A new azo dye for the selective detection of glycine

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Abstract

In this manuscript, we report the synthesis of new azo dye (E)-4-((5-methoxythiazolo[4,5-b]pyridine-2-yl)diazenyl)N-phenylaniline (**BK2**). This new azo dye revealed a pink color in the solution. Notably, this dye selectively detects only glycine among all the amino acids and a visual color change from light pink to purple can be assessed. Hence, the new azo dye finds application as colorimetric chemosensor for the rapid, selective and sensitive detection of glycine (Gly). The dye can be potentially used for the detection of high levels of glycine in the serum caused due to hyperglycinaemia.

Keywords

Azo dye, Glycine, Colorimetric chemosensor, Amino acid

Introduction

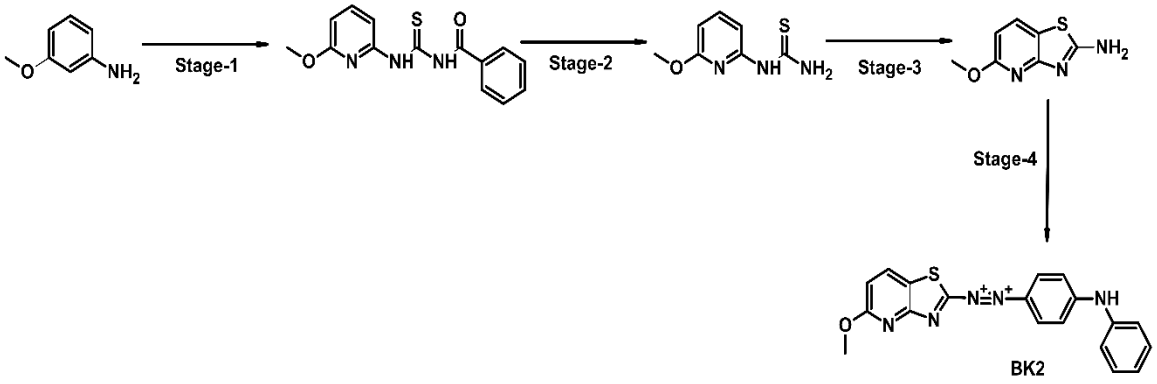
Nowadays, azo dyes are widely used in the field of chemistry. They are also used in the field of pharmaceutical, cosmetic,[1] and textile industries.[2-4] Azo dyes are easily synthesized by the process of diazotization.[5-7] Approximately 70% dyes are azo dyes which are used in the industry.[8] The color of the azo dyes are classified according to the number of azo groups which are present in the molecule. A number of heterocyclic azo dyes have been used in the medicinal application.

Various methods have also been used for amino acid sensing which include the colorimetric and fluorescence detection of natural amino acid. In this context, copper complex of the quinacridone ligand is used as a fluorescent sensor for the detection of amino acids L-methionine (Met) and L-leucine (Leu)[9]. In other study a water soluble fluorescein-based ligand forming a non-fluorescent complex with Cu^{2+} is used for the

sensing of amino acid.[10] Various literature report suggest application of azo dyes for selective sensing of amino acid,[11 12]

Our group has been interested in assessing the self-assembling properties of amino acids,[13, 14] its sensing, peptide, oligonucleotide, biopolymers, and heterocyclic compounds.[15] Recently, we also reported a colorimetric detection of Cu^{2+} and lactic by using disaggregation-induced emission mechanisms.[16] In other study we also reported a new azo dye based sensor for selective and sensitive detection of Cu(II), Sn(II), and Al(III) ions.[17] Hence, motivated by our previous studies we were inspired to synthesize a new azo dye that could efficiently be used for the colorimetric detection of amino acids.. In this study, we report a rapid, highly sensitive and selective chemosensor for the detection of glycine employing azo dyes (E)-4-((5-methoxythiazolo[4,5-b]pyridine-2-yl)diazenyl)N-phenylaniline (**BK2**).

Result and discussion:



Scheme 1: Schematic representation of synthesis of **BK2**

BK2 was synthesized via Scheme 1**.** In the first step the reaction between benzoyl chloride and ammonium thiocyanate leads to the formation of benzoyl isothiocyanate. It is followed by the condensation reaction between 2-amino-6-methoxy pyridine and benzoyl isothiocyanate leading to the formation of an acyl thiourea intermediate. In the next step, the hydrolysis of an acyl thiourea intermediate is carried out which leads to the formation of 1-(6-methoxypyridin-2-yl)thiourea. The cyclization reaction further yields 5-methoxythiazolo[4,5-b]pyridin-2-amine. In the final step the synthesized amine was conjugated with diphenylamine through the diazotization reaction which leads to the formation of a new azo dye **BK2**.

For an excellent chemosensor, a high selectivity and sensitivity of the chemosensor is required. Photophysical properties of **BK2** in methanol were investigated upon the addition of all amino acids. As a shown in figure 1, the color changes observed only with the glycine and not with the other amino acids. **BK2** forms a light pink to purple color by addition of glycine. Moreover, no obvious change has been observed in the absorption when performing the titration of glycine in the mixture of other amino acids. This fact, indicate a high selectivity of **BK2** towards glycine.

Figure 1: The color change of **BK2** (50 μM) in methanol with 50 μM of amino acids.

Amino acid glycine (Gly) plays a crucial role in living system. A mild deficiency of glycine participates in the etiology of metabolic disease. Glycine is an inhibitory neurotransmitter in the central nervous system, including the spinal cord. Therefore, determination of glycine is important in biological system. The excess amount of glycine is also very harmful. Hyperglycinemia is an inborn amino acid disorders which is characterized by the elevated levels of glycine in the blood. Hence, a colorimetric sensors for sensitive detection of glycine through naked eye without using any expensive instrument may be of great utility in diagnosis and treatment.

3. Experimental section

Materials and Reagents

Amino acids including glycine (Gly), cysteine (Cys), histidine (His), tyrosine (Tyr), lysine (Lys), threonine (Thr), methionine (Met), phenylalanine (Phe), tryptophane (Trp), glutamine (Gln), glutamic acid (Glu), isoleucine (Ile), leucine (Leu), alanine (Ala), arginine (Arg), aspartic acid (Asp), valine (Val), serine (Ser), threonine (Thr), and asparagine (Asn) were purchased from SRL (India). 2-amino 6-methoxy pyridine purchased from combi-blocks (USA), Diphenylamine, benzoyl chloride, sodium nitrite and sodium hydroxide were purchased from SD Fine chemical (India). The solvents of analytical grade were purchased from Finar and all the solvents were used without further purification.

General Information

All organic chemicals and solvents were purchased from SD Fine and Sigma-Aldrich and used without further purification. ^{1}H NMR spectra of chemosensor **BK2** were recorded on a Bruker 500 MHz (USA), using TMS as an internal standard, and DMSO as a solvent. Mass spectra were recorded on Bruker-MicrOTOF II (USA). All the amino acids solutions were prepared in the Milli Q water. A 25 mM stock solution of **BK2** has been prepared while 10 mM stock solutions of all the amino acids were prepared.

Conclusion

In conclusion, we have synthesized a new azo dye (E)-4-((5-methoxythiazolo[4,5-b]pyridine-2-yl)diazenyl)N-phenylaniline (**BK2**) which can be used as a highly selective and sensitive colorimetric chemosensor for glycine. Notably, the color of dye changes from pink to purple only on addition of glycine while it remains unaffected by the presence of other amino acids.

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Author contributions

Manuscript is written by the contribution of all authors.

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