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Formation, Organic Investigation, Fluorescence Study of New Cyclic Derivatives of Thiophene-Triazole Compounds

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Abstract

Azo compounds are used as intermediates in the preparation of many well-known and diverse organic derivatives. Cyclical or related azo derivatives, such as triazoles and thiophenes, possess useful applications in medicinal and pharmaceutical chemistry. Thiophene compounds and their derivatives have demonstrated a variety of biological activities, including antibacterial, antifungal, anti-tuberculosis, anti-inflammatory, analgesic, sedative, hypnotic, immunosuppressive, and antihypertensive properties. Furthermore, thiophene derivatives can be used in the treatment of gastrointestinal disorders, diabetes prevention, and antioxidant activities. Most thiophene and triazole derivatives are of the most importance because they form part of the structure of some important medical compounds, such as drugs used for anesthesia, muscle relaxation, and sedation in animals. They are also used as anxiolytics and muscle relaxants. In this study, and in continuation of the work of previous researchers, we have prepared several cyclic compounds of thiophene and triazole, and they were linked to other rings, as well as linked to azo groups by forming the carbanion ion and attacking the azo group through the coupling reaction, and then the compounds were identified by spectroscopic means and other applied studies to know the effectiveness of the prepared compounds like fluorescence study and measurements of absorption and emission of molecules in optical analysis. *These additional observations further highlight the importance of innovative synthetic approaches and detailed analytical evaluation. By expanding our understanding of molecular interactions, these findings support the development of novel compounds with enhanced properties, offering broader potential applications across several scientific fields and contributing to ongoing advancements in chemical research.*

Keywords: Thiophene, triazole, azo, coupling, hetero, five-membered, six, seven-membered

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INTRODUCTION

Thiophene is one of the most interesting compounds because it forms an important class in both natural and synthetic products, and because of the presence of sulfur and double bonds in its composition. It possesses a wide range of biological properties due to its chemical composition, including analgesic, anti-inflammatory, antibacterial, antimalarial, antipyretic, antimicrobial, and antirheumatic activities [1–3]. Its composition gives it unparalleled antifungal properties against skin infections. In the field of analytical and coordination chemistry, they have been used in qualitative and quantitative analysis because they often form colored chelate complexes with transition metals. Azo derivatives of thiophene and triazole rings have also been used in condensation reactions and photochemical ring expansion reactions. They have also been used in organic synthesis as selective catalysts for opening the aziridine ring. They have also been used in agriculture as insecticides due to the presence of active groups such as azo and chlorine. Some Schiff bases containing heterocyclic rings have also been shown to have medicinal properties as cardiotonic and diuretic agents. Researchers have also devised several methods for using azo-linked thiophene compounds to prepare stronger polymers. This remarkable development has led to the involvement of derivatives of five-, six-, and seven-membered rings in the fields of water treatment from heavy metal pollution, and their use in the manufacture of photosensitizers [4–8]. The spectral results have given unique characteristics in electrical conductivity measurements of solid polymer complexes and increased surface area when used in removing trace concentrations of heavy metal pollutants. Triazoles share some properties in common with thiophene in terms of activity, but the presence of additional nitrogen atoms in the former increases the electron density, making substitution by proton substitution and withdrawal easier, and their interaction with electrolytes. Thiophene and triazole are used in the composition of natural compounds, some hypnotics, some dermatological medications, and some anesthetics used as hypnotics (Figure 1) [9–12].

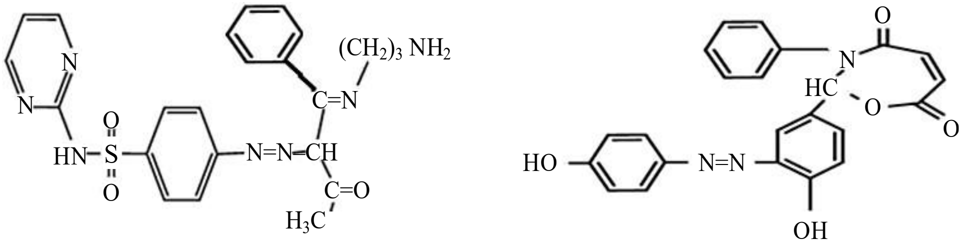

Figure 1. Types of heterocyclic-azo derivatives.

EXPERIMENTAL PRACTICES

Creation of Thiophene-Triazole Derivative (1)

The hydrazine derivative, amino-guanidine, was taken at a concentration of 0.001 mole and is known for its high effectiveness in the closing reaction to form cyclic compounds of all kinds. It was placed in the reaction flask and reacted with 0.001 mole 4-methylthiophenaldehyde, with the addition of 7 drops of a 6% solution of sodium hydroxide, slowly and gradually within an hour of continuous sublimation for 30 h. After the precipitation of the compound was completed by comparison with previous working methods, it was filtered and purified to give the cyclic compound (1) [12–14].

Creation of Thiophene-Imidazole Derivative (2)

The cyclic derivative (1) amino terminal was taken at a concentration of 0.001 mole and is known for its high effectiveness in the closing reaction to form cyclic compounds of all kinds. It was placed in the reaction flask and reacted with 0.001 mole of chloroacetyl chloride, with the addition of 0.0001 mole potassium carbonate, with rotation for 4 h. After the precipitation of the compound was completed by comparison with previous working methods, it was filtered and purified to give the cyclic compound (2) [15–18].

Creation of Thiophene-Pyrimidinone Derivative (3)

The cyclic derivative (1) amino terminal was taken at a concentration of 0.001 mole and is known for its high effectiveness in the closing reaction to form cyclic compounds of all kinds. It was placed in the reaction flask and reacted with 0.001 mole of diethyl malonate, with refluxing for 3 h. After the precipitation of the compound was completed by comparison with previous working methods, it was filtered and purified to give the cyclic compound (3).

Creation of Thiophene-Benzodiazepine Derivative (4)

The cyclic derivative (1) amino terminal was taken at a concentration of 0.001 mole and is known for its high effectiveness in the closing reaction to form cyclic compounds of all kinds. It was placed in the reaction flask and reacted with 0.001 mole of diethyl phthalate, with refluxing for 5 h. After the precipitation of the compound was completed by comparison with previous working methods, it was filtered and purified to give the cyclic compound (4) (Figure 2) [19–22].

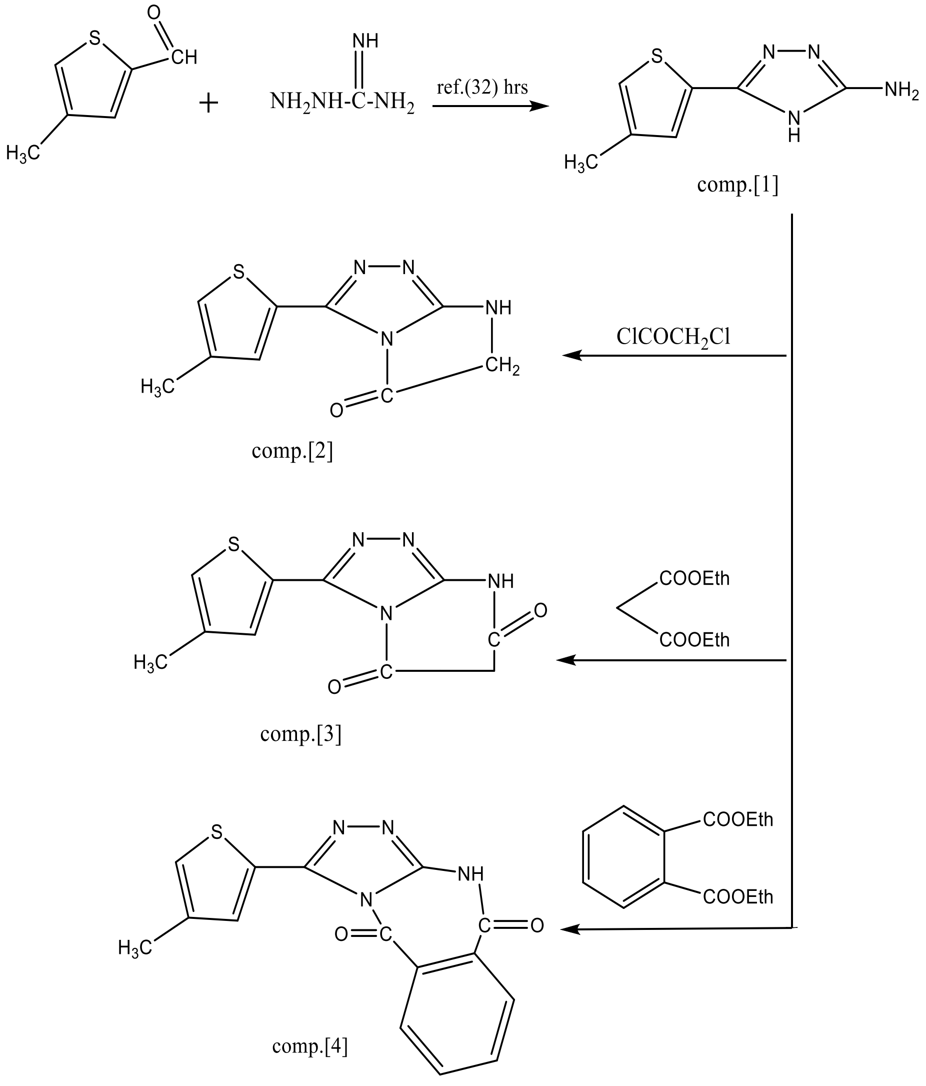

Figure 2. Description of compounds [1–4].

Creation of Thiophene-Pyrimidine Alkene Derivative (5)

The cyclic derivative (3) was taken at a concentration of 0.001 mole and dissolved in alkali solution to form a carbanion ion, then reacted with 0.001 mole of 4-methyl-2-formal thiophene, with rotation for 6 h. After the precipitation of the compound was completed by comparison with previous working methods, it was filtered and purified to give the alkene compound (5).

Creation of Thiophene-Pyrimidine Azo Derivative (6)

The cyclic derivative (3) was taken at a concentration of 0.001 mole and dissolved in an alkaline solution to form a carbanion, then reacted with 0.001 mole of the diazonium salt of 4-methylbenzene. The mixture was left for 24 hours and then washed with distilled water. After the precipitation of the compound was completed by comparison with previous working methods, it was filtered and purified to give the cyclic-Azo compound (6) [23–26].

Creation of Thiophene-Pyrimidine Azo Derivative (7)

The cyclic derivative (3) was taken at a concentration of 0.001 mole and dissolved in an alkaline solution to form a carbanion, then reacted with 0.001 mole of the diazonium salt of 4-N,N-dimethylaniline. The mixture was left for 24 hours and then washed with distilled water. After the precipitation of the compound was completed by comparison with previous working methods, it was filtered and purified to give the cyclic-Azo compound (7) [27–31].

Creation of Thiophene-Pyrimidine Azo Derivative (8)

The cyclic derivative (3) was taken at a concentration of 0.001 mole and dissolved in an alkaline solution to form a carbanion, then reacted with 0.001 mole of the diazonium salt of 3,5-dichlorobenzene. The mixture was left for 24 hours and then washed with distilled water. After the precipitation of the compound was completed by comparison with previous working methods, it was filtered and purified to give the cyclic-Azo compound (8) (Figure 3).

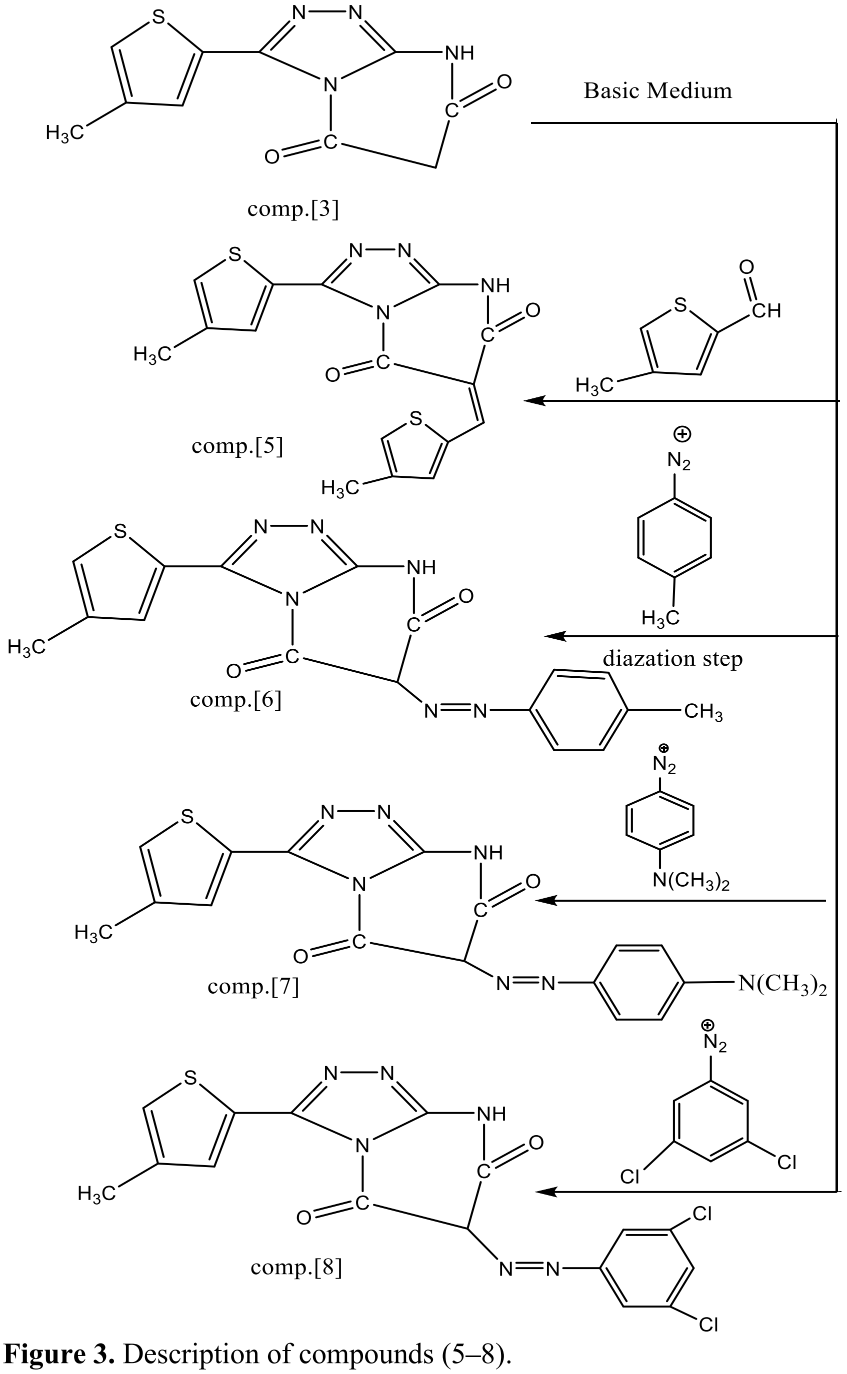

Figure 3. Description of compounds (5–8).

RESULTS AND DISCUSSION

FT-IR-Supernatural Dimensions

The FT-IR spectra of thiophene-triazole compounds (1) showed a medium intensity absorption band at position 2930 to 2950 cm^{-1} due to the stretching of the (CH) bond for aliphatic (CH_3) and absorption band at frequencies of 3010 to 3035 cm^{-1} due to the stretching of the aromatic ((C-H) bond in all compounds (1–8), while in compounds (6, 7, 8) absorption bands appeared at frequencies of 1400–1460 cm^{-1} due to the (N=N) bond. The spectrum also showed an absorption band at frequencies of 1667–1684 cm^{-1} due to the stretching of the (C=O) bond of amide groups in compounds (2–8), in addition to other bands as shown in Figures 4–7 [32–34].

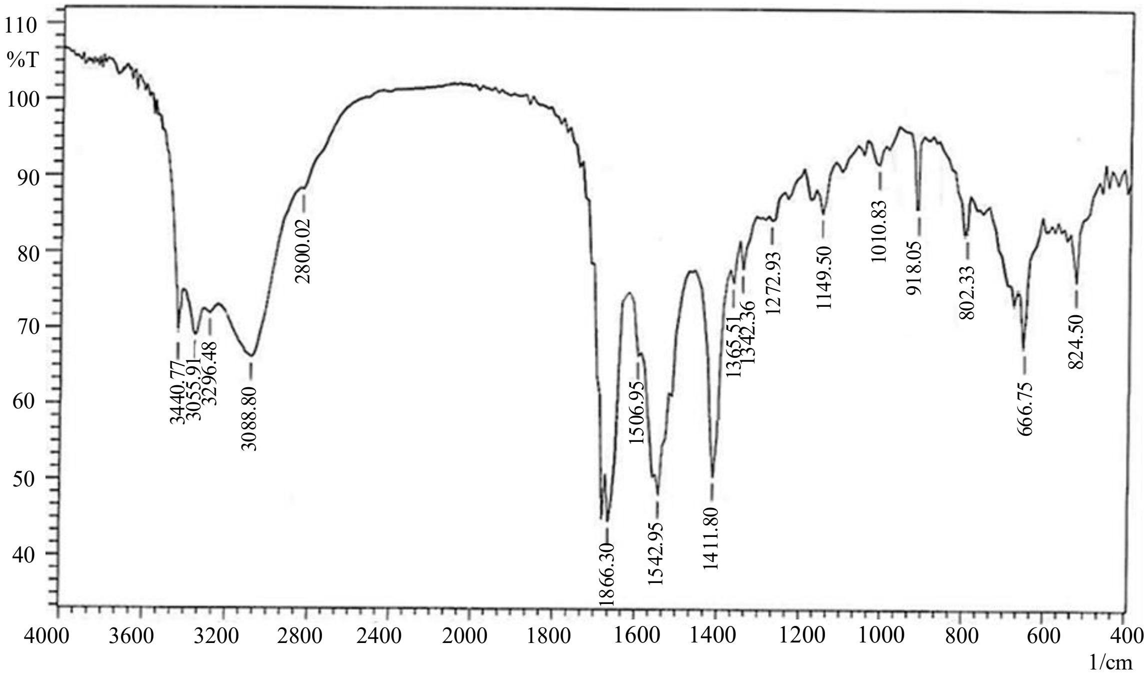

Figure 4. FT-IR of comp (1).

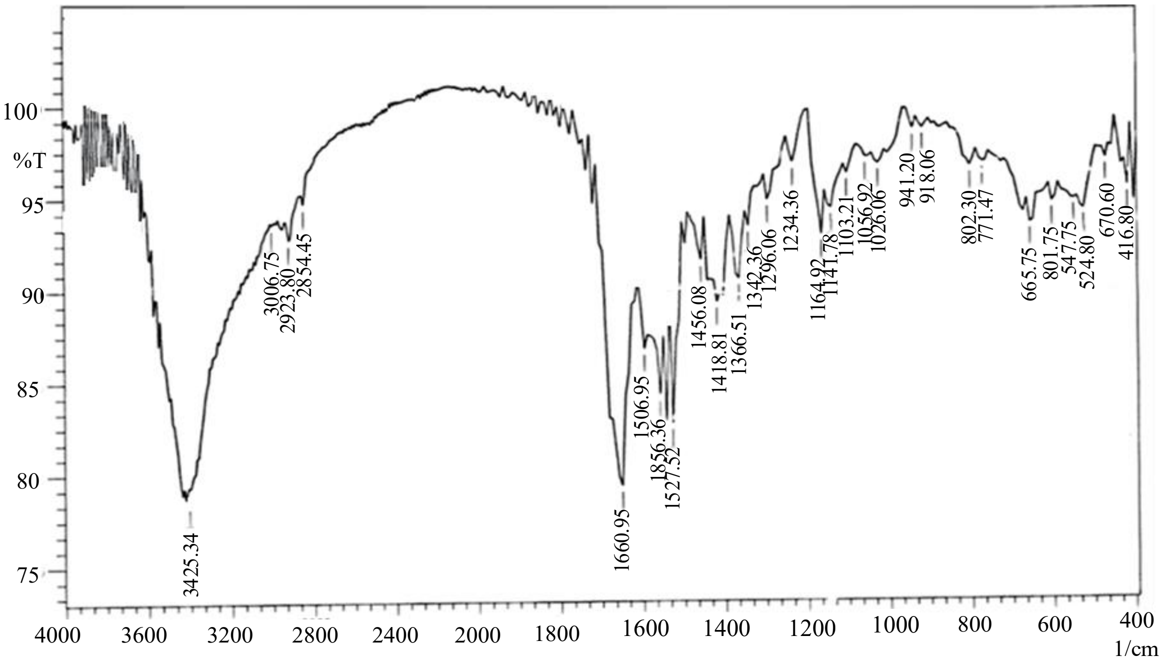

Figure 5. FT-IR of comp (4).

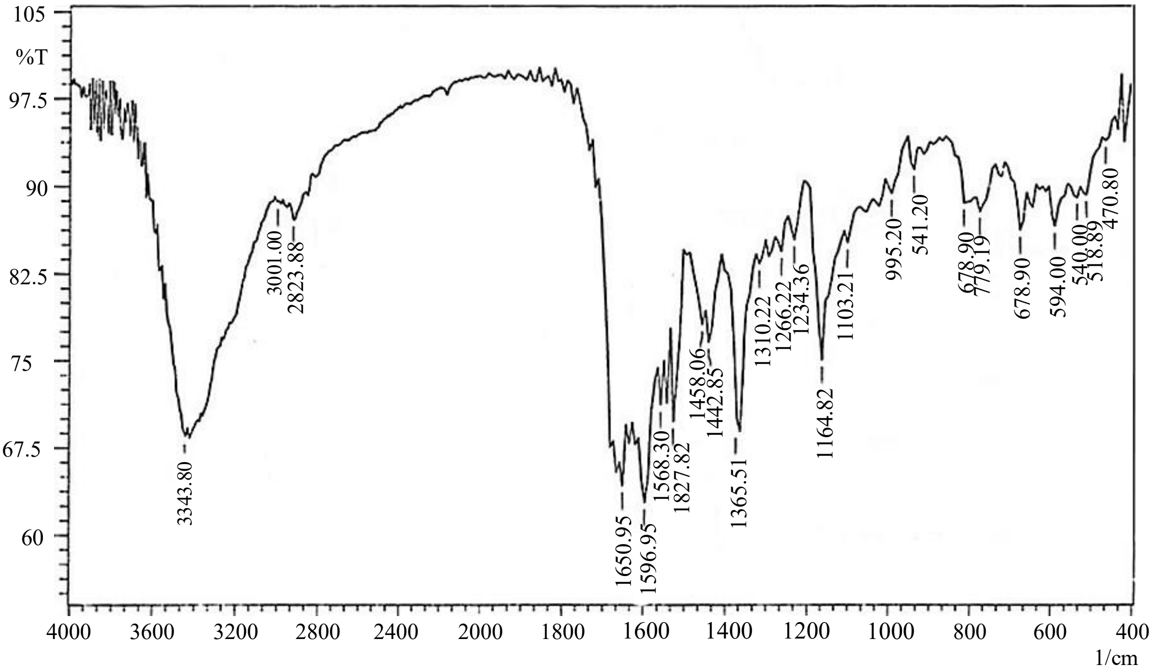

Figure 6. FT-IR of comp (6).

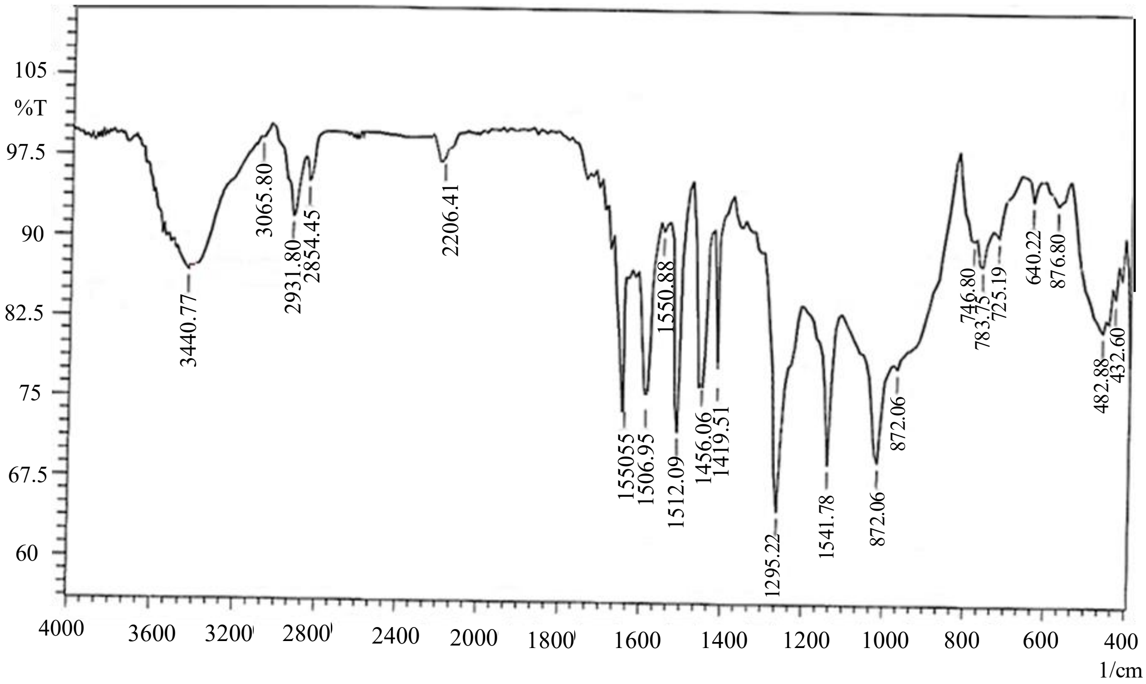

Figure 7. FT-IR of comp (8).

H-NMR-Supernatural Dimensions

A multi-signal was observed at the position 7.96–6.82 ppm due to protons in the phenyl ring and aromatic groups, while signals appeared at the position 1.3 ppm due to protons in the (CH) group, which is linked with the thiophene ring, and a signal appeared at the position 9.97 ppm due to 1H in the CO-NH amide group in the cyclic compounds. The spectrum also showed a signal at the position 1.6 ppm due to protons in the CH_3 groups in coupling compounds in compound (7), and finally, the solvent signal appeared at the position 2.5 ppm, in addition to other bands in the spectrum (Figures 8–10) [35–38].

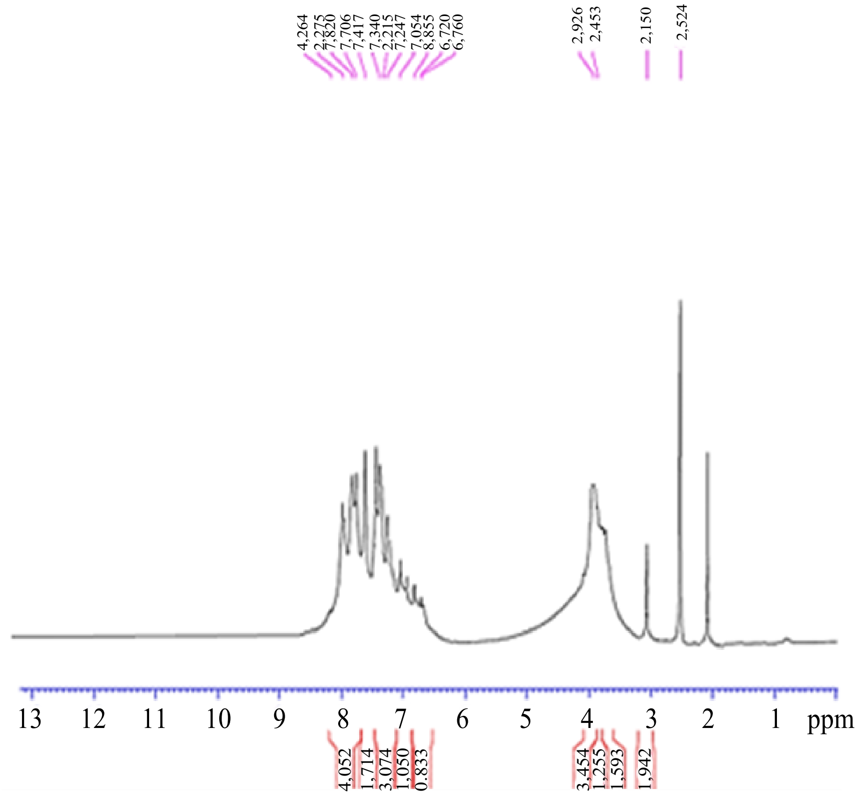

Figure 8. H-NMR of comp (2).

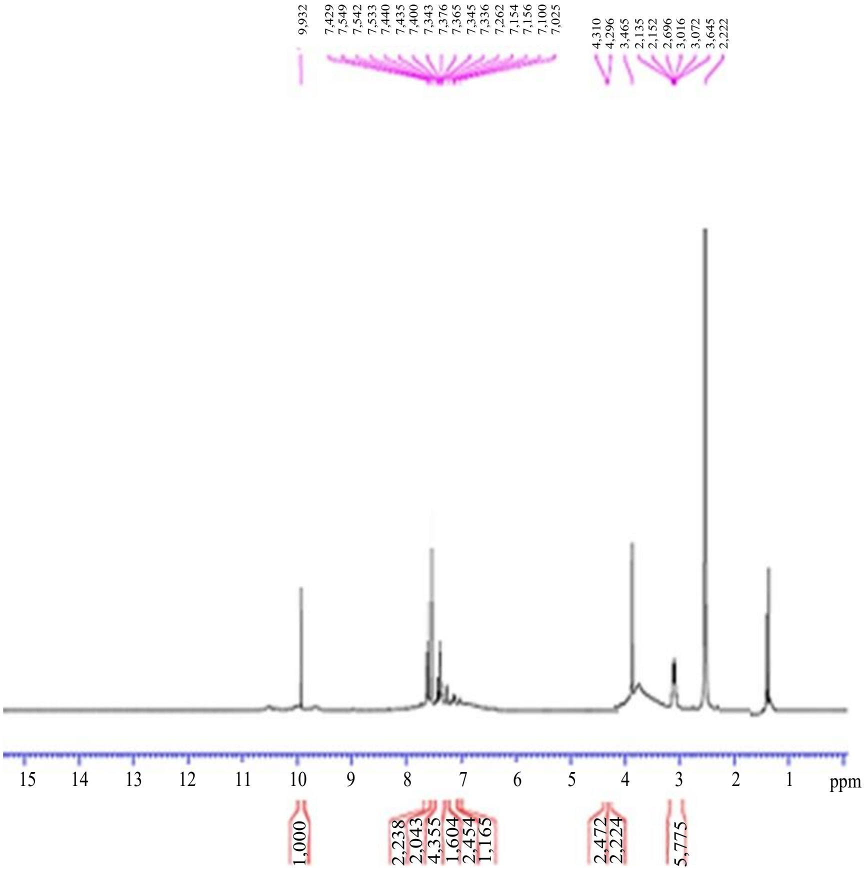

Figure 9. H-NMR of comp (6).

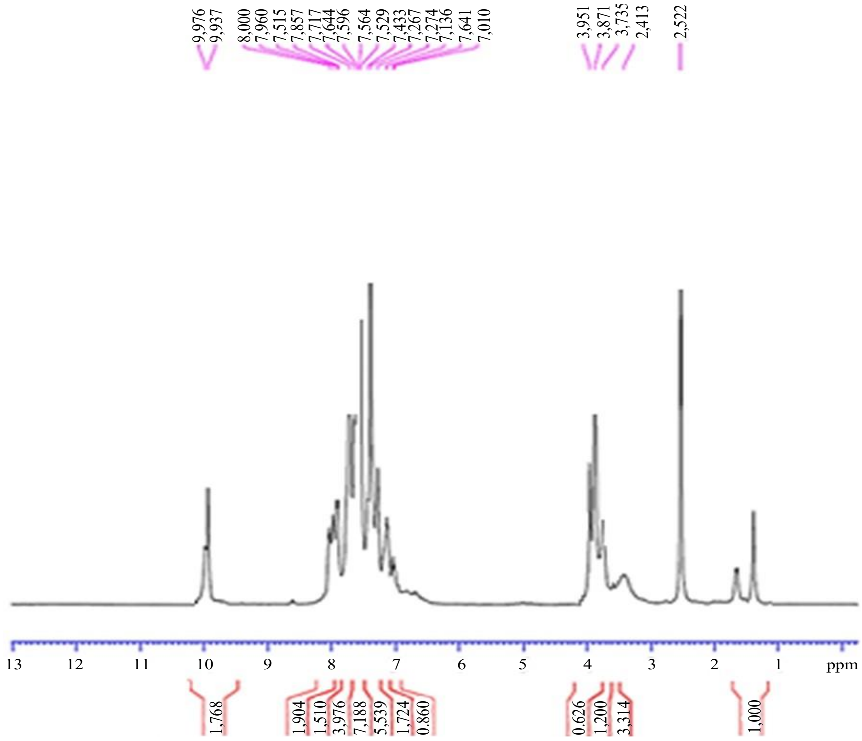

Figure 10. H-NMR of comp (7).

C-NMR-Supernatural Dimensions

A multi-signal was observed at the position 115–145 ppm due to carbon atoms in the phenyl ring and aromatic groups, while signals appeared at the position 160 to 164 ppm due to carbon atom of carbonyl groups in the CO-N amide group, and a signal appeared at the position 10.0 to 15.0 ppm due to carbon atom of the (CH_3) methyl group in all compounds. The spectrum also showed a signal at the position 100.0 ppm due to carbon atoms of the alkene (C=CH) group in compound (5), and finally, the solvent signal appeared at the position 40.0 ppm, in addition to other bands in the spectral (Figures 11–13) [39–41].

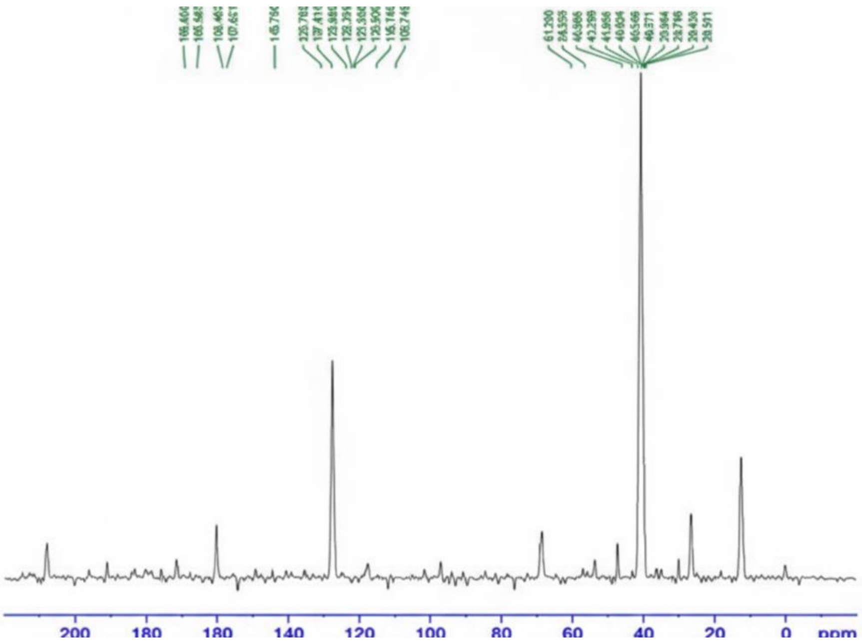

Figure 11. C-NMR of comp (3).

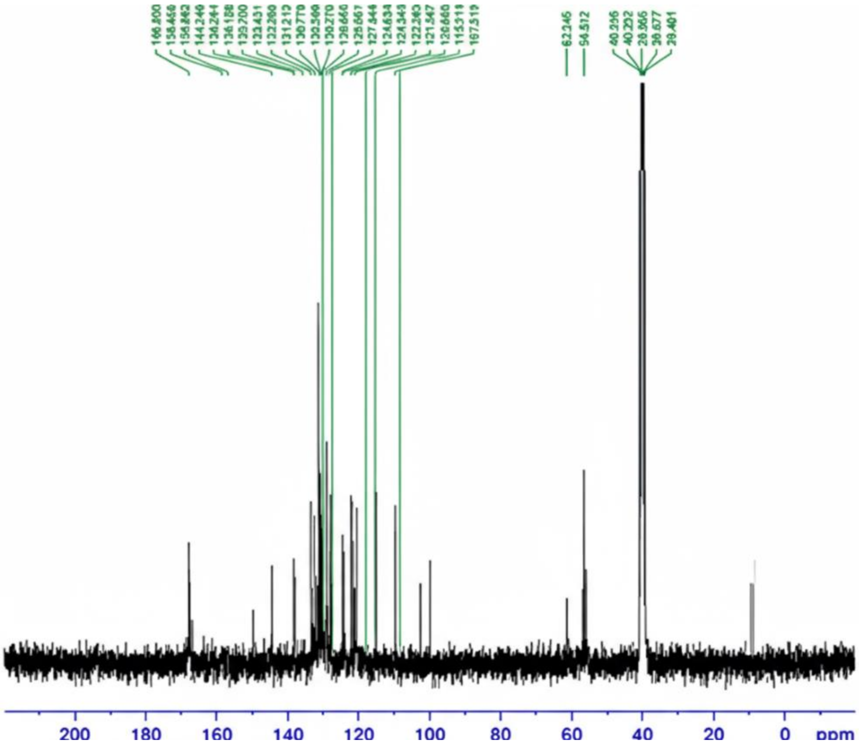

Figure 12. C-NMR of comp (5).

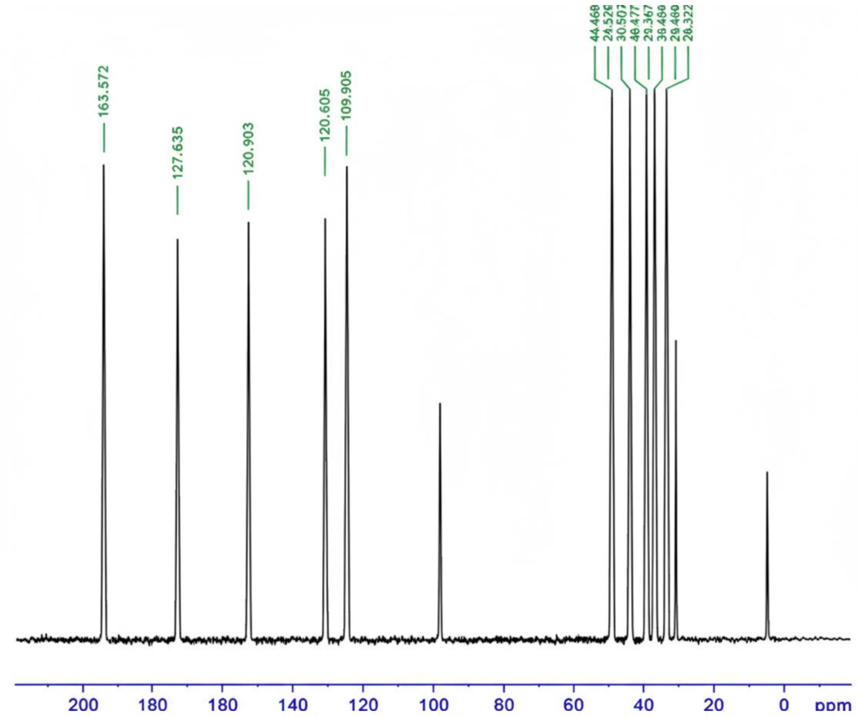

Figure 13. C-NMR of comp. (8).

Study of Fluorescence Behaviors of Compounds

The fluorescence properties of some of the cyclic compounds prepared in the research were studied. There are four compounds (Table 1). Concentrations of 0.001 molar were prepared from them. The temperature and acid function were adjusted to measure the fluorescence ratio, intensity, absorption, emission, and the maximum wavelength for each transition. The results showed that the prepared compounds possess clear fluorescence properties through Figures 14 and 15 [42–47].

Table 1. Fluorescence behaviors of compounds (1, 3, 5, 8).

Compounds no.	Excitation wavelength (nm)	Emission wavelength (nm)
Comp. (1)	320	418
Comp. (3)	336	430
Comp. (5)	312	412
Comp. (8)	354	448

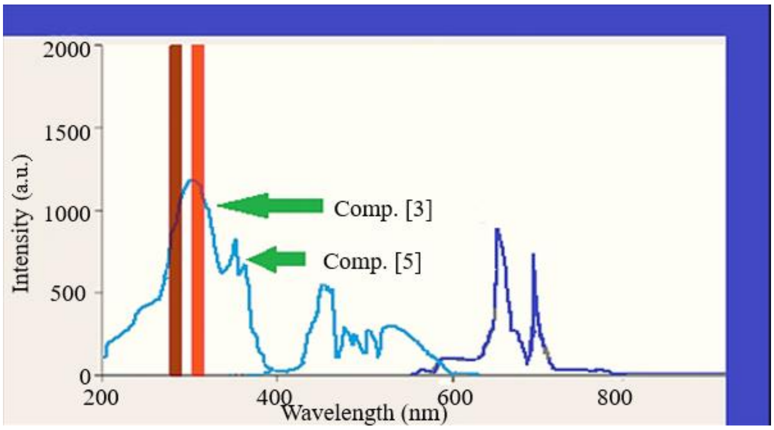

Figure 14. Fluorescence behaviors of compounds (3, 5).

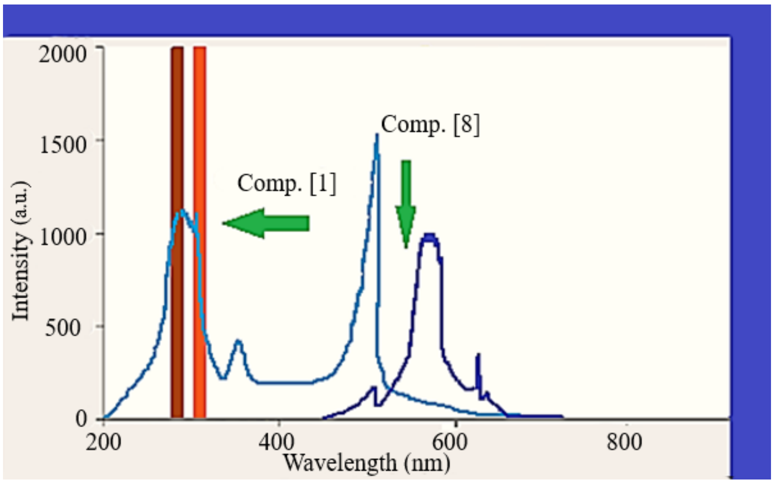

Figure 15. Fluorescence behaviors of compounds (1, 8).

CONCLUSION

All investigations conducted in this work have established the formation of synthesized compounds and have given static and clear spectral regularity bands. Studies of the fluorescence spectra were also conducted using the optical analysis and have given good evidence for absorption and emission properties for the studied compounds.

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