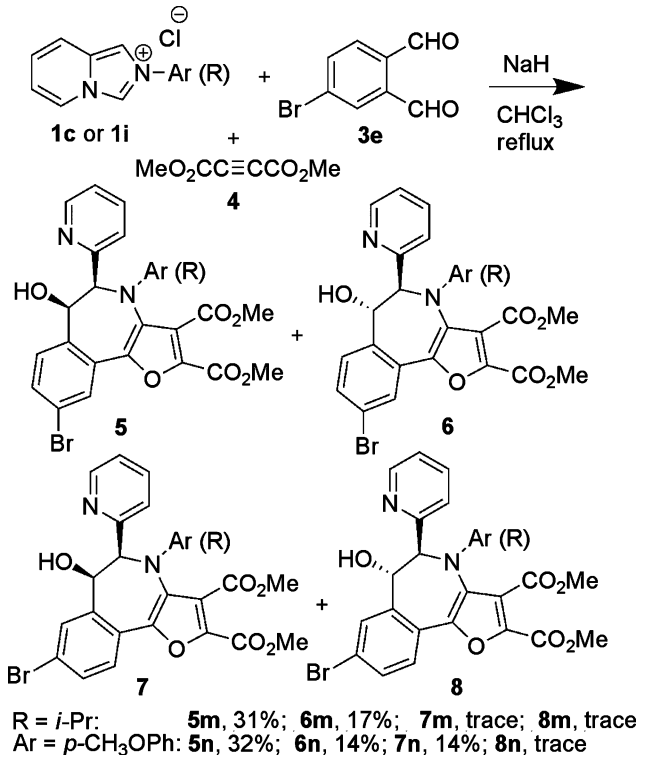
[a] Isolated yields.

2-phenylimidazo[1,5-*a*]pyridinium salt **1a**, which was prepared from pyridine-2-carbaldehyde and aniline *via* a $POCl_3$-mediated cyclization of a formamide intermediate.[7,8,10] Thus, under a nitrogen atmosphere, 2-phenylimidazo[1,5-*a*]pyridinium salt **1a** was mixed with phthalaldehyde **3a** and dimethyl acetylenedicarboxylate **4** in dry dichloromethane at room temperature. The reaction occurred when sodium hydride was added. After a very short period, the starting materials were consumed. To our delight, a pair of diastereoisomers of three-ring fused products **5a** and **6a** were isolated in 39% and 9% yields, respectively, as yellow colored and fluorescent crystals. To improve the chemical yields of products, the reaction conditions were optimized by varying reaction temperature, solvents and bases used. It was found that an increase of temperature improved the total yield of **5a** and **6a** in dichloromethane (Table 1, entries 1–3), while the reaction in refluxing chloroform afforded 66% yield of **5a** and **6a** (**5a** : **6a** ~ 2 : 1. Table 1, entry 4). The use of other solvents including 1,2-dichloroethane, THF, acetone, acetonitrile and benzene at a higher or a lower temperature led to diminished yields of **5a** and **6a**. The employment of a base such as *t*-BuOK, $EtN(i\text{-}Pr)_2$ or DBU instead of NaH did not increase neither the yields of products, nor the ratio between **5a** and **6a**.

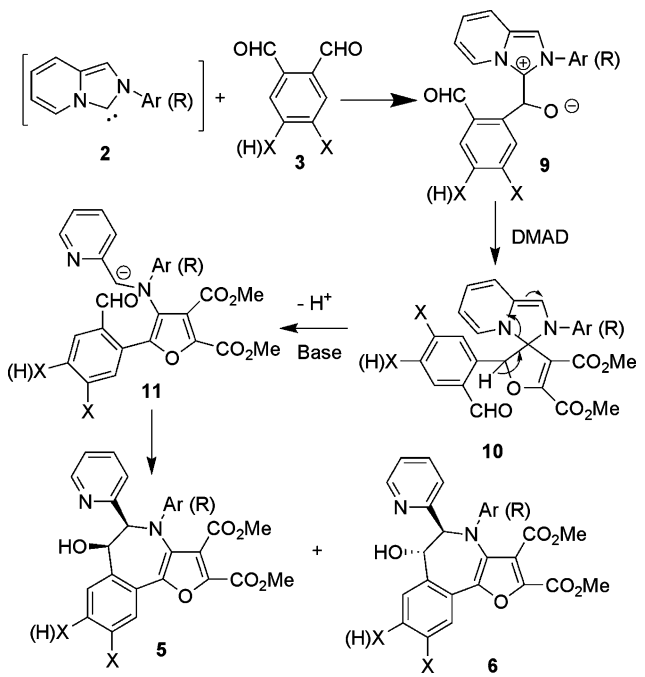
Under the optimized conditions, the generality of the reaction was then studied using imidazo[1,5-*a*]pyridinium salts **1** and phthalaldehydes **3** that bear different substituents. As evidenced by the results summarized in Table 2, the reaction showed tolerance for the *N*-substituents on the carbene reactants. For example, imidazo[1,5-*a*]pyridine-3-ylidenes **2** either bearing an alkyl group including *i*-propyl, *n*-butyl and benzyl, or a phenyl substituted by an electron-donating or electron-withdrawing group reacted equally efficiently with phthalaldehyde and DMAD to produce diastereomers **5** and **6** in 42–59% and 12–39% yields, respectively (Table 2, entries 1–9). On the other hand, phthalaldehydes **3** that were substituted by electron-donating groups such as methoxy and methyl, or weak electron-withdrawing groups like bromine atoms, underwent reaction smoothly with carbene **2i** and DMAD **4** to yield products **5j–5l** and **6j–6l** (Table 2, entries 10–12). However, the phthalaldehyde substituted by a strong electron-withdrawing group, 4-nitrophthalaldehyde for example, could not give the expected azepines because the electron-deficient phthalaldehyde was unstable under reaction conditions. When an unsymmetrically substituted phthalaldehyde was used, the reaction gave a mixture of four isomers due to the two unequal aldehyde groups. This has been exemplified by the reaction of carbenes **2** with 4-bromophthalaldehyde **3e** and DMAD, which produced two *cis*-configured azepines **5** and **7**, along with two *trans*-configured azepines **6** and **8** (Scheme 1).

The structures of the products were elucidated on the basis of spectroscopic data and microanalysis. The NMR spectra, mass data and elemental analyses indicated all products are 1 + 1 + 1 adducts of imidazo[1,5-*a*]pyridine-3-ylidenes **2** with phthalaldehydes **3** and DMAD **4**. The stereochemistry of products **5** and **6** was revealed by ^{1}H NMR spectroscopy. The coupling constants (^3J) of two vicinal protons on azepine ring were 0–1 Hz and 6–7 Hz, respectively, for **5** and **6**. They are in agreement with the *cis*- and *trans*-configurations respectively. Since spectroscopic data did not allow full verification of the structures of the products, the structures of compounds **5m**, **6m** and **7m** were determined unambiguously by single crystal X-ray diffraction analyses.[11] X-ray molecular structure indicated that the major product **5m** derived from 4-bromophthalaldehyde contains bromo and furanyl groups that are *meta*-substituted on benzene ring.

To account for the formation of benzo[*d*]furo[3,2-*b*]azepines from the interaction of imidazo[1,5-*a*]pyridine-3-ylidenes **2** with phthalaldehydes **3** and DMAD, a tandem reaction mechanism comprising nucleophilic addition of imidazo[1,5-*a*]pyridine carbene, [3 + 2]-cycloaddition and intramolecular cyclization was



Scheme 1 The reaction of imidazo[1,5-*a*]pyridinium salts **1c**, **1i** with 4-bromophthalaldehyde **3e** and DMAD in the presence of NaH.



Scheme 2 The proposed mechanism for the reaction of imidazo[1,5-*a*]pyridine-3-ylidenes **2** with phthalaldehydes **3** and dimethyl acetylenedicarboxylate **4**.

proposed. As depicted in Scheme 2, imidazo[1,5-*a*]pyridine-3-ylidenes **2** undergo a nucleophilic addition to phthalaldehydes **3** to form dipolar intermediates **9**. The consecutive [3 + 2] cycloaddition of dipoles **9** with DMAD **4** leads to the formation of dihydrofuran-spiro-imidazo[1,5-*a*]pyridine intermediates **10**. Aromatization of the dihydrofuran intermediates **10** gives rise to the opening of the imidazole ring to form carbanions **11**. Intramolecular addition of the carbanion to the different faces of aldehyde of **11** yields benzo[*d*]furo[3,2-*b*]azepines **5** and **6**. The preferential formation of the *cis*-isomer **5** is most probably attributed to the thermodynamic stability of **5**, in which an intramolecular hydrogen bond is formed between the hydroxyl and the pyridine nitrogen atom. The intramolecular hydrogen bond was evidenced indeed by the X-ray molecular structure of **5**, in which the distance between the hydroxyl oxygen and the pyridine nitrogen is 2.8 Å. In the reaction of imidazo[1,5-*a*]pyridine carbene **2i** or **2c** with 4-bromophthalaldehyde **3e** and DMAD, the major product **5m** or **5n** was derived from the addition of carbene **2** to the aldehyde *meta* to the bromine atom. This regioselectivity can be best explained by the electronic effects of bromine, because the inductive electron-withdrawing effect of bromine activates the 2-aldehyde whereas its conjugative electron-donating effect deactivates the 1-aldehyde of 4-bromophthalaldehyde in the reaction with nucleophiles.

A large number of aromatic ring-fused azepines possess remarkable biological and pharmacological activities[12] Due to their important chemical and biological properties, interest in the synthesis of fused azepines remains undiminished.[13–15] However, to the best of our knowledge, the benzo[*d*]furo[3,2-*b*]azepines have been unknown so far. The reaction of imidazo[1,5-*a*]pyridine-3-ylidenes with phthalaldehydes and dimethyl acetylenedicarboxylate not only constructed a new heterocyclic skeleton, but also might be developed into a versatile strategy for the syntheses of aromatic ring-fused furo[3,2-*b*]azepines by varying the structures of *ortho*-substituted aromatic dialdehydes.

Both benzo[*d*]furo[3,2-*b*]azepines **5** and **6** are fluorescent compounds. Consideration of the *cis ortho* hydroxyl and pyridyl substituted azepine structures of the major products **5**, we envisioned that compounds **5** might be novel *N*,*O*-, *N*,*N*- or *N*,*N*,*O*-ligands, and therefore might be potential optical sensors for metal ions. Thus, the photophysical properties of **5** were then studied in different solvents. As shown in Table 3, the maximum absorption wavelengths (λ_{abs}) and emission wavelengths (λ_{em}) of **5** were in the range of 345–386 nm and 463–543 nm, respectively. It should be noted that the substituents on the azepine nitrogen atoms strongly affected the fluorescence quantum yields of **5**. For example, among the *N*-aryl substituted azepines **5a–5f** and **5n**, the strong electron-withdrawing *N*-trifluoromethylphenyl substituted azepine **5f** has much higher fluorescence quantum yield (Φ_F = 0.81, 0.77 and 0.62 in CH_3CN, THF and DMSO, respectively) than the azepines **5a–5e** and **5n** substituted by weak electron-withdrawing and electron-donating groups (Table 4, entries 1–7). Meanwhile, the fluorescence quantum yields of weak electron-withdrawing *N*-chlorophenyl and *N*-bromophenyl substituted azepines **5d** and **5e** are higher than the phenyl, anisyl and tolyl substituted azepines **5a–5c** and **5n** (Table 4, entries 1–6). On the other hand, *N*-alkyl including *i*-propyl, *n*-butyl and benzyl substituted azepines **5g–5m** generally have higher fluorescence quantum yields ($\Phi_F \sim 0.3$–0.6 in CH_3CN, THF and DMSO) than *N*-aryl, except *N*-(4-trifluoromethyl)phenyl, substituted azepines **5a–5e** and **5n** (Table 4). Besides the *N*-substituents of azepines, solvents have also been found to have a significant influence on fluorescence quantum yields of **5**. For instance, the *N*-trifluoromethylphenyl and *N*-alkyl substituted azepines **5f,5m** have higher fluorescence quantum yields in non-protonic solvents

Table 3 Maximum absorption wavelengths and emission wavelengths of **5** in different solvents

	Compound		CH_3CN		THF		DMSO		CH_3OH	
Entry	**5**	Ar or R, X, X	λ_{abs}(nm)	λ_{em}(nm)	λ_{abs}(nm)	λ_{em}(nm)	λ_{abs}(nm)	λ_{em}(nm)	λ_{abs}(nm)	λ_{em}(nm)
1	**5a**	Ph, H, H	380	498	364	492	364	514	379	501
2	**5b**	*p*-MePh, H, H	366	500	360	498	358	474	363	498
3	**5c**	*p*-MeOPh, H, H	366	485	365	522	374	474	368	511
4	**5n**	*p*-MeOPh, Br, H	366	514	374	543	374	508	366	527
5	**5d**	*p*-ClPh, H, H	358	495	358	472	362	515	361	513
6	**5e**	*p*-BrPh, H, H	358	497	360	468	358	508	354	496
7	**5f**	*p*-CF_3Ph, H, H	356	480	357	463	359	498	363	500
8	**5g**	Bn, H, H	345	503	347	495	350	517	353	526
9	**5h**	*n*-Bu, H, H	358	505	358	489	364	507	363	521
10	**5i**	*i*-Pr, H, H	369	502	365	487	373	525	369	517
11	**5j**	*i*-Pr, Me, Me	382	505	369	499	382	511	371	531
12	**5k**	*i*-Pr, OMe, OMe	385	515	380	507	382	522	378	529
13	**5l**	*i*-Pr, Br, Br	380	491	370	482	386	506	371	507
14	**5m**	*i*-Pr, Br, H	380	498	370	491	373	508	370	514

Table 4 The fluorescence quantum yields of **5** in different solvents[a]

	Compound		CH_3CN	THF	DMSO	CH_3OH
Entry	**5**	Ar or R, X, X	Φ_F	Φ_F	Φ_F	Φ_F
1	**5a**	Ph, H, H	0.03	0.01	0.004	0.01
2	**5b**	*p*-MePh, H, H	0.06	0.19	0.01	0.01
3	**5c**	*p*-MeOPh, H, H	0.07	0.01	0.004	0.01
4	**5n**	*p*-MeOPh, Br, H	0.03	0.01	0.01	0.01
5	**5d**	*p*-ClPh, H, H	0.26	0.44	0.13	0.01
6	**5e**	*p*-BrPh, H, H	0.18	0.37	0.05	0.03
7	**5f**	*p*-CF_3Ph, H, H	0.81	0.77	0.62	0.27
8	**5g**	Bn, H, H	0.54	0.43	0.34	0.31
9	**5h**	*n*-Bu, H, H	0.54	0.50	0.39	0.27
10	**5i**	*i*-Pr, H, H	0.46	0.37	0.32	0.20
11	**5j**	*i*-Pr, Me, Me	0.45	0.50	0.45	0.20
12	**5k**	*i*-Pr, OMe, OMe	0.42	0.48	0.33	0.17
13	**5l**	*i*-Pr, Br, Br	0.60	0.54	0.59	0.33
14	**5m**	*i*-Pr, Br, H	0.52	0.47	0.50	0.29

[a] The quantum yields (Φ_F) were determined with reference to quinine hemisulfate (in 0.1 M aqueous H_2SO_4) excited at the maximal excitation wavelengths.

CH_3CN, THF and DMSO than in the protonic solvent methanol. Meanwhile, the fluorescence quantum yields of **5f,5m** measured in CH_3CN and THF are generally slightly higher than those obtained in DMSO. The influence of solvents on the fluorescence of **5** was most probably due to the formation of hydrogen bonds between **5** and the solvents. As mentioned above, the *cis*-isomers **5** have intramolecular hydrogen bonds between their hydroxyl and pyridyl nitrogen, and the protonic solvent methanol probably broke the intramolecular hydrogen bonds through the formation of intermolecular hydrogen bonds between the methanol hydroxyl and the pyridyl or hydroxyl of **5**. The non-protonic solvents CH_3CN, THF and DMSO could neither provide a hydrogen bond donor, nor a strong hydrogen bond acceptor that could replace the pyridyl nitrogen atom of **5**. Thus, the solvents CH_3CN, THF and DMSO must have less influence on the structures and therefore on the fluorescence of **5**.

Conclusions

In summary, we have reported for the first time the multicomponent reaction of N-heterocyclic carbenes with phthalaldehydes and DMAD. Imidazo[1,5-*a*]pyridine-3-ylidenes that were generated *in situ* from imidazo[1,5-*a*]pyridinium salts with NaH reacted with phthalaldehydes and DMAD under mild conditions to produce a pair of *cis*- and *trans*-substituted fused tricyclic 6-hydroxy-5-pyridylbenzo[*d*]furo[3,2-*b*]azepine compounds. The reaction proceeded most probably through a tandem nucleophilic addition of an imidazo[1,5-*a*]pyridine carbene to one aldehyde of phthalaldehyde to afford a dipole which underwent [3 + 2]-cycloaddition with DMAD followed by aromatization and intramolecular condensation of carbanions with the aldehyde group. This study provides not only a unique approach to fused azepine derivatives that are not easily accessible by other methods, but also opens a new avenue to complex molecular skeletons. The fluorescence properties of long emission wavelength and high fluorescence quantum yields of **5f–5m** predict potential applications as optical sensors.

Experimental section

Melting points are uncorrected. ^{1}H-NMR (400 MHz) and 13 C NMR (100 MHz) were recorded in the indicated solvents. *J* values are reported in Hz. IR spectra were recorded using an AVATAR 360 FT-IR spectrometer. Mass spectra were recorded

on a Surveyor MSQ Plus (ESI) instrument and elemental analyses were performed on a GMBH Vario EL instrument. Column chromatography was performed using 200–300 mesh silica gel.

General procedure for the reaction of imidazo[1,5-*a*]pyridinium salts with phthalaldehydes and DMAD in the presence of NaH. Under a nitrogen atmosphere and at ambient temperature, imidazo[1,5-*a*]pyridinium salts **1** (1.2 mmol),[10] phthalaldehydes **3** (1.0 mmol) and DMAD (1.2 mmol) were mixed in dry chloroform (60 mL). To the reaction mixture, NaH (1.8 mmol) was added at room temperature, and the mixture was then stirred in refluxing chloroform for 2–4 h. After removal of NaCl, the excess NaH and solvent, the residue was chromatographed on a silica gel column eluting with a mixture of petroleum ether (30–60 °C) and ethyl acetate (5 : 1) to afford yellow crystalline **5** and **6** in 32–59% and 14–39% yield, respectively (Note: The reaction of **1c**, or **1i**, with 4-bromophthalaldehyde **3e** and DMAD produced four isomeric products **5**, **6**, **7** and **8**. The minor products **7m**, **8m** and **8n** were detected by using TLC without isolation).

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 6-hydroxyl-4-phenyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 5a. 44%, mp 185–187 °C; IR ν (cm^{-1}) 3339, 1754, 1728; ^{1}H NMR (100 MHz, DMSO-d_6) δ (ppm) 7.98 (d, J = 4.2 Hz, 1H), 7.52 (dd, J = 5.9, 4.5 Hz, 1H), 7.42 (dd, J = 6.7, 4.3 Hz, 1H), 7.33 (dt, J = 7.8, 1.6 Hz, 1H), 7.01–7.10 (m, 5H), 6.95 (d, J = 7.8 Hz, 2H), 6.88 (t, J = 7.3 Hz, 1H), 6.80 (dd, J = 7.2, 5.0 Hz, 1H), 5.74 (d, J = 7.8 Hz, 1H), 5.37 (s, 1H), 4.61 (d, J = 7.7 Hz, 1H), 3.58 (s, 3H), 3.02 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 163.0, 158.9, 158.0, 148.3, 147.5, 143.1, 139.3, 138.7, 137.4, 129.5, 127.7, 127.4, 127.2, 126.8, 124.6, 124.0, 123.9, 123.6, 122.3, 122.2, 121.3, 73.5, 70.4, 52.3, 52.0; MS (ESI): 471(M+1). Anal. Calcd for $C_{27}H_{22}N_2O_6$: C 68.93, H 4.71, N 5.95; Found: C 69.03, H 4.52, N 5.86.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 6-hydroxyl-4-phenyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 6a. 24%, mp 165–167 °C; IR ν (cm^{-1}) 3478, 1743, 1700; ^{1}H NMR (100 MHz, $CDCl_3$) δ (ppm) 8.41 (d, J = 4.7 Hz, 1H), 7.88 (d, J = 7.7 Hz, 1H), 7.74 (br, 1H), 7.68 (br, 1H), 7.58 (d, J = 7.4 Hz, 1H), 7.32 (t, J = 7.5 Hz, 2H), 7.24–7.28 (m, 2H), 7.11–7.13 (br, 2H), 7.05 (t, J = 7.3 Hz, 1H), 6.01 (d, J = 5.7 Hz, 1H), 5.82 (d, J = 7.0 Hz, 1H), 3.91 (s, 3H), 3.40 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 161.6, 156.9, 156.6, 147.3, 147.1, 140.5, 137.8, 135.5, 134.6, 130.0, 127.6, 127.1, 126.5, 125.8, 125.3, 122.9, 122.1, 120.7, 120.5, 120.4, 119.5, 68.4, 50.8, 50.5; MS (ESI): 471(M+1). Anal. Calcd for $C_{27}H_{22}N_2O_6$: C 68.93, H 4.71, N 5.95; Found: C 68.53, H 5.09, N 5.81.

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 6-hydroxyl-5-(2-pyridyl)-4-(4-tolyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 5b. 47%, mp 209–210 °C; IR ν (cm^{-1}) 3432, 1750, 1728; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.20 (d, J = 4.3 Hz, 1H), 8.02 (d, J = 7.0 Hz, 1H), 7.88 (d, J = 7.4 Hz, 1H), 7.53 (t, J = 7.8 Hz, 1H), 7.46 (d, J = 7.8 Hz, 1H), 7.29–7.22 (m, 3H), 7.13 (d, J = 8.1 Hz, 2H), 7.07 (d, J = 8.2 Hz, 2H), 7.00 (t, J = 5.1 Hz, 2H), 5.77 (s, 1H), 4.88 (s, 1H), 3.90 (s, 3H), 3.40 (s, 3H), 2.33 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 163.1, 159.0, 158.1, 147.6, 146.0, 142.8, 139.2, 138.7, 137.3, 134.4, 130.0, 127.71, 127.66, 127.0, 126.8, 124.2, 123.8, 123.6, 122.3, 122.1, 121.3, 73.4, 70.6, 52.3, 52.1, 20.8; MS (ESI): 485 (M+1). Anal. Calcd for $C_{28}H_{24}N_2O_6$: C 69.41, H 4.99, N 5.78; Found: C 69.09, H 5.11, N 5.65.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 6-hydroxyl-5-(2-pyridyl)-4-(4-tolyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 6b. 22%, mp 197–199 °C; IR ν (cm^{-1}) 3457, 3365, 1751, 1730; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.37 (d, J = 3.1 Hz, 1H), 7.88 (d, J = 7.9 Hz, 1H), 7.59–7.63 (m, 2H), 7.55 (d, J = 7.4 Hz, 1H), 7.31 (t, J = 7.6 Hz, 1H), 7.23 (t, J = 7.4 Hz, 1H), 7.07 (brs, 4H), 6.08 (d, J = 5.7 Hz, 1H), 5.77 (d, J = 6.0 Hz, 1H), 3.91 (s, 3H), 3.40 (s, 3H), 2.31 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ (ppm) 163.3, 158.3, 158.2, 148.0, 146.5, 136.0, 133.6, 131.5, 129.7, 129.1, 128.1, 127.3, 127.0, 124.5, 122.6, 122.2, 122.1, 121.4, 69.9, 52.4, 52.1, 20.8; MS (ESI): 485 (M+1). Anal. Calcd for $C_{28}H_{24}N_2O_6$: C 69.41, H 4.99, N 5.78; Found: C 69.08, H 4.71, N 5.65.

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 6-hydroxyl-4-(4-methoxyphenyl)-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 5c. 58%, mp 210–211 °C; IR ν (cm^{-1}) 3432, 1754, 1728; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.20 (d, J = 3.3 Hz, 1H), 8.02 (d, J = 7.4 Hz, 1H), 7.88 (d, J = 7.4 Hz, 1H), 7.52 (t, J = 7.4 Hz, 1H), 7.44 (d, J = 7.9 Hz, 1H), 7.27–7.21 (m, 3H), 7.12 (d, J = 8.7 Hz, 2H), 6.99 (t, J = 5.2 Hz, 1H), 6.87 (d, J = 8.8 Hz, 2H), 5.65 (s, 1H), 4.86 (s, 1H), 3.89 (s, 3H), 3.81 (s, 3H), 3.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 163.1, 159.0, 158.1, 157.1, 147.5, 142.4, 142.0, 139.1, 138.6, 137.4, 128.1, 127.5, 126.9, 126.8, 126.1, 123.8, 123.7, 122.3, 122.1, 121.3, 114.7, 73.2, 71.2, 55.6, 52.2, 52.1; MS (ESI): 501 (M+1). Anal. Calcd for $C_{28}H_{24}N_2O_7$: C 67.19, H 4.83, N 5.60; Found: C 67.25, H 4.89, N 5.61.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 6-hydroxyl-4-(4-methoxyphenyl)-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 6c. 24%, mp 214–216 °C; IR ν (cm^{-1}) 3289, 1741, 1713; ^{1}H NMR (400 MHz, DMSO-d_6, 60 °C) δ (ppm) 8.30 (d, J = 4.2 Hz, 1H), 7.67 (d, J = 7.6 Hz, 1H), 7.55 (dt, J = 7.8, 1.6 Hz, 1H), 7.31 (d, J = 7.8 Hz, 2H), 7.26 (t, J = 7.6 Hz, 1H), 7.12–7.16 (m, 3H), 7.01 (dd, J = 7.2, 4.9 Hz, 1H), 6.83 (d, J = 8.9 Hz, 2H), 5.86 (t, J = 5.7 Hz, 1H), 5.44 (d, J = 6.4 Hz, 1H), 5.23 (d, J = 5.0 Hz, 1H), 3.81 (s, 3H), 3.74 (s, 3H), 3.29 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ (ppm) 163.3, 158.3, 158.1, 156.6, 148.0, 142.3, 140.6, 139.1, 137.7, 135.7, 131.6, 129.7, 128.1, 127.2, 127.0, 125.3, 124.4, 122.1, 121.9, 121.3, 114.3, 77.2, 70.3, 55.6, 52.3, 52.1; MS (ESI): 501 (M+1). Anal. Calcd for $C_{28}H_{24}N_2O_7$: C 67.19, H 4.83, N 5.60; Found: C 67.05, H 4.90, N 5.41.

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 4-(4-chlorophenyl)-6-hydroxyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 5d. 44%, mp 251–253 °C; IR ν (cm^{-1}) 3420, 1751, 1728; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.25 (d, J = 3.9 Hz, 1H), 7.96 (d, J = 5.9 Hz, 1H), 7.88 (d, J = 6.9 Hz, 1H), 7.59 (t, J = 7.5 Hz, 1H), 7.43 (d, J = 8.0 Hz, 1H), 7.29–7.27 (m, 4H), 7.10–7.12 (m, 3H), 5.92 (s, 1H), 4.96 (s, 1H), 3.91 (s, 3H), 3.46 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 162.9, 158.5, 157.9, 147.7, 146.9, 143.4, 139.5, 138.6, 137.3, 129.8, 129.5, 127.8, 127.4, 126.9, 126.8, 125.1, 124.0, 123.4, 122.2, 122.1, 121.2, 73.4, 70.2, 52.3, 52.2; MS (ESI): 505 (M+1). Anal. Calcd for $C_{27}H_{21}ClN_2O_6$: C 64.23, H 4.19, N 5.55; Found: C 64.25, H 4.23, N 5.41.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 4-(4-chlorophenyl)-6-hydroxyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 6d. 15%, mp 245–247 °C; IR ν (cm^{-1}) 3445, 3357, 1750, 1730; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.35 (d, J = 3.6 Hz, 1H), 7.89 (d, J = 4.6 Hz, 1H), 7.51–7.55 (m, 3H), 7.32 (t, J = 6.4 Hz, 1H), 7.22–7.25 (m, 3H), 7.11 (d, J = 8.7 Hz, 2H), 7.01 (t, J = 4.6 Hz,

1H), 6.02 (d, J = 5.8 Hz, 1H), 5.66 (d, J = 6.6 Hz, 1H), 3.91 (s, 3H), 3.47 (s, 3H), 2.48 (br, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 163.1, 158.0, 157.9, 147.8, 147.4, 142.8, 139.7, 138.1, 136.3, 131.2, 129.1, 128.6, 128.22, 128.2, 127.8, 126.8, 124.7, 123.2, 122.5, 122.1, 121.5, 114.9, 76.9, 70.2, 52.4, 52.3; MS (ESI): 505 (M+1). Anal. Calcd for $C_{27}H_{21}ClN_2O_6$: C 64.23, H 4.19, N 5.55; Found: C 64.41, H 4.09, N 5.49.

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 4-(4-bromophenyl)-6-hydroxyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 5e. 45%, mp 250–251 °C; IR ν (cm^{-1}) 3424, 1751, 1726; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.10 (d, J = 4.8 Hz, 1H), 7.97 (d, J = 7.8 Hz, 1H), 7.80 (dd, J = 7.8, 1.3 Hz, 1H), 7.43 (dt, J = 7.8, 1.7 Hz, 1H), 7.36 (d, J = 8.7 Hz, 3H), 7.21 (dt, J = 7.4, 1.4 Hz, 1H), 7.15 (t, J = 6.7 Hz, 1H), 6.98 (d, J = 8.8 Hz, 2H), 6.89 (dd, J = 7.4, 4.9 Hz, 1H), 5.90 (br, 1H), 5.63 (d, J = 2.6 Hz, 1H), 4.74 (d, J = 2.3 Hz, 1H), 3.82 (s, 3H), 3.39 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 162.9, 158.3, 158.0, 147.5, 147.2, 143.4, 139.5, 138.5, 137.7, 132.5, 127.7, 127.5, 127.0, 126.7, 125.3, 124.0, 123.4, 122.4, 122.0, 121.4, 117.4, 73.4, 70.1, 52.5, 52.3; MS (ESI): 549 (M+1). Anal. Calcd for $C_{27}H_{21}BrN_2O_6$: C 59.03, H 3.85, N 5.10; Found: C 58.93, H 3.98, N 4.97.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 4-(4-bromophenyl)-6-hydroxyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 6e. 27%, mp 240–242 °C; IR ν (cm^{-1}) 3444, 3263, 1750, 1730; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.26 (d, J = 4.7 Hz, 1H), 7.79 (d, J = 7.7 Hz, 1H), 7.42–7.48 (m, 3H), 7.28 (d, J = 8.8 Hz, 2H), 7.23 (dt, J = 7.5, 1.1 Hz, 1H), 7.16 (dt, J = 7.4, 1.1 Hz, 1H), 6.95 (d, J = 8.8 Hz, 2H), 6.92 (t, J = 5.2 Hz, 1H), 5.91 (d, J = 6.8 Hz, 1H), 5.57 (d, J = 6.8 Hz, 1H), 3.82 (s, 3H), 3.39 (s, 3H), 2.45 (br, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 163.2, 158.2, 158.1, 148.8, 148.1, 142.7, 139.6, 137.0, 136.3, 132.1, 131.4, 128.2, 127.6, 126.8, 124.6, 123.6, 122.1, 122.0, 120.9, 116.1, 77.2, 70.1, 52.5, 52.3; MS (ESI): 549 (M+1). Anal. Calcd for $C_{27}H_{21}BrN_2O_6$: C 59.03, H 3.85, N 5.10; Found: C 59.04, H 3.96, N 4.90.

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 6-hydroxyl-5-(2-pyridyl)-4-(4-(trifluoromethyl)phenyl) - 5,6 -d ihydrobenzo[*d*]furo[3,2 - *b*]azepine - 2,3-dicarboxylate 5f. 51%, mp 223–224 °C; IR ν (cm^{-1}) 3410, 1749, 1727; ^{1}H NMR (400 MHz, DMSO-d_6, 60 °C) δ (ppm) 8.28 (dd, J = 4.8, 0.8 Hz, 1H), 7.68–7.73 (m, 2H), 7.56–7.60 (m, 3H), 7.26–7.34 (m, 5H), 7.08 (dd, J = 7.1, 4.9 Hz, 1H), 5.87 (d, J = 7.1 Hz, 1H), 5.73 (d, J = 2.6 Hz, 1H), 4.96 (dd, J = 7.0, 2.3 Hz, 1H), 3.85 (s, 3H), 3.35 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 162.9, 158.0, 157.9, 150.6, 147.6, 144.1, 139.6, 138.5, 137.7, 128.1, 127.9, 127.8 127.1, 126.7, 126.3, 126.1, 125.9, 125.6, 125.4, 125.3, 124.1, 123.2, 122.8, 122.7, 122.5, 121.9, 121.4, 120.0, 73.7, 69.3, 52.5, 52.2; MS (ESI): 539 (M+1). Anal. Calcd for $C_{28}H_{21}F_3N_2O_6$: C 62.45, H 3.93, N 5.20; Found: C 62.48, H 4.00, N 5.07.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 6-hydroxyl-5-(2-pyridyl)-4-(4-(trifluoromethyl)phenyl) - 5,6 - dihydrobenzo[*d*]furo[3,2 - *b*]azepine - 2,3-dicarboxylate 6f. 12%, mp 181–183 °C; IR ν (cm^{-1}) 3495, 1749, 1708; ^{1}H NMR (400 MHz, DMSO-d_6, 60 °C) δ (ppm) 8.31 (d, J = 4.1 Hz, 1H), 7.71 (dd, J = 7.8, 1.3 Hz, 1H), 7.61 (dt, J = 7.8, 1.8 Hz, 1H), 7.54 (d, J = 8.6 Hz, 2H), 7.49 (dd, J = 7.3, 1.1 Hz, 1H), 7.44 (d, J = 7.8 Hz, 1H), 7.34 (dt, J = 7.5, 1.4 Hz, 1H), 7.34 (dd, J = 7.1, 1.5 Hz, 1H), 7.28 (d, J = 7.7 Hz, 2H), 7.07 (dd, J = 7.3, 4.8 Hz, 1H), 5.83 (t, J = 6.4 Hz, 1H), 5.71 (d, J = 6.7 Hz, 1H), 5.37 (d, J = 5.3 Hz, 1H), 3.84 (s, 3H), 3.30 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ (ppm) 167.5, 163.4, 162.5, 157.3, 154.0, 148.1, 144.1, 143.1, 141.9, 137.2, 132.9, 132.83, 132.79, 131.4, 131.2, 131.1, 128.7, 128.4, 127.9, 127.6, 127.3, 127.2, 126.9, 126.4, 125.7, 80.7, 74.7, 57.7, 57.0; HRMS (ESI): 539.1437 (M+1), Anal. Calcd for $C_{28}H_{22}F_3N_2O_6$: 539.1430 (M+1).

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 4-benzyl-6-hydroxyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 5g. 48%, mp 215–217 °C; IR ν (cm^{-1}) 3393, 1730, 1721; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.09 (d, J = 4.6 Hz, 1H), 8.01 (d, J = 7.8 Hz, 1H), 7.85 (d, J = 7.8 Hz, 1H), 7.49 (d, J = 7.4 Hz, 2H), 7.45 (dt, J = 7.8, 1.5 Hz, 1H), 7.35 (t, J = 7.1 Hz, 2H), 7.24–7.30 (m, 3H), 7.19 (t, J = 7.6 Hz, 1H), 6.89 (dd, J = 7.3, 5.1 Hz, 1H), 6.07 (br, 1H), 4.91 (s, 1H), 4.79 (s, 1H), 4.74 (d, J = 15.8 Hz, 1H), 4.33 (d, J = 15.9 Hz, 1H), 3.94 (s, 3H), 3.85 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 164.3, 158.7, 158.2, 147.6, 142.8, 139.1, 138.9, 137.1, 136.9, 130.7, 128.8, 127.9, 127.8, 127.3, 127.1, 126.6, 124.0, 123.4, 123.2, 121.7, 121.0, 71.8, 65.8, 61.0, 53.2, 52.5; MS (ESI): 485 (M+1). Anal. Calcd for $C_{28}H_{24}N_2O_6$: C 69.41, H 4.99, N 5.78; Found: C 69.26, H 4.92, N 5.73.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 4-benzyl-6-hydroxyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 6g. 22%, mp 186–187 °C; IR ν (cm^{-1}) 3564, 1727; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.26 (d, J = 4.2 Hz, 1H), 7.79 (d, J = 7.8 Hz, 1H), 7.47 (br, 1H), 7.34 (d, J = 7.2 Hz, 2H), 7.19–7.32 (m, 5H),7.12 (t, J = 7.4 Hz, 1H), 6.93 (br, 1H), 5.86 (d, J = 6.4 Hz, 1H), 5.09 (d, J = 6.8 Hz, 1H), 5.05 (d, J = 16.8 Hz, 1H), 4.63 (d, J = 16.8 Hz, 1H), 3.92 (s, 3H), 3.67 (s, 3H), 2.60 (br, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 164.6, 158.8, 158.3, 148.1, 140.6, 139.1, 138.0, 136.9, 136.2, 133.0, 130.6, 128.5, 128.0, 127.7, 127.5, 127.3, 127.1, 124.7, 122.2, 121.7, 121.2, 67.0, 59.6, 52.9, 52.3; MS (ESI): 485 (M+1). Anal. Calcd for $C_{28}H_{24}N_2O_6$: C 69.41, H 4.99, N 5.78; Found: C 69.11, H 5.03, N 5.69.

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 4-butyl-6-hydroxyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 5h. 42%, mp 134–135 °C; IR ν (cm^{-1}) 3399, 1730, 1710; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.14 (d, J = 4.8 Hz, 1H), 7.99 (d, J = 7.8 Hz, 1H), 7.79 (dd, J = 7.8, 1.0 Hz 1H), 7.40 (dt, J = 7.8, 1.7 Hz 1H), 7.22 (t, J = 7.2 Hz 1H), 7.16 (t, J = 7.3 Hz 1H), 7.11 (d, J = 7.9 Hz, 1H), 6.89 (dd, J = 7.4, 4.9 Hz 1H), 6.07 (brs, 1H), 5.06 (s, 1H), 4.73 (s, 1H), 4.03 (s, 3H), 3.92 (s, 1H), 3.35–3.41 (m, 1H), 3.26–3.30 (m, 1H), 1.69–1.75 (m, 2H), 1.32–1.38 (m, 2H), 0.95 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 163.3, 157.8, 156.9, 146.3, 139.8, 137.5, 136.8, 135.4, 129.6, 125.7, 125.3, 125.2, 122.39, 122.37, 121.0, 120.4, 119.6, 72.0, 65.9, 56.1, 51.7, 51.0, 29.8, 18.6, 12.6; MS (ESI): 451 (M+1). Anal. Calcd for $C_{25}H_{26}N_2O_6$: C 66.65, H 5.82, N 6.22; Found: C 66.54, H 6.06, N 6.12.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 4-butyl-6-hydroxyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 6h. 39%, mp 162–163 °C; IR ν (cm^{-1}) 3277, 1729; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.33 (d, J = 4.3 Hz, 1H), 7.77 (d, J = 7.9 Hz, 1H), 7.43 (t, J = 7.4 Hz 1H), 7.37 (d, J = 7.5 Hz 1H), 7.22 (t, J = 7.6 Hz 1H), 7.09–7.16 (m, 2H), 6.94 (t, J = 6.1 Hz, 1H), 5.84 (brs, 1H), 5.11 (d, J = 6.9 Hz, 1H), 4.01 (s, 3H), 3.93 (s, 3H), 3.58–3.64 (m, 1H), 3.40–3.44 (m, 1H), 2.37 (br, 1H), 1.59–1.66 (m, 2H), 1.22–1.27 (m, 2H), 0.90 (t, J = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 165.1, 159.0, 158.3, 148.7, 139.0,

138.5, 136.6, 135.7, 132.1, 130.9, 127.9, 127.5, 126.6, 124.3, 121.7, 120.9, 120.8, 76.2, 68.7, 56.6, 53.1, 52.3, 31.6, 19.9, 13.9; MS (ESI): 451 (M+1). Anal. Calcd for $C_{25}H_{26}N_2O_6$: C 66.65, H 5.82, N 6.22; Found: C 66.29, H 6.17, N 6.01.

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 6-hydroxyl-4-isopropyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 5i. 59%, mp 174–176 °C; IR ν (cm^{-1}) 3304, 1732, 1718; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.16 (d, J = 4.6 Hz, 1H), 7.98 (d, J = 7.6 Hz, 1H), 7.79 (d, J = 7.9 Hz, 1H), 7.42 (t, J = 7.6 Hz, 1H), 7.14–7.22 (m, 3H), 6.92 (t, J = 5.8 Hz, 1H), 6.27 (br, 1H), 5.22 (s, 1H), 4.69 (s, 1H), 4.04 (s, 3H), 3.93 (s, 3H), 3.83–3.91 (m, 1H), 1.34 (t, J = 6.4 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 165.0, 159.9, 158.3, 147.6, 140.4, 139.0, 137.7, 137.0, 130.6, 127.0, 126.6, 126.4, 124.0, 123.6, 121.8, 121.4, 121.1, 76.3, 61.1, 55.5, 53.1, 52.3, 21.0, 19.8; MS (ESI): 437(M+1). Anal. Calcd for $C_{24}H_{24}N_2O_6$: C 66.04, H 5.54, N 6.42; Found: C 66.08, H 5.60, 6.29.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 6-hydroxyl-4-isopropyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 6i. 30%, mp 144–145 °C; IR ν (cm^{-1}) 3204, 1745, 1718; ^{1}H NMR (400 MHz, DMSO-d_6, 60 °C) δ (ppm) 8.30 (dd, J = 4.7, 0.7 Hz, 1H), 7.57 (d, J = 7.9 Hz, 1H), 7.47 (dt, J = 7.7, 1.7 Hz, 1H), 7.18–7.23 (m, 2H), 7.07 (dt, J = 7.4, 1.1 Hz, 1H), 7.01 (d, J = 7.9 Hz, 1H), 6.96 (dd, J = 7.3, 4.9 Hz, 1H), 5.62 (t, J = 6.3 Hz, 1H), 5.18 (d, J = 5.4 Hz, 1H), 5.07 (d, J = 7.0 Hz, 1H), 3.90 (s, 3H), 3.87–3.94 (m, 1H), 3.86 (s, 3H), 1.24 (d, J = 6.4 Hz, 3H), 1.04 (d, J = 6.6 Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ (ppm) 164.9, 160.4, 157.5, 148.6, 137.7, 137.5, 136.8, 136.1, 132.3, 131.1, 127.9, 127.3, 125.7, 123.0, 121.3, 120.3, 119.9, 74.0, 61.9, 53.2, 53.0, 52.3, 22.0, 21.6; HRMS (ESI): 437.1705 (M+1), Anal. Calcd for $C_{24}H_{25}N_2O_6$: 437.1713 (M+1).

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 6-hydroxyl-4-isopropyl-8,9-dimethyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 5j. 41%, mp 218–219 °C; IR ν (cm^{-1}) 3324, 1747,1723; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.16 (d, J = 4.6 Hz, 1H), 7.74 (s, 1H), 7.55 (s, 1H), 7.41 (t, J = 7.8, 1H), 7.20 (d, J = 7.9 Hz 1H), 6.90 (t, J = 6.0 Hz, 1H), 6.33 (br, 1H), 5.14 (d, J = 1.7 Hz, 1H), 4.67 (s, 1H), 4.03 (s, 3H), 3.92 (s, 3H), 3.80–3.87 (m, 1H), 2.26 (s, 1H), 2.20 (s, 1H), 1.32 (s, 3H), 1.30 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 165.2, 160.2, 158.4, 147.6, 141.4, 138.3, 136.9, 135.4, 135.3, 134.9, 129.9, 128.4, 124.53, 124.52, 121.8, 121.6, 121.5, 121.3, 76.0, 60.8, 55.4, 53.1, 52.3, 20.9, 20.0, 19.7, 19.3; MS (ESI): 465 (M+1). Anal. Calcd for $C_{26}H_{28}N_2O_6$: C 67.23, H 6.08, N 6.03; Found: C 67.23, H 5.93, N 5.99.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 6-hydroxyl-4-isopropyl-8,9-dimethyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 6j. 15%, mp 158–159 °C; IR v (cm^{-1}) 3505, 3469, 1727, 1711; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.41 (d, J = 4.2 Hz, 1H), 7.54 (t, J = 7.1 Hz, 1H), 7.48 (s, 1H), 8.45 (d, J = 7.7 Hz, 1H), 7.33 (s, 1H), 7.04 (t, J = 6.7 Hz, 1H), 5.42 (d, J = 7.8 Hz, 1H), 4.92 (d, J = 7.8 Hz, 1H), 4.00 (s, 3H), 3.93 (s, 1H), 3.71–3.77 (m, 1H), 3.50 (br, 1H), 2.24 (s, 6H), 1.09 (d, J = 6.4 Hz, 3H), 1.00 (d, J = 6.7 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 165.2, 161.7, 158.4, 148.3, 143.4, 138.8, 136.8, 136.5, 136.3, 135.1, 131.5, 130.7, 125.48, 125.46, 124.7, 122.7, 121.8, 121.5, 74.1, 64.8, 54.6, 53.0, 52.3, 21.8, 21.5, 19.6, 19.4; HRMS (ESI): 465.2027; Anal. Calcd for $C_{26}H_{29}N_2O_6$: 465.2026.

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 6-hydroxyl-4-isopropyl-8,9-dimethoxy-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 5k. 52%, mp 187–189 °C; IR ν (cm^{-1}) 3313, 1732, 1718; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.16 (d, J = 4.1 Hz, 1H), 7.54 (s, 1H), 7.43 (dt, J = 7.8, 1.7 Hz, 1H), 7.25 (s, 2H), 7.20 (d, J = 7.9 Hz, 1H), 6.92 (dd, J = 7.4, 4.9 Hz, 1H), 6.48 (d, J = 4.1 Hz, 1H), 5.15 (d, J = 2.2 Hz, 1H), 4.66 (d, J = 8.2 Hz,1H), 4.03 (s, 3H), 3.95 (s, 3H), 3.91 (s, 3H), 3.87 (s, 3H), 3.80–3.85 (m, 1H), 1.32 (d, J = 6.6 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 165.1, 160.1, 158.3, 148.2, 147.5, 141.0, 138.2, 137.0, 131.6, 129.3, 121.9, 121.7, 121.3, 116.9, 110.2, 106.3, 75.9, 60.7, 55.9, 55.4, 53.0, 52.3, 21.0, 19.9; MS (ESI): 497(M+1). Anal. Calcd for $C_{26}H_{28}N_2O_8$: C 62.89, H5.68, N5.64; Found: C 62.97, H 5.83, N 5.48.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 6-hydroxyl-4-isopropyl-8,9-dimethoxy-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 6k. 17%, mp 184–185 °C; IR ν (cm^{-1}) 3365, 1729; ^{1}H NMR (400 MHz, DMSO-d_6, 60 °C) δ (ppm) 8.33 (dd, J = 4.8, 0.8 Hz, 1H), 7.52 (dt, J = 7.7, 1.8 Hz, 1H), 7.10 (d, J = 7.9 Hz, 1H), 7.06 (s, 2H), 7.02 (dd, J = 7.2, 5.2 Hz, 1H), 6.90 (s, 1H) 5.50 (dd, J = 6.9, 5.8 Hz, 1H), 5.10 (d, J = 5.6 Hz, 1H), 4.94 (d, J = 7.2 Hz,1H), 3.88 (s, 3H), 3.84 (s, 3H), 3.76–3.81 (m, 1H), 3.74 (s, 6H), 1.15 (d, J = 6.4 Hz, 3H), 0.99 (d, J = 6.6 Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ (ppm) 164.8, 160.8, 157.5, 148.4, 147.9, 147.3, 139.1, 137.0, 136.1, 131.3, 131.1, 121.33, 121.27, 120.4, 120.1, 114.1, 106.2, 73,5, 62.9, 55.5, 55.3, 53.4, 52.9, 52.3, 21.8, 21.6; HRMS (ESI): 497.1938 (M+1), Anal. Calcd for $C_{26}H_{29}N_2O_8$: 497.1924 (M+1).

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 8,9-dibromo-6-hydroxyl-4-isopropyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 5l. 37%, mp 227–228 °C; IR ν (cm^{-1}) 3320, 1723; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.24 (d, J = 1.0 Hz, 1H), 8.20 (dd, J = 4.1, 0.7 Hz, 1H), 7.96 (s, 1H), 7.45 (dt, J = 7.8, 1.8 Hz, 1H), 7.13 (dd, J = 7.9, 0.7 Hz, 1H), 6.98 (dd, J = 7.6, 4.9 Hz, 1H), 6.41 (br, 1H), 5.19 (d, J = 2.2 Hz, 1H), 4.54 (d, J = 1.3 Hz, 1H), 4.04 (s, 3H), 3.94 (s, 3H), 3.83–3.90 (m, 1H), 1.32 (d, J = 6.8 Hz, 3H);^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 164.6, 159.1, 158.0, 148.0, 139.8, 138.2, 138.0, 137.2, 132.5, 131.6, 127.8, 124.6, 122.8, 122.6, 122.2, 121.2, 121.1, 75.7, 60.6, 55.5, 53.2, 52.5, 20.9, 19.8; MS (EI): 516 (100%), 548 (85), 591 (M^+, 50), 593 (45). Anal. Calcd for $C_{24}H_{22}Br_2N_2O_6$: C 48.51, H 3.73, N 4.71; Found: C 48.59, H 3.92, N 4.67.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 8,9-dibromo-6-hydroxyl-4-isopropyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 6l. 22%, mp 210–211 °C; IR ν (cm^{-1}) 3460, 1737, 1716; ^{1}H NMR (400 MHz, DMSO-d_6, 70 °C) δ (ppm) 8.32 (d, J = 4.2 Hz, 1H), 7.71 (s, 1H), 7.57 (s, 1H), 7.51 (dt, J = 7.7, 1.4 Hz, 1H), 7.00 (dd, J = 7.1, 5.0 Hz, 1H), 6.96 (d, J = 8.0 Hz, 1H), 5.68 (t, J = 5.5 Hz, 1H), 5.49 (d, J = 5.2 Hz, 1H), 5.16 (d, J = 6.8 Hz, 1H), 3.92 (s, 3H), 3.86 (s, 3H), 3.85–3.93 (m, 1H), 1.29 (d, J = 6.4 Hz, 3H), 1.08 (d, J = 6.5 Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ (ppm) 164.6, 159.3, 157.4, 148.9, 138.7, 137.4, 136.4, 135.9, 134.0, 133.7, 129.0, 126.6, 122.6, 121.6, 119.8, 119.7, 119.5, 72.6, 60.4, 53.3, 53.2, 52.5, 22.3, 21.4; HRMS (TOF-ESI): 592.9915 (M+1),Anal. Calcd for $C_{24}H_{23}Br_2N_2O_6$ (M+1): 592.9923.

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 9-bromo-6-hydroxyl-4-isopropyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 5m. 32%, mp 190–191 °C; IR *v* (cm^{-1}) 3324, 1737, 1724; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.16 (d, *J* = 4.1 Hz, 1H), 7.89 (d, *J* = 2.0 Hz, 1H), 7.85 (d, *J* = 8.5 Hz, 1H), 7.43 (dt, *J* = 7.8, 1.7 Hz, 1H), 7.29 (dd, *J* = 8.5, 2.0 Hz, 1H), 7.13 (d, *J* = 8.0 Hz, 1H), 6.94 (dd, *J* = 7.4, 4.9 Hz, 1H), 6.28 (br, 1H), 5.18 (s, *J* = 1.7 Hz, 1H), 4.57 (d, *J* = 1.3 Hz, 1H), 4.04 (s, 3H), 3.94 (s, 3H), 3.84–3.91 (m, 1H), 1.33 (d, *J* = 6.5 Hz, 3H), 1.32 (d, *J* = 6.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 164.8, 159.5, 158.1, 147.8, 139.6, 138.7, 137.1, 136.6, 131.3, 129.04, 128.97, 125.84, 125.8, 122.0, 121.2, 121.1, 120.6, 76.1, 60.9, 55.5, 53.1, 52.5, 20.9, 19.8; MS (ESI): 515 (M+1). Anal. Calcd for $C_{24}H_{23}BrN_2O_6$: C 55.93, H 4.50, N 5.44; Found: C 55.96, H 4.85, N 5.21.

(5*R*,6*S*)- and (5*S*,6*R*)-Dimethyl 9-bromo-6-hydroxyl-4-isopropyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 6m. 14%, mp 140–141 °C; IR *v* (cm^{-1}) 3367, 1741, 1724; ^{1}H NMR (400 MHz, DMSO-d_6, 60 °C) δ (ppm) 8.29 (dd, *J* = 2.6, 0.9 Hz, 1H), 7.61 (s,1H), 7.48 (t, *J* = 7.7 Hz, 1H), 7.19 (dd, *J* = 8.1, 1.4 Hz, 1H), 7.14 (d, *J* = 8.1 Hz, 1H), 6.97 (d, *J* = 7.6 Hz, 1H), 5.66 (t, *J* = 5.8 Hz, 1H), 5.28 (d, *J* = 5.0 Hz, 1H), 5.12 (d, *J* = 6.8 Hz, 1H), 3.92 (s, 3H), 3.87 (s, 3H), 3.87–3.96 (m, 1H), 1.29 (d, *J* = 6.4 Hz, 3H), 1.07 (d, *J* = 6.5 Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6, 60 °C) δ (ppm) 164.7, 159.7, 157.4, 148.8, 138.4, 136.3, 135.6, 134.8, 133.6, 133.2, 130.1, 127.8, 124.6, 121.5, 120.5, 119.73, 119.68, 79.1, 73.2, 60.8, 53.2, 52.5, 22.2, 21.5; MS (ESI): 517 (M+1). HRMS (ESI): 515.0810 (M+1), Anal. Calcd for $C_{24}H_{24}BrN_2O_6$: 515.0810 (M+1).

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 8-bromo-6-hydroxyl-4-isopropyl-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]azepine-2,3-dicarboxylate 7m. 14%, mp 161–162 °C; IR *v* (cm^{-1}) 3296, 1731; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.20 (d, *J* = 4.6 Hz, 1H), 8.15 (s, 1H), 7.64 (d, *J* = 8.6 Hz, 1H), 7.44 (dt, *J* = 7.8, 1.7 Hz, 1H), 7.27 (dd, *J* = 8.7, 2.0 Hz, 1H), 7.15 (d, *J* = 8.0 Hz, 1H), 6.95 (dd, *J* = 7.2, 5.2 Hz, 1H), 6.40 (br, 1H), 5.20 (s, 1H), 4.62 (s, 1H), 4.04 (s, 3H), 3.92 (s, 3H), 3.83–3.90 (m, 1H), 1.33 (d, *J* = 6.4 Hz, 3H), 1.32 (d, *J* = 6.7 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 164.8, 159.4, 158.2, 147.7, 139.6, 139.5 139.2, 137.2, 130.9, 130.2, 129.7, 125.1, 123.0, 122.0, 121.4, 121.1, 121.0, 75.9, 60.8, 55.5, 53.1, 52.4, 20.9, 19.8; MS (ESI): 515 (M+1). Anal. Calcd for $C_{24}H_{23}BrN_2O_6$: C 55.93, H 4.50, N 5.44; Found: C 55.91, H 4.43, N 5.34.

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 9-bromo-6-hydroxyl-4-(4-methoxyphenyl)-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]-azepine-2,3-dicarboxylate 5n. 31%, mp 249–250 °C; IR *v* (cm^{-1}) 3543, 1725, 1704; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.20 (d, *J* = 4.7 Hz, 1H), 7.98 (d, *J* = 2.0 Hz, 1H), 7.91 (d, *J* = 8.6 Hz, 1H), 7.53 (dt, *J* = 7.8, 1.6 Hz, 1H), 7.41 (d, *J* = 7.9 Hz, 1H), 7.35 (dd, *J* = 8.5, 2.0 Hz, 1H), 7.11 (d, *J* = 8.6 Hz, 2H), 7.02 (dd, *J* = 7.4, 5.0 Hz, 1H), 6.87 (d, *J* = 8.9 Hz, 2H), 6.12 (br, 1H), 5.60 (d, *J* = 1.8 Hz, 1H), 4.74 (d, *J* = 1.4 Hz, 1H), 3.90 (s, 3H), 3.81 (s, 3H), 3.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 162.9, 158.6, 157.9, 157.2, 147.6, 141.6, 140.6, 139.6, 137.6, 137.4, 129.6, 129.5, 128.9, 126.2, 126.1, 125.4, 122.4, 122.1, 121.2, 120.9, 114.7, 73.1, 71.0, 55.6, 52.4, 52.3; MS (ESI): 579 (M+1). Anal. Calcd for $C_{28}H_{23}BrN_2O_7$: C 58.04, H 4.00, N 4.83; Found: C 58.02, H 4.37, N 4.64.

(5*R*,6*R*)- and (5*S*,6*S*)-Dimethyl 8-bromo-6-hydroxyl-4-(4-methoxyphenyl)-5-(2-pyridyl)-5,6-dihydrobenzo[*d*]furo[3,2-*b*]-azepine-2,3-dicarboxylate 6n. 17%, mp 175–176 °C; IR *v* (cm^{-1}) 3461, 1725; ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.32 (d, *J* = 4.2 Hz, 1H), 8.00 (d, *J* = 1.9 Hz, 1H), 7.50 (dt, *J* = 7.9, 1.8 Hz, 1H), 7.45 (d, *J* = 7.5 Hz, 1H), 7.30 (d, *J* = 8.2 Hz, 1H), 7.26 (dd, *J* = 8.1, 1.9 Hz, 1H), 7.20 (d, *J* = 9.0 Hz, 2H), 6.98 (t, *J* = 6.0 Hz, 1H), 6.83 (d, *J* = 9.1 Hz, 2H), 6.07 (t, *J* = 4.4 Hz, 1H), 5.63 (d, *J* = 6.6 Hz, 1H), 3.90 (s, 3H), 3.79 (s, 3H), 3.41 (s, 3H), 2.04 (brs, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm) 163.1, 158.1, 158.0, 156.8, 149.0, 142.2, 139.6, 138.5, 136.9, 134.4, 133.5, 130.6, 129.4, 129.1, 126.8, 125.5, 122.4, 122.0, 121.7, 120.7, 114.3, 70.0, 55.5, 52.4, 52.2; MS (ESI): 579 (M+1). Anal. Calcd for $C_{28}H_{23}BrN_2O_7$: C 58.04, H 4.00, N 4.83; Found: C 57.70, H 4.12, N 4.68.

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11 Crystal data for **5m**: $C_{24}H_{23}BrN_2O_6$, M = 515.35, *T* = 113 K, monoclinic, space group $P2_1/n$, *a* = 8.5580(12), *b* = 15.813(2), *c* = 16.673(2) Å,

α = 90°, = 98.473(5)°, γ = 90°, V = 2231.7(5) Å^3, Z = 4, ρ_c = 1.534 g cm^{-3}, absorption coefficient 1.886 mm^{-1}, reflections collected/unique 18766/5327 [R(int) = 0.0450], final R indices [$I > 2\sigma(I)$], R_1 = 0.0317, wR_2 = 0.0707. Crystal data for **7m**: $C_{24}H_{23}BrN_2O_6$, M = 515.35, T = 296(2) K, Triclinic, space group $P\bar{1}$, a = 7.9953(17), b = 12.083(3), c = 13.275(3) Å, α = 65.855 (3)°, = 88.718(4)°, γ = 84.251(4)°, V = 1164.2(4) Å^3, Z = 2, ρ_c = 1.470 g cm^{-3}, absorption coefficient 1.808 mm^{-1}, reflections collected/unique 5905/4184 [R(int) = 0.0136], final R indices [$I > 2\sigma(I)$], R_1 = 0.0352, wR_2 = 0.0850. Crystal data for **6m**: $C_{24}H_{23}BrN_2O_6$, M = 515.35, T = 293(2) K, Tetragonal, space group P-4, a = 29.5080(10), b = 29.5080(10), c = 12.1390(10) Å, α = 90°, = 90°, γ = 90°, V = 10569.7(10) Å^3, Z = 16, ρ_{calcd} = 1.295 g cm^{-3}, absorption coefficient 1.593 mm^{-1}, reflections collected/unique 19871/19871 [R(int) = 0.0000], final R indices [$I > 2\sigma(I)$], R_1 = 0.0446, wR_2 = 0.1038. CCDC 791270 (**5m**), 802475 (**6m**) and 802476 (**7m**) contain the supplementary crystallographic data for this paper.† These data can be obtained free of charge from The Cambridge Crystallographic Data Centre *via* www.ccdc.cam.ac.uk/data_request/cif.

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