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"Fries Like" Rearrangement : a Novel and Efficient Method for the Synthesis of 6-Acyl-2(*3H*)-benzoxazolones and 6-Acyl-2(*3H*)-benzothiazolones

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Abstract : 6-Acyl-2(*3H*)-benzoxazolone and 6-acyl-2(*3H*)-benzothiazolone derivatives have particularly interesting anti-inflammatory, antiepileptic, analgesic and antiviral properties. In this study, we report an original method of acylation on the 6-position of 2(*3H*)-benzoxazolone and 2(*3H*)-benzothiazolone which consists in a two-step procedure involving migration of the acyl group from the *N*-position to the 6-position of the heterocycle, at 165 °C and catalyzed by $AlCl_3$. This new procedure was found to be more efficient with regard to the consumption of $AlCl_3$ and the yield (76-90%) than other acylation methods previously described.

The use of the aluminium chloride–*N*, *N*-dimethylformamide ($AlCl_3$-DMF, 11:1) reagent in the Friedel-Crafts *C*-acylation reaction of 2(3*H*)-benzoxazolones and 2(3*H*)-benzothiazolones was previously reported.[1-3] These heterocycles are highly basic substrates toward a Lewis acid such as $AlCl_3$. They are therefore extensively complexed and become consequently extremely deactivated in this electrophilic aromatic substitution process. [4] Use of $AlCl_3$-DMF reagent allows to circumvent this problem.[3] These acylation reactions were found to proceed with high regioselectivity. The precise position of acylation was unequivocally assigned by X-ray single-crystal diffraction in the case of 6-benzoyl-2(3*H*)-benzoxazolone and 6-benzoyl-2(3*H*)-benzothiazolone.[5,6] The assignment of the position of acylation was extended to other terms by use of high-field ^{1}H-NMR.[3] Use of $AlCl_3$-DMF was also applied successfully to the Haworth reaction of 2(3*H*)-benzothiazolones[2] and to the synthesis of various serotonine receptor ligands.[7,8]

Since the pioneering discovery of the hypnotic properties of 2(*3H*)-benzoxazolone, over these last twenty years, the 2(*3H*)-benzoxazolone ring became an important building block in medicinal chemistry and led to the discovery of a number of derivatives endowed with anti-inflammatory, antispasmodic, antitubercular, antibacterial, antimicrobial, antifungal and normolipemic effects.[9-16]

Recently, we discovered that 6-acyl-2(*3H*)-benzoxazolones and 6-acyl-2(*3H*)-benzothiazolones

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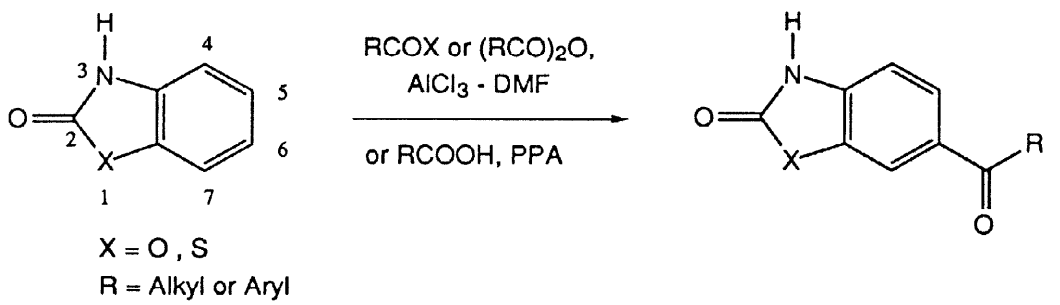
derivatives possessed potent *in vivo* anticonvulsant[17,18] (against MES-induced seizures) and *in vitro* antiviral (Van derpoorten *et al.*, in preparation) activities. Moreover, 6-acyl-2(*3H*)-benzoxazolones and 6-acyl-2(*3H*)-benzothiazolones have interesting analgesic properties and can be used for the management of chronic moderate pain in man. In view of the clinical interest of these compounds, an optimization study of their synthesis was performed.

While the acylation reactions of 2(*3H*)-benzoxazolones and 2(*3H*)-benzothiazolones proceed smoothly with aliphatic acid chlorides or anhydrides, aromatic acylation reagents were far less reactive under the same reaction conditions (Scheme 1). It should also be noted that an important drawback of the use of $AlCl_3$-DMF reagent is the important consumption of $AlCl_3$ necessary to accomplish the reaction in high yield ; in general, acylation was found to proceed with satisfactory rate and yield only when the ratio $AlCl_3$-DMF/substrate was in the range of 7-11.[4] 6-Benzoyl-2(*3H*)-benzoxazolone and 6-benzoyl-2(*3H*)-benzothiazolone are prepared more readily[3] by reacting the heterocycle with benzoic acid in polyphosphoric acid (PPA) at 130 °C for 4 h (Scheme 1). This method, however, lacks versatility[19] ; we therefore searched for an alternative synthetic method that would be flexible and more effective with regard to the consumption of $AlCl_3$.



Scheme 1

RESULTS AND DISCUSSION

Under the best conditions in our hands, 6-benzoyl-2(*3H*)-benzoxazolone was prepared in 30 % yield by reaction of benzoyl bromide and 2(*3H*)-benzoxazolone in the presence of 7-11 equivalents of the $AlCl_3$-DMF reagent. Benzoyl chloride or fluoride and benzoic anhydride gave in all cases much lower yields.

In an effort to overcome this difficulty, we first *N*-acylated 2(*3H*)-benzoxazolone using acid anhydrides or acyl halides and triethylamine in THF (Step a , Fig.1). Yields of *N*-acyl derivatives were in all case quite good (94-99 %, Table 1). The *N*-acyl derivatives were subsequently rearranged in a "Fries-like"[20-23] type of process to give the 6-acyl derivatives in high yield (Table 1) by heating a melt of 3-acyl-2(*3H*)-benzoxazolone and $AlCl_3$ at 165 °C for 3 h. The same reaction sequence was

extended to the 2(*3H*)-benzothiazolone series. The acyl migration of some 3-acylbenzoxazolone derivatives in PPA has been described by a two-steps method involving a Chattaway rearrangement.[24] However, this method had several drawbacks in comparison with the conditions b. It is not versatile enough and consumes an high quantity of polyphosphoric acid (50 g for 10 mmol of 3-acylbenzoxazolones) and the yields of this rearrangement method (66-68 %) were lower than those of method b (76-90 %).

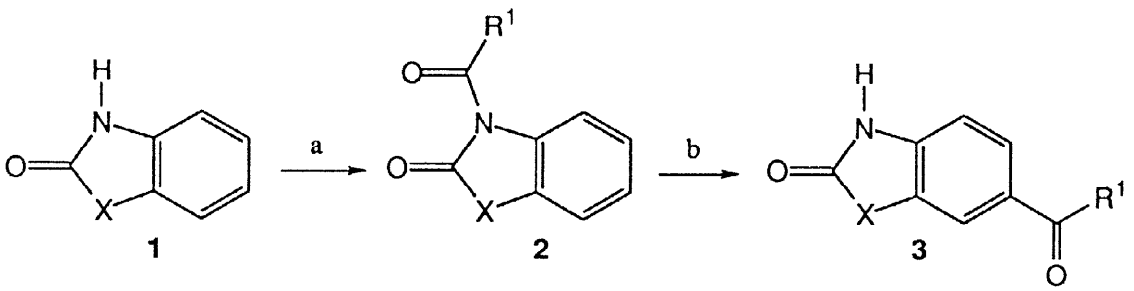


Fig. 1. 6-Acylation of 2(*3H*)-benzoxazolones and 2(*3H*)-benzothiazolones. Conditions : a. R^1COCl or $(R^1CO)_2O$, TEA , THF , reflux , 2 h ; b. $AlCl_3$, 165 °C , 3 h

Table 1. Yields of *N*-acyl derivatives **2** and 6-acyl derivatives **3** .

	X	R^1	**1 → 2** Yields (%)	**1 → 3** Yields (%)
a	O	CH_3	94	76
b	O	C_2H_5	99	88
c	O	C_6H_5	95	80
d	O	3-F-C_6H_4	97	80
e	O	4-F-C_6H_4	98	81
f	O	4-Cl-C_6H_4	96	88
g	O	4-NO_2-C_6H_4	96	82
h	S	CH_3	96	78
i	S	C_2H_5	97	83
j	S	3-F-C_6H_4	96	90
k	S	4-F-C_6H_4	99	83
l	S	4-Cl-C_6H_4	97	87
m	S	4-NO_2-C_6H_4	96	84

As noted earlier, an important drawback of the use of $AlCl_3$-DMF reagent is the important consumption of $AlCl_3$. The present method requires only 2.5 equivalents of $AlCl_3$ to perform the reaction in good yields (Table 1). The 6-acyl derivative was the only product which could be isolated from the reaction medium; no evidence (TLC or ^1H- and ^{13}C-NMR) could be found for the concomitant formation of isomeric *C*-acyl derivatives.

To investigate the mechanism of this rearrangement, 3-benzoylbenzoxazolin-2-one (3-benzoylbenzothiazolin-2-one) was reacted in the presence of 2(*3H*)-benzothiazolone [2(*3H*)-benzoxazolone]. In these conditions, no product resulting from the migration of the benzoyl group of the benzoxazolone (benzothiazolone) ring to benzothiazolone (benzoxazolone) ring was detected by TLC and ^1H- and ^{13}C-NMR. This observation suggests that under the experimental conditions described here the acyl migration observed on the substrate was probably intramolecular.

CONCLUSION

In this study, we reported an original and efficient method of acylation of 2(*3H*)-benzoxazolone and 2(*3H*)-benzothiazolone on the 6-position. This new procedure involves the migration of the acyl group from the *N*-position to the 6-position of the heterocycle. This method presents many advantages with regard to other acylation methods. It uses 4-fold less quantity of $AlCl_3$ to produce 6-acyl-2(*3H*)-benzoxazolones and 6-acyl-2(*3H*)-benzothiazolones with yields (76-90%) higher than acylation methods previously described [1-3] (55–75%). Moreover this method is more universal in comparison to the previous ones. From these results, it appears clearly that this novel method can be an alternative to the former acylation procedures of 2(*3H*)-benzoxazolone and 2(*3H*)-benzothiazolone.

EXPERIMENTAL

Uncorrected melting points were determined using an Electrothermal melting point apparatus. The IR spectra (KBr pellets) were recorded on a Perkin-Elmer 457 spectrometer. ^1H-NMR spectra were recorded using a Bruker AC 300 spectrometer with TMS as internal standard and the chemical shifts are reported in the δ scale in parts per million (δ, ppm). Elemental analysis were performed by the Laboratory of Medicinal Chemistry of the University of Liège. All compounds were found homogeneous by TLC (Merck silica gel 60_{254} , ethyl acetate/ hexane, 3/2, v/v). THF was redistilled over a bed of $LiAlH_4$. DMF (Gold label grade), $AlCl_3$ and PPA were purchased

from Aldrich. 3-benzoyl-2(*3H*)-benzothiazolone and 6-benzoyl-2(*3H*)-benzothiazolone were previously described.[19]

General procedure for the synthesis of 3-acyl-2(3H)-benzoxazolone and 3-acyl-2(3H)-benzothiazolone derivatives

The acyl chloride (12 mmol) was added dropwise over 15 min to a solution of 2(*3H*)-benzoxazolone or 2(*3H*)-benzothiazolone (10 mmol) and dry TEA (3.03 g, 30 mmol) in 10 mL of dry THF cooled at ~4°C. The reaction mixture was heated under reflux for 2 h, added to 200 mL of ice water and stirred for 1 h. The resulting precipitate was filtered, washed with water, dried, and recrystallized from ethanol.

3-acetylbenzoxazolin-2-one ***2 a***

mp 95-96 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1770 cm^{-1} (C=O lactam), 1720 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 2.60 (3H, s), 7.33 (3H, m), 7.91 (1H, m) ; Anal. Calcd for $C_9H_7NO_3$: C, 61.02 ; H, 3.98 ; N, 7.91 . Found : C, 60.98 ; H, 4.16 ; N, 7.88 .

3-propanoylbenzoxazolin-2-one ***2 b***

mp 93-95 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1770 cm^{-1} (C=O lactam), 1720 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, $CDCl_3$) δ 1.28 (3H, t), 3.13 (2H, q), 7.23 (3H, m) 8.07 (1H, t) ; Anal. Calcd for $C_{10}H_9NO_3$: C, 62.82 ; H, 4.74 ; N, 7.33 . Found : C, 62.66 ; H, 4.84 ; N, 7.48 .

3-benzoylbenzoxazolin-2-one ***2 c***

mp 172-173 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1770 cm^{-1} (C=O lactam), 1700 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, $CDCl_3$) δ 7.26 (3H, m) 7.50 (2H, m) 7 .64 (1H, m) 7.83 (3H, m) ; Anal. Calcd for $C_{14}H_9NO_3$: C, 70.29 ; H, 3.79 ; N, 5.85 . Found : C, 70.27 ; H, 3.78 ; N, 5.97 .

3-(3-fluoro)benzoylbenzoxazolin-2-one ***2 d***

mp 131-133 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1770 cm^{-1} (C=O lactam), 1700 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.34 (2H, m) 7.53 (3H, m) 7.70 (1H, dd, J = 1.1, 8.4 Hz) 7.81 (2H, m) ; Anal. Calcd for $C_{14}H_8NO_3F$: C, 65.37 ; H, 3.13 ; N, 5.45 . Found : C, 65.23 ; H, 3.00 ; N, 5.57 .

3-(4-fluoro)benzoylbenzoxazolin-2-one ***2 e***

mp 160-162 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1770 cm^{-1} (C=O lactam), 1700 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, $CDCl_3$) δ 7.19 (2H, m) 7.28 (3H, m) 7.84 (3H, m) ; Anal. Calcd for $C_{14}H_8NO_3F$: C, 65.37 ; H, 3.13 ; N, 5.45 . Found : C, 65.13 ; H, 3.02 ; N, 5.59 .

3-(4-chloro)benzoylbenzoxazolin-2-one ***2 f***

mp 174-176 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1770 cm^{-1} (C=O lactam), 1700 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, $CDCl_3$) δ 7.25 (3H, m) 7.48 (2H, dd, J = 1.5, 8.5 Hz) 7.74 (2H, dd, J = 1.5, 8.5 Hz) 7.86 (1H, m) ; Anal. Calcd for $C_{14}H_8NO_3Cl$: C, 61.44 ; H, 2.95 ; N, 5.12 . Found: C, 61.52 ; H, 3.03 ; N, 5.26 .

3-(4-nitro)benzoylbenzoxazolin-2-one ***2 g***

mp 207-209 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1770 cm^{-1} (C=O lactam), 1700 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.36 (2H, m) 7.48 (1H, m) 7.93 (1H, m) 8.10 (2H, d, J = 8.5 Hz) 8.35 (2H, d, J = 8.5 Hz) ; Anal. Calcd for $C_{14}H_8N_2O_5$: C, 59.16 ; H, 2.84 ; N, 9.86 . Found: C, 59.23 ; H, 2.73 ; N, 9.83 .

3-acetylbenzothiazolin-2-one ***2 h***

mp 61-63 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1660 cm^{-1} (C=O lactam), 1640 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, $CDCl_3$) δ 2.74 (3H, s), 7.31 (3H, m) 8.32 (1H, dd, J = 1.1, 8.5 Hz) ; Anal. Calcd for $C_9H_7NO_2S$: C, 55.95 ; H, 3.65 ; N, 7.25 ; S, 16.59 . Found: C, 55.63 ; H, 3.58 ; N, 7.32 ; S, 16.64 .

3-propanoylbenzothiazolin-2-one ***2 i***

mp 86-88 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1660 cm^{-1} (C=O lactam), 1640 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, $CDCl_3$) δ 1.26 (3H, t), 3.13 (2H, q), 7.30 (3H, m) 8.30 (1H, d, J = 8.4 Hz) ; Anal. Calcd for $C_{10}H_9NO_2S$: C, 57.96 ; H, 4.38 ; N, 6.76 ; S, 15.47 . Found: C, 57.87 ; H, 4.45 ; N, 6.90 ; S, 15.42 .

3-(3-fluoro)benzoylbenzothiazolin-2-one ***2 j***

mp 99-100 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1660 cm^{-1} (C=O lactam), 1630 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.34 (4H, m) 7.47 (2H, m) 7.55 (1H, m) 7.64 (1H, d, J = 8.5 Hz) ; Anal. Calcd for $C_{14}H_8NO_2SF$: C, 61.53 ; H, 2.95 ; N, 5.13 ; S, 11.73 . Found: C, 61.00 ; H, 2.92 ; N, 5.19 ; S, 11.70 .

3-(4-fluoro)benzoylbenzothiazolin-2-one ***2 k***

mp 107-108 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1660 cm^{-1} (C=O lactam), 1630 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, $CDCl_3$) δ 7.25 (4H, m) 7.44 (1H, dd, J = 1.5, 8.5 Hz) 7.56 (1H, dd, J = 1.5, 8.5 Hz) 7.91 (2H, m) ; Anal. Calcd for $C_{14}H_8NO_2SF$: C, 61.53 ; H, 2.95 ; N, 5.13 ; S, 11.73 . Found : C, 61.05 ; H, 2.92 ; N, 5.18 ; S, 11.66 .

3-(4-chloro)benzoylbenzothiazolin-2-one ***2 l***

mp 109-110 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1660 cm^{-1} (C=O lactam), 1630 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, $CDCl_3$) δ 7.30 (2H, m) 7.46 (3H, m) 7.61 (1H, dd, J = 1.5, 8.5 Hz) 7.81 (2H, dd, J = 1.5, 8.5 Hz) ; Anal. Calcd for $C_{14}H_8NO_2SCl$: C, 58.04 ; H, 2.78; N, 4.83 ; S, 11.07. Found : C, 58.14 ; H, 2.84 ; N, 4.91 ; S, 10.95 .

3-(4-nitro)benzoylbenzothiazolin-2-one ***2 m***

mp 160-161 °C ; IR (KBr) 3040 cm^{-1} (C-H arom), 1660 cm^{-1} (C=O lactam), 1630 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.41 (2H, m) 7.78 (1H, d, J = 8.4 Hz) 7.86 (1H, d, J = 8.4 Hz) 8.11 (2H, d, J = 8.8 Hz) 8.32 (2H, m) ; Anal. Calcd for $C_{14}H_8N_2O_4S$: C, 56.00 ; H, 2.69 ; N, 9.33 ; S, 10.68 . Found : C, 56.00 ; H, 2.67 ; N, 9.34 ; S, 10.79 .

General procedure for the synthesis of 6-acyl-2(3H)-benzoxazolones and 6-acyl-2(3H)-benzothiazolones by "Fries like" reaction.

An intimate mixture of 3-acyl-2(*3H*)-benzoxazolone (**2a – g**) or 3-acyl-2(*3H*)-benzothiazolone (**2h – m**, 10 mmol) and $AlCl_3$ (3.33 g, 25 mmol) was slowly (30 min) brought to 165°C using an oil bath. This temperature was maintained for 3 h and, after cooling, the resulting dark residue was

decomposed by addition of 100 mL of 0.1 N HCl. The resulting precipitate was stirred for 30 min, filtered, washed with water, dried, and recrystallized from ethanol.

6-acetylbenzoxazolin-2-one ***3 a***

mp 228 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1775 cm^{-1} (C=O lactam), 1655 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 2.57 (3H, s), 7.18 (1H, d, J = 8.1 Hz) 7.79 (1H, d, J = 8.1 Hz) 7.84 (1H, dd, J = 1.5, 8.1 Hz), 12.18 (1H, broad) ; Anal. Calcd for $C_9H_7NO_3$: C, 61.02 ; H, 3.98 ; N, 7.91 . Found : C, 60.91 ; H, 3.86 ; N, 7.95 .

6-propanoylbenzoxazolin-2-one ***3 b***

mp 205 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1775 cm^{-1} (C=O lactam), 1655 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 1.10 (3H, t), 3.01 (2H, q), 7.16 (1H, d, J = 8.1 Hz) 7.78 (1H, s) 7.82 (1H, dd, J = 1.5, 8.1 Hz), 12.20 (1H, broad) ; Anal. Calcd for $C_{10}H_9NO_3$: C, 62.82 ; H, 4.74 ; N, 7.33 . Found : C, 62.69 ; H, 4.82 ; N, 7.49 .

6-benzoylbenzoxazolin-2-one ***3 c***

mp 169-170 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1780 cm^{-1} (C=O lactam), 1635 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.23 (1H, d, J = 8.1 Hz) 7.57 (3H, m) 7.68 (4H, m), 12.1 (1H, broad) ; Anal. Calcd for $C_{14}H_9NO_3$: C, 70.29 ; H, 3.79 ; N, 5.85 . Found : C, 70.32 ; H, 3.86 ; N, 5.99 .

6-(3-fluoro)benzoylbenzoxazolin-2-one ***3 d***

mp 266-268 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1780 cm^{-1} (C=O lactam), 1635 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.24 (1H, d, J = 8.4 Hz), 7.52 (3H, m), 7.61 (2H, dd, J = 1.5, 8.1 Hz) 7.66 (1H, d, J = 1.1 Hz), 12.19 (1H, broad) ; Anal. Calcd for $C_{14}H_8NO_3F$: C, 65.37 ; H, 3.13 ; N, 5.45 . Found : C, 65.43 ; H, 3.04 ; N, 5.53 .

6-(4-fluoro)benzoylbenzoxazolin-2-one ***3 e***

mp 222-224 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1780 cm^{-1} (C=O lactam), 1635 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.33 (4H, m) 8.02 (3H, m), 12.14 (1H, broad) ; Anal. Calcd for $C_{14}H_8NO_3F$: C, 65.37 ; H, 3.13 ; N, 5.45 . Found : C, 65.21 ; H, 3.00 ; N, 5.57 .

6-(4-chloro)benzoylbenzoxazolin-2-one ***3 f***

mp 254-255 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1780 cm^{-1} (C=O lactam), 1635 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.23 (1H, d, J = 8.1 Hz) 7.61 (4H, m) 7.73 (2H, dd, J = 1.8, 8.1 Hz), 12.15 (1H, broad) ; Anal. Calcd for $C_{14}H_8NO_3Cl$: C, 61.44 ; H, 2.95; N, 5.12 . Found : C, 61.34 ; H, 2.96 ; N, 5.23 .

6-(4-nitro)benzoylbenzoxazolin-2-one ***3 g***

mp 223-224 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1780 cm^{-1} (C=O lactam), 1635 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.25 (1H, d, J = 8.1 Hz) 7.60 (1H, dd, J = 1.5, 8.1 Hz) 7.69 (1H, d, J = 1.5 Hz) 7.93 (2H, m) 8.23 (2H, dd, J = 1.5, 8.1 Hz), 12.24 (1H, broad) ; Anal. Calcd for $C_{14}H_8N_2O_5$: C, 59.16 ; H, 2.84 ; N, 9.86 . Found : C, 59.26 ; H, 2.78 ; N, 9.89 .

6-acetylbenzothiazolin-2-one ***3 h***

mp 189-191 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1700 cm^{-1} (C=O lactam), 1660 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 2.56 (3H, s) 7.20 (1H, d, J = 8.4 Hz) 7.89 (1H, dd, J = 1.8, 8.4 Hz), 8.23 (1H, d, J = 1.5 Hz), 12.19 (1H, broad) ; Anal. Calcd for $C_9H_7NO_2S$: C, 55.95 ; H, 3.65 ; N, 7.25 ; S, 16.59 . Found : C, 55.75 ; H, 3.65 ; N, 7.28 ; S, 16.54 .

6-propanoylbenzothiazolin-2-one ***3 i***

mp 204-205 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1690 cm^{-1} (C=O lactam), 1650 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 1.09 (3H, t), 3.01 (2H, q), 7.19 (1H, d, J = 8.4 Hz) 7.89 (1H, d, J = 8.4 Hz) 8.21 (1H, s), 12.25 (1H, broad) ; Anal. Calcd for $C_{10}H_9NO_2S$: C, 57.96 ; H, 4.38 ; N, 6.76 ; S, 15.47 . Found : C, 57.89 ; H, 4.53 ; N, 6.93 ; S, 15.47 .

6-(3-fluoro)benzoylbenzothiazolin-2-one ***3 j***

mp 187-189 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1680 cm^{-1} (C=O lactam), 1630 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.26 (1H, d, J = 8.4 Hz) 7.52 (3H, m) 7.62 (1H, m) 7.72 (1H, dd, J = 1.1, 8.4 Hz) 8.08 (1H, s), 12.22 (1H, broad) ; Anal. Calcd for $C_{14}H_8NO_2SF$: C, 61.53 ; H, 2.95 ; N, 5.13 ; S, 11.73 . Found : C, 61.08 ; H, 2.96 ; N, 5.17 ; S, 11.66 .

6-(4-fluoro)benzoylbenzothiazolin-2-one ***3 k***

mp 235-237 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1680 cm^{-1} (C=O lactam), 1630 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.25 (1H, d, J = 8.1 Hz) 7.38 (2H, m) 7.68 (1H, d, J = 8.1 Hz) 7.81 (2H, m) 8.04 (1H, s), 12.17 (1H, broad) ; Anal. Calcd for $C_{14}H_8NO_2SF$: C, 61.53 ; H, 2.95 ; N, 5.13 ; S, 11.73 . Found : C, 61.01 ; H, 2.98 ; N, 5.20 ; S, 11.62 .

6-(4-chloro)benzoylbenzothiazolin-2-one ***3 l***

mp 275-277 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1680 cm^{-1} (C=O lactam), 1630 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.25 (1H, d, J = 8.4 Hz) 7.63 (2H, d, J = 8.4 Hz) 7.72 (3H, m), 8.05 (1H, s), 12.21 (1H, broad) ; Anal. Calcd for $C_{14}H_8NO_2SCl$: C, 58.04 ; H, 2.78 ; N, 4.83 ; S, 11.07 . Found : C, 58.12 ; H, 2.74 ; N, 4.92 ; S, 11.08 .

6-(4-nitro)benzoylbenzothiazolin-2-one ***3 m***

mp 255-256 °C ; IR (KBr) 3160 cm^{-1} (N-H), 3040 cm^{-1} (C-H arom), 1685 cm^{-1} (C=O lactam), 1630 cm^{-1} (C=O) ; ^{1}H-NMR (300 MHz, DMSO-d_6) δ 7.27 (1H, d, J = 8.4 Hz) 7.73 (1H, d, J = 8.4 Hz) 7.94 (2H, m), 8.08 (1H, s) 8.37 (2H, m), 12.23 (1H, broad) ; Anal. Calcd for $C_{14}H_8N_2O_4S$: C, 56.00 ; H, 2.69 ; N, 9.33 ; S, 10.68 . Found : C, 55.93 ; H, 2.59 ; N, 9.31 ; S, 10.77 .

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