

## Research Article

# One-Pot Synthesis of 2'-Aminobenzothiazolo-Arylmethyl-2-Naphthols Catalyzed by NBS under Solvent-Free Conditions

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To develop a new facile protocol for the synthesis of 2'-aminobenzothiazolo-arylmethyl-2-naphthol derivatives, N-bromosuccinimide (NBS) was used as an efficient catalyst for the one-pot synthesis of 2'-aminobenzothiazolo-arylmethyl-2-naphthols in excellent yields from  $\beta$ -naphthol (1 mmol), aromatic aldehydes (1 mmol), and 2-aminobenzothiazole (1 mmol) at 60°C under solvent-free conditions.

## 1. Introduction

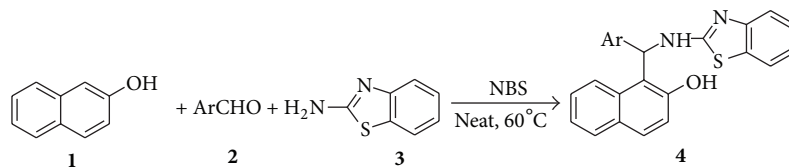
Organic reactions under solvent-free conditions have attracted much interest of chemists particularly from the viewpoint of green chemistry. Green chemistry approaches are significant due to the reduction in byproducts, reduction in produced waste, and reduction of energy cost. The possibility of performing multicomponent reactions under solvent-free conditions with a heterogeneous catalyst could enhance their efficiency from an economic as well as an ecological point of view [1–5].

The synthesis of new heterocyclic compounds has always been a subject of great interest due to their wide applicability. Heterocyclic compounds occur very widely in nature and are essential to life. Amongst a large variety of heterocyclic compounds, heterocycles containing benzothiazole moiety are of interest because they show some pharmacological and biological activities. Benzothiazole derivatives were reported to possess anti-inflammatory [6], anti-tumour [7–9], anticonvulsant [10, 11], antibacterial [12], antifungal [13], and topoisomerase II inhibitory activities [14]. Thus, the synthesis of benzothiazole is an important and useful task in organic chemistry. In recent years, the synthesis

of 2'-aminobenzothiazolo-arylmethyl-2-naphthols has been reported using LiCl [15] and [Hnmp] HSO<sub>4</sub> [16] as catalysts.

The use of organic molecules as catalysts has become an attractive alternative to traditional metal catalysts. Interest in the field of organocatalysis has increased spectacularly in the last few years as the result of both the novelty of the concept and, more importantly, the fact that the efficiency and selectivity of many organocatalytic reactions meet the standards of established organic reactions [17]. NBS is one such catalyst, which has recently received considerable attention as a catalyst in various organic transformations [18–25], and is widely used as a brominating reagent. Furthermore, it is also used in oxidation and free radical reactions under mild and convenient conditions to afford the desired products in excellent yields and with high selectivities. However, there are no examples of the use of NBS as a catalyst for the synthesis of 2'-aminobenzothiazolo-arylmethyl-2-naphthols.

In continuation of our efforts to explore newer reactions for the synthesis of heterocyclic compounds, we wish to report here a facile and improved protocol for preparation of 2'-aminobenzothiazolo-arylmethyl-2-naphthols from  $\beta$ -naphthol, aromatic aldehydes, and 2-aminobenzothiazole in the presence of NBS as a catalyst under solvent-free conditions (Scheme 1).



SCHEME 1

TABLE 1: The synthesis of 2'-aminobenzothiazolo-phenyl-2-naphthol in various conditions.

Entry	Solvent	NBS (mol%)	Temperature (°C)	Time (min)	Yield (%)
1	Water	10	25	90	59
2	Water	10	60	60	88
3	Ethanol-water	10	25	60	56
4	Ethanol-water	10	60	30	85
5	Neat	0	60	60	0
6	Neat	2	60	30	73
7	Neat	5	60	20	89
8	Neat	10	25	60	65
9	Neat	10	60	10	94
10	Neat	15	60	10	92
11	Neat	20	60	10	92

## 2. Results and Discussion

Initially, we decided to explore the role of our catalyst in water and ethanol-water (1:1) as solvent system for the synthesis of 2'-aminobenzothiazolo-phenylmethyl-2-naphthol used as a model compound. With respect to the solvent system, the best results were achieved using water (Table 1, Entry 2). In recent years, the synthesis of compounds under solvent-free conditions is an important task in heterocyclic synthesis. Therefore, we decided to test this solvent-free reaction with various ratios of catalysts. We found that the reaction was rapid and gave excellent yields of the products when using 10 mol% NBS.

These results encouraged us to investigate the scope and generality of this new protocol for various aromatic aldehydes under optimized conditions. As shown in Table 2, a series of aromatic aldehydes containing either electron-withdrawing or electron-donating substituents successfully react with  $\beta$ -naphthol and 2-aminobenzothiazole which afforded good to high yields of products with high purity, at 60°C under solvent-free conditions.

It is likely that the reagent releases  $\text{Br}^+$  *in situ*, which can act as an electrophilic species. Therefore, the mechanism shown in Scheme 2 can be suggested for the conversion of the  $\beta$ -naphthol 2-aminobenzothiazole and various aromatic aldehydes to 2'-aminobenzothiazolo-aryl-methyl-2-naphthols.

In summary, we have developed a new facile protocol for the synthesis of 2'-aminobenzothiazolo-aryl-methyl-2-naphthol derivatives from the reaction of  $\beta$ -naphthol,

TABLE 2: Preparation of 2'-aminobenzothiazolo-aryl-methyl-2-naphthols<sup>a</sup>.

Entry	Ar	Time (min)	Products	Yield (%) <sup>b</sup>	m.p. (lit.) (°C) <sup>c</sup>
1	C <sub>6</sub> H <sub>5</sub>	10	<b>4a</b>	94	202–204 (204–205) [15]
2	4-Cl-C <sub>6</sub> H <sub>4</sub>	8	<b>4b</b>	95	209–210 (209–210) [15]
3	4-Me-C <sub>6</sub> H <sub>4</sub>	10	<b>4c</b>	92	183–184 (182–183) [15]
4	4-F-C <sub>6</sub> H <sub>4</sub>	10	<b>4d</b>	98	189–190 (188–189) [16]
5	4-NO <sub>2</sub> -C <sub>6</sub> H <sub>4</sub>	5	<b>4e</b>	97	188–189 (190–191) [16]
6	4-MeO-C <sub>6</sub> H <sub>4</sub>	10	<b>4f</b>	90	172–173 (175–176) [16]
7	3-NO <sub>2</sub> -C <sub>6</sub> H <sub>4</sub>	8	<b>4g</b>	93	197–199 (198–199) [15]
8	2-Cl-C <sub>6</sub> H <sub>4</sub>	8	<b>4h</b>	91	185–186 (189–190) [16]
9	2,4-Cl <sub>2</sub> -C <sub>6</sub> H <sub>4</sub>	8	<b>4i</b>	96	203–204 (206–207) [16]
10	4-OH-3-MeO-C <sub>6</sub> H <sub>3</sub>	15	<b>4j</b>	88	192–194 (194–195) [16]
11	3,4,5-MeO <sub>3</sub> C <sub>6</sub> H <sub>2</sub>	15	<b>4k</b>	92	159–160

<sup>a</sup> Reaction conditions:  $\beta$ -naphthol (1 mmol), aldehyde (1 mmol), 2-aminobenzothiazole (1 mmol), NBS (0.1 mmol), 60°C, and neat.

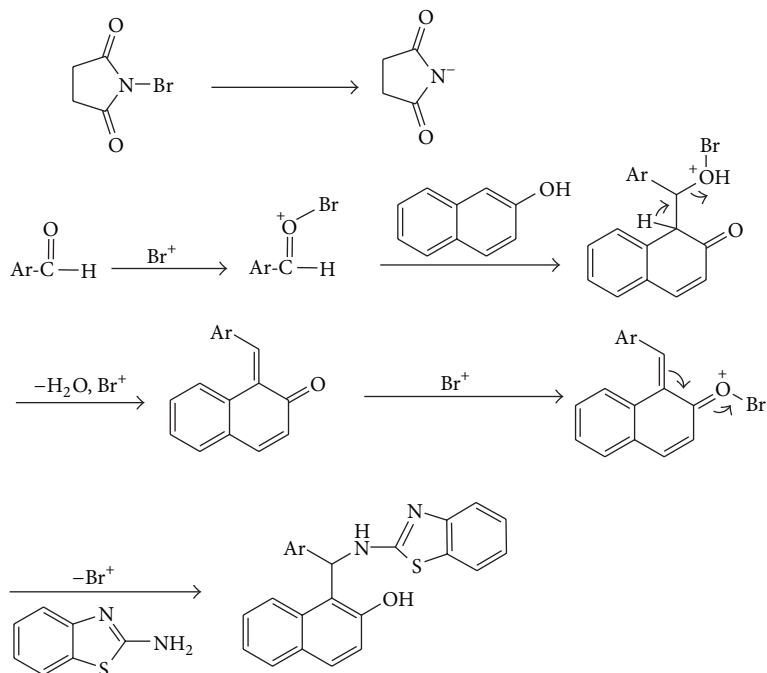
<sup>b</sup> Isolated yield.

<sup>c</sup> Temperature value in the reference.

aromatic aldehydes, and 2-aminobenzothiazole compounds using NBS under solvent-free conditions.

## 3. Experimental Part

*General.* IR spectra were determined on FTS-40 infrared spectrometer; NMR spectra were recorded on Bruker AV-400 spectrometer at room temperature using TMS as an internal standard; coupling constants ( $J$ ) were measured in Hz; elemental analysis was performed by a Vario-III elemental analyzer; melting points were determined on an XT-4 binocular microscope and were uncorrected; commercially available reagents were used throughout without further purification unless otherwise is stated.



SCHEME 2

**3.1. General Procedure for the Preparation of 4.** A mixture of the  $\beta$ -naphthol (1 mmol), aldehydes (1 mmol), 2-aminobenzothiazole (1 mmol), and NBS (0.1 mmol) was stirred at 60°C for the appropriate time according to Table 2. Completion of the reaction was indicated by TLC. The reaction was cooled to room temperature, washed with water, and extracted with ethyl acetate (3  $\times$  10 mL). The combined organic layers were dried over sodium sulfate and concentrated under reduced pressure to afford a white powder. The pure solid products were obtained by recrystallization from ethanol.

### 3.2. Spectral Data of New Products

**2'-Aminobenzothiazolo-(3-nitrophenyl)methyl-2-naphthol (4g).** IR (KBr):  $\nu$  3335 (–OH), 1627 (C=N), 1597 (aromatic C=C), 1541, 1531 (aromatic C=C), 1452, 1436, 1347, 1312, 1270, 1252, 1210, 813, 753  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (DMSO- $d_6$ , 400 MHz)  $\delta$ : 7.05–7.88 (m, 15H, ArH and CH), 8.90 (s, 1H, NH), 10.12 (brs, 1H, OH, D $_2$ O, exchangeable); Anal. calcd. for C $_{24}$ H $_{17}$ N $_3$ O $_3$ S: C 67.43, H 4.01, N 9.83, S 7.50; found C 67.50, H 4.00, N 9.87, S 7.42.

**2'-Aminobenzothiazolo-(3,4,5-trimethoxyphenyl)methyl-2-naphthol (4k).** IR (KBr):  $\nu$  3347 (–OH), 2936, 2836, 2599, 1627 (C=N), 1595 (aromatic C=C), 1544, 1507 (aromatic C=C), 1436, 1417, 1332, 1268, 1233, 1129, 1006, 816, 753  $\text{cm}^{-1}$ ;  $^1\text{H}$  NMR (DMSO- $d_6$ , 400 MHz)  $\delta$ : 3.62 (s, 9H, OCH $_3$ ), 6.80–7.81 (m, 13H, ArH and CH), 8.81 (s, 1H, NH), 10.15 (s, 1H, OH, D $_2$ O, exchangeable); Anal. calcd. for C $_{27}$ H $_{24}$ N $_2$ O $_4$ S:

C 68.62, H 5.12, N 5.93, S 6.79; found C 68.70, H 5.04, N 6.00, S 6.82.

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