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Synthesis and Spectroscopic Characterization Study of Some Schiff Bases 1,3[N,N-Bis(5-Methyl-1,3,4-Triazole-2-Thione)] Benzene and 1,4[N,N-Bis(5-Methyl-1,3,4-Triazole-2-Thione)] Benzene

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Some of triazole derivatives are synthesized by cyclization reaction of thiocarbohydrazide synthesized by reaction of carbon disulphide and aqueous hydrazine; the basic nucleus 3-methyl-4-amino-1,2,4-triazole-5-thione (*L*) is prepared by reaction of thiocarbohydrazide compound with glacial acetic acid under reflux condition. The compound (*L*) is subjected to addition reaction with different aldehydes to synthesize Schiff bases 1,3[N,N-Bis(5-methyl-1,3,4-triazole-2-thione)] benzene (L_1) and 1,4[N,N-Bis(5-methyl-1,3,4-triazole-2-thione)] benzene (L_2). The compounds (L_1) and (L_2) are confirmed by means of their melting point, FTIR, UV-visible, and ^{1}H-NMR spectra.

Деякі з похідних триазолу синтезуються реакцією циклізації тіокарбогідразиду, синтезованого реакцією сірковуглецю та водного гідразину; основне ядро 3-метил-4-аміно-1,2,4-триазол-5-тіон (*L*) одержують реакцією тіокарбогідразидної сполуки з крижаною (кристалічною) оцтовою кислотою у (флегмових) умовах рефлюксу. Сполука (*L*) піддається реакції приєднання з різними альдегідами для синтези Шиффових основ 1,3[N,N-Біс(5-метил-1,3,4-триазол-2-тіон)] бензол (L_1) і 1,4[N,N-Біс(5-метил-1,3,4-триазол-2-тіон)] бензол (L_2). Сполуки (L_1) і (L_2) підтверджуються їхньою температурою топлення, інфрачервоною спектроскопією на основі Фур'є-перетвору, спектрофотометричною аналізою у видимій та ультрафіолетовій областях світла та спектрами ядрового магнетного резонансу на ядрах ^{1}H.

Key words: synthesis, Schiff bases, thiocarbohydrazide, triazole derivatives.

Ключові слова: синтеза, Шиффові основи, тіокарбогідразид, похідні триазолу.

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1. INTRODUCTION

Schiff bases having the general structure *R*–CH=N–*Ar* (*R* and *Ar* are aromatic and aliphatic groups, respectively) [1] are resulted from the condensation of primary amines with ketones or aldehydes [2]. They are characterized by –N=CH– (imine) groups, which have biology performance such as antimicrobial, antitumor, antiinflammation, and anticancer [1] and are used in excellent antibacterial, antifungal, antidiabetic, and anti-inflammatory activities [3]. They have other applications in different other fields, co-ordination chemistry, analytical chemistry, pigments, and polymer industrial [4].

There is a considerable interest in the co-ordination chemistry of heterocyclic thione. The chemical interest in these thiones is due to the fact that they are multifunctional ligands with sulphur or nitrogen donor atoms [5] and their easy synthetic procedures and effective biological importance. The 1,2,4-triazole moiety contain S=C–N–N=C– unit resembling thiosemicarbazones [6]. It is evident that the azomethine linkage (C=N) is an essential structural requirement for biological activity, which is served as skeletal backbone to a wide range of synthetic intermediates [6]. In addition, the triazole ring is highly reactive and emerges as an important synthon to generate new chemical entities. Diverse modifications of the triazole rings at various positions have led to a variety of novel compounds with wide spectrum of pharmacological activities and therapeutic drugs such as antifungal, antibacterial, anti-inflammatory, antiviral, antitumor [7], antimalarial, antioxidant, antileishmanial, antiviral and herbicide agents [8].

1,2,4-thiotriazines and 1,2,4-thiotriazoles are well-known heterocyclic thiones derived from thiocarbohydrazide. Some of their derivatives exhibit biological activity [5] and have been used for various purposes such as herbicides, neutral antibiotics, antibacterial agents. The heterocyclic thiones exist in thione and thiol tautomeric forms. Therefore, there has been considerable interest in studying the co-ordination properties of both the neutral thione and thiol ligands and various binding modes to the metal atom [5, 7]. Triazole derivatives comprise of amine and thione substitutes. The presence of exocyclic thione group on the heterocyclic moiety is of considerable importance because the combination of the two groups (amine and thione) generates species with effective and synergistic co-ordination potential [9]. 3-methyl-4-amino-1,2,4-triazole-5-thione (MATT) is a representative of the heterocyclic thiones' family. Like the other members of this group, it shows the thione–thiol tautomerism (forms I and II) [7], as shown in Fig. 1.

The 1,2,4-triazol nucleus has been incorporated into a wide variety of therapeutically interesting drug candidates including h1/h2

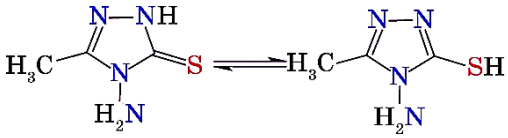

Fig. 1. Thionic (I) and thiolic (II) forms of 3-methyl-4-amino-1,2,4-triazole-5-thione.

histamine receptor blockers, stimulants, antianxiety agents and sedative. A number of 1,3,4-thiadiazoline possess antibacterial properties comparable with sulphonamide drugs. Subsequently, thiadiazole derivatives have found applications as antitumour agents, pesticides, dyes, lubricants and analytical reagents [10].

In the present paper, 3-methyl-4-amino-1,2,4-triazole-5-thione were converted into their respective Schiff bases by condensing them with isophtalaldehyde and terephtalaldehyde in the presence of few drops of concentrated sulphuric acid. The structures of compounds were confirmed on the basis of IR, ^{1}H-NMR and MS spectral data analysis.

2. MATERIALS AND METHODS

All chemicals were purchased from Sigma Aldrich Chemical Co. and Merck Chemical Co. (Germany). Melting points of the compounds were determined by using an electrothermal digital melting point apparatus. The infrared (IR) spectra of the compounds were recorded in the region of 4000–400 cm^{-1} using KBr on a FTIR Perkin-Elmer spectrophotometer. Vibrational transition frequencies were reported in wave numbers (cm^{-1}). ^{1}H-NMR spectra were recorded with a model Bruker AMX400 MHZ spectrometer operating at 400 MHZ using DMSO as a solvent and TMS as an internal standard, Mass spectra were recorded on a Shimadzu Agilent Technologies 70 at 5975°C and MSD energy using a direct insertion probe (low-energy ACQ method) at temperatures of 90–110°C. Purity of the compounds was checked by thin-layer chromatography (TLC) on silica gel plates using a *n*-hexane/ethyl acetate (2:8) solvent.

3. SYNTHESIS

3.1. Preparation of Thiocarbohydrazide by Reaction of Carbon Disulphide and Aqueous Hydrazine

The investigation of the reaction of hydrazine with carbon disulphide was carried out by adding carbon disulphide to the specified

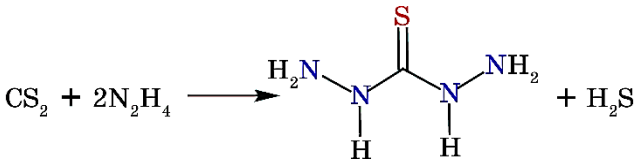

Fig. 2. Preparation of thiocarbohydrazide.

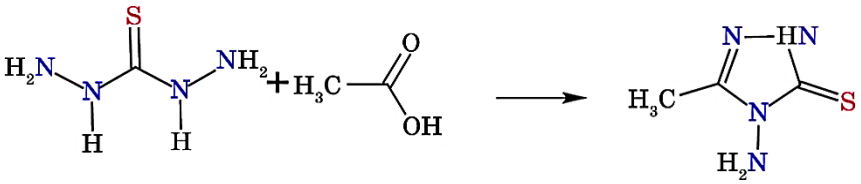

Fig. 3. Preparation of 3-methyl-4-amino-1,2,4-triazole-5-thione (*L*).

quantity of hydrazine in aqueous solution and, then, refluxing the resulting solution for the desired time.

To a vigorously stirred solution of 85% hydrazine hydrate 15 ml (0.3 moles), 7.6 g (0.1 mole) of carbon disulphide was added dropwise for 1 hour, cooled in an ice-bath (10°C) for 30 min. The reaction mixture was then heated at reflux for 30 min. The temperature of the solution rose to 62°C, cooled in an ice-bath for 3 hour, and the precipitated thiocarbohydrazide was filtered off, washed with ethanol and ether, and air-dried. The sample was recrystallized from the minimum amount of water acidified with a few drops of concentration hydrochloric acid [11]; thiocarbohydrazide was obtained (m.p. = 171°C) with yields of 61%. The reaction equation of the synthesis of the ligand is shown in Fig. 2.

3.2. Preparation of 3-Methyl-4-Amino-1,2,4-Triazole-5-Thione (*L*)

A mixture of thiocarbohydrazide (5 g) and glacial acetic acid (25 ml) was heated under reflux for 4 hours at 140°C while stirring. At the end of the time, the reaction system was cooled to room temperature and washed with cold water and air-dried. The residue solid was recrystallized from methanol and dried to obtain colourless shining flakes (m.p. = 203–205°C) with yields of 72%. The scheme of the synthesis of the ligand is shown in Fig. 3.

3.3. Synthesis of 1,3[N,N-Bis(5-Methyl-1,3,4-Triazole-2-Thione)] Benzene (L_1)

Isophtalaldehyde (0.005 mol, 0.71 g) was dissolved in ethanol (10

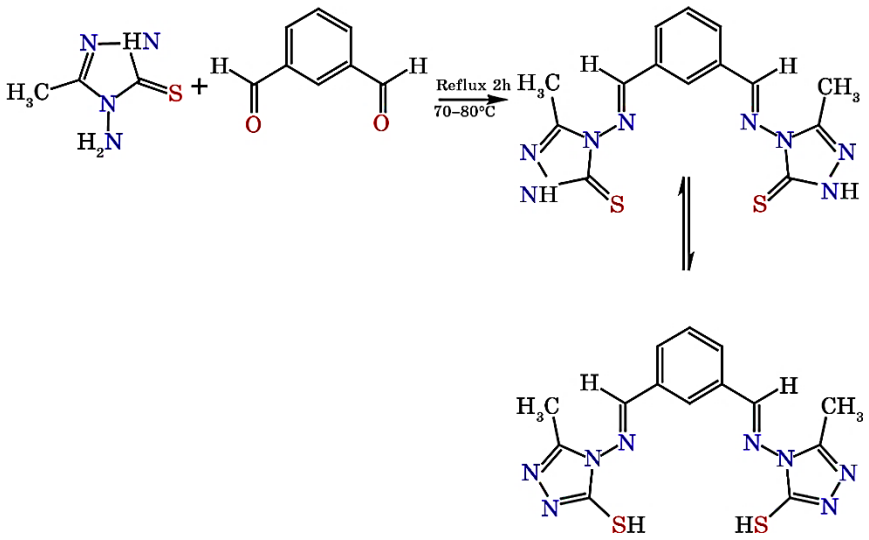

Fig. 4. Synthesis of 1,3[N,N-Bis(5-methyl-1,3,4-triazole-2-thione)] benzene (L_1).

ml), equimolar amount of 3-methyl-4-amino-1,2,4-triazole-5-thione (L) (0.01 mol, 1.3 g) was added and refluxed for 2 hour at 78°C. The solid was formed, after that filtered through suction, washed with hot ethanol and dried to obtained white crystals (m.p. = 280°C) with yields of 86%. The scheme of the synthesis of the ligand (L_1) is shown in Fig. 4.

3.4. Synthesis of 1,4[N,N-Bis(5-Methyl-1,3,4-Triazole-2-Thione)] Benzene (L_2)

Terephtalaldehyde (0.005 mol, 0.71 g) was dissolved in ethanol (10 ml), equimolar amount of 3-methyl-4-amino-1,2,4-triazole-5-thione (L) (0.01 mol, 1.3 g) was added and refluxed for 2 hour at 78°C. The solid was formed, after that filtered through suction, washed with hot methanol and dried to obtained yellow crystals. (m.p. = 285°C) with yields of 68%. The scheme of the synthesis of the ligand (L_2) is shown in Fig. 5.

4. RESULTS AND DISCUSSION

The synthesized compounds were variedly coloured solids (data in Table). They were generally insoluble in common organic solvents but soluble in co-ordinating solvents such as DMSO and DMF. They are stable in air and exist in crystalline form. They have high melt-

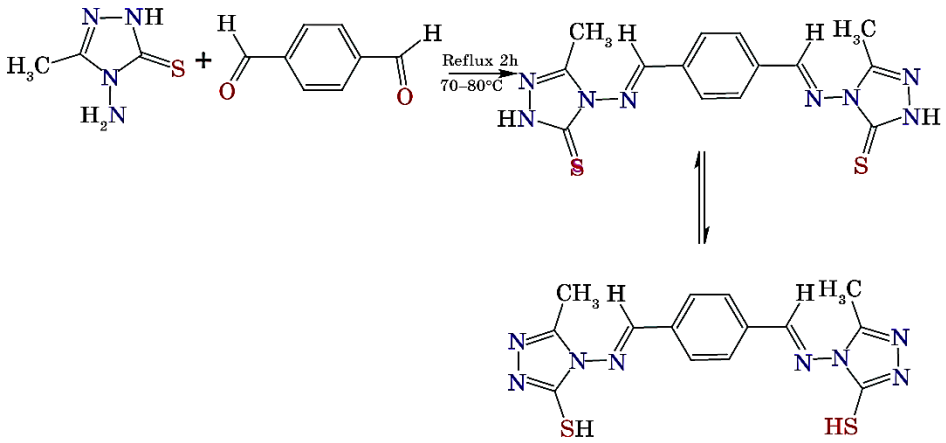

Fig. 5. Synthesis of 1,4[N,N-Bis(5-methyl-1,3,4-triazole-2-thione)] benzene (L_2).

TABLE. Physical data for the compounds.

Physical data for the compounds	Chemical formulae	M, wt·g/mole	Colour	Melting point (m.p.), °C	Yield, %	Solvent
L_1	$C_{14}H_{14}N_8S_2$	358.44	White	280	86%	DMSO·DMF
L_2	$C_{14}H_{14}N_8S_2$	358.44	Yellow	285	68%	DMSO·DMF

ing points indicating strong bonding network within the compound.

4.1. Chemistry

The compounds were identified by MS, FTIR spectrum, ^{1}H-NMR spectrum. The results were discussed using articles [12–16].

4.2. 3-Methyl-4-Amino-1,2,4-Triazole-5-Thione (*L*)

The FTIR spectrum of 3-methyl-4-amino-1,2,4-triazole-5-thione shows characteristic absorption bands at 34, 77 cm^{-1} for N–H and 3352, 3224 cm^{-1} for NH_2 group and absorption band at 2927 cm^{-1} due to C–H aliphatic and absorption band at 1633 cm^{-1} due to amine group (Fig. 6).

The data of ^{1}H NMR show singlet at 5.52 ppm for NH_2, singlet signal at 13.401 ppm due to S–H, and signals 2.24 for 3 H of methyl group, singlet signals at 2.50 ppm and 3.10–3.90 ppm due to the solvent DMSO-d6 and water dissolved in DMSO-d6, respectively, as shown in Fig. 7.

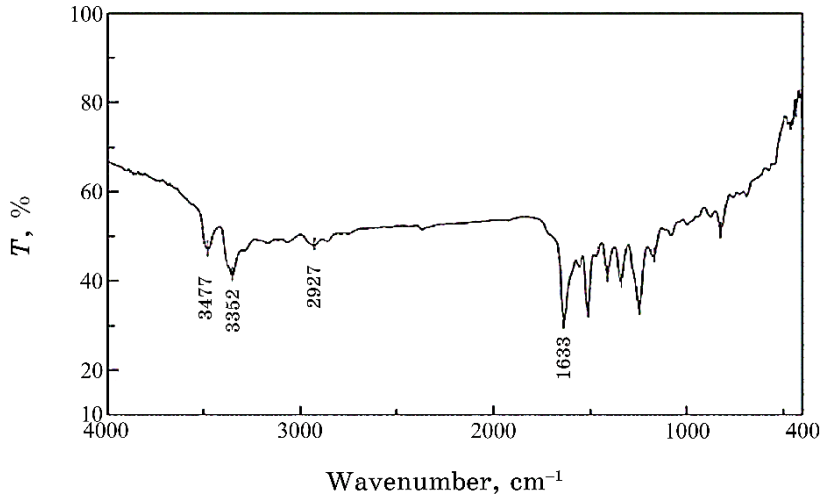

Fig. 6. FTIR spectrum for compound (*L*).

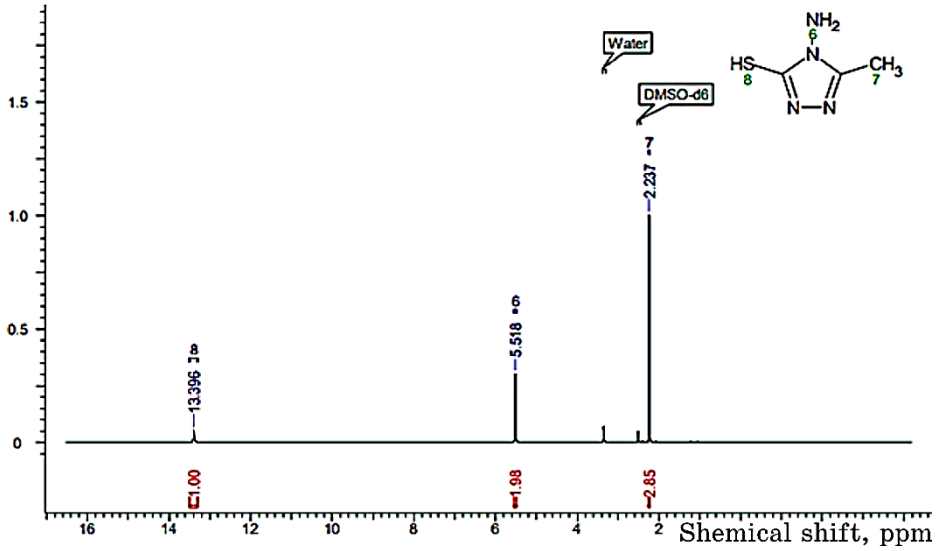

Fig. 7. ^{1}H-NMR spectrum for compound (*L*).

4.3. 1,3[N,N-Bis(5-Methyl-1,3,4-Triazole-2-Thione)] Benzene (L_1)

Schiff base of 1,3[N,N-Bis(5-methyl-1,3,4-triazole-2-thione)] benzene (L_1), IR showed disappearance of NH_2 absorption band and showed absorption bands at 3068 cm^{-1} due to C–H aromatic, 2938 cm^{-1} due to C–H aliphatic, 2742 cm^{-1} for S–H group and absorption band at

1593 cm^{-1} for C=N group Fig. 8.

^{1}H-NMR spectrum shows disappearance of NH_2 and appearances of singlet signal at 13.97 ppm for 2 H of S–H, singlet signal at 10.13 ppm due to 2 H of azomethine group (CH=N), and signals (8.41–8.15–7.75) for (*s*, 1 H), (*d*, 2 H), (*t*, 1 H) of phenyl group respectively, and singlet signal at 2.38 ppm for 6 H of methyl group as shown in Fig. 9.

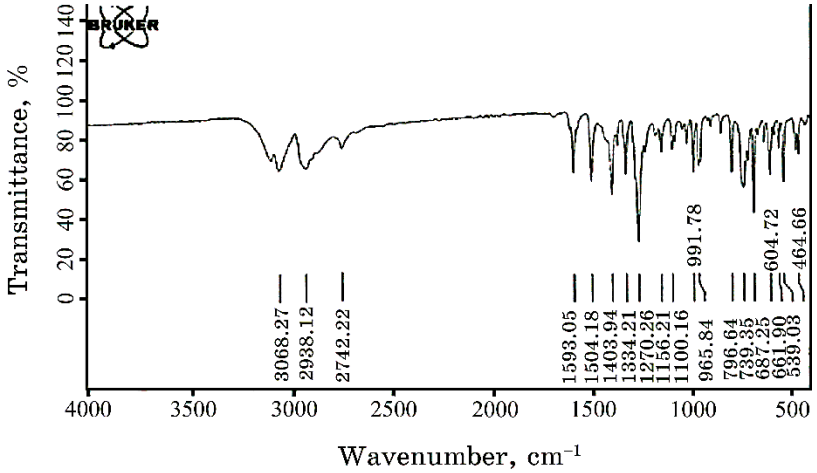

Fig. 8. FTIR spectrum for compound (L_1).

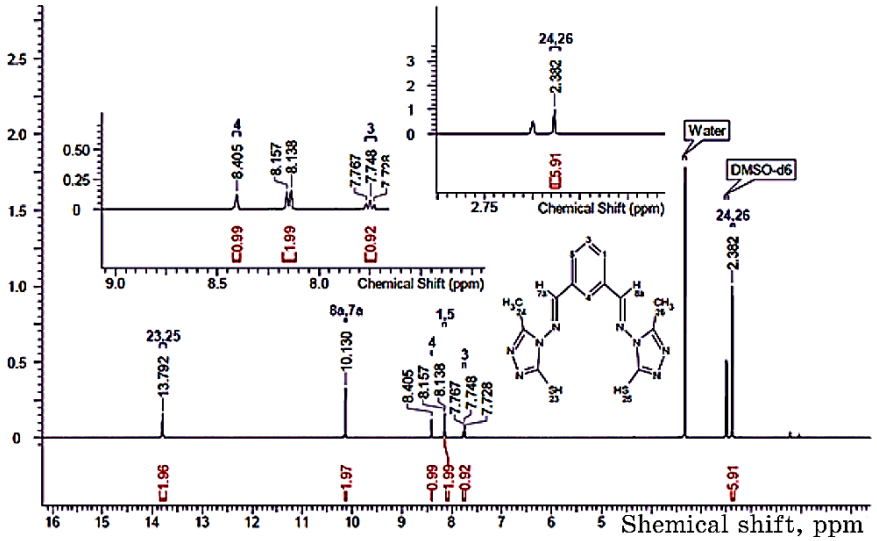

Fig. 9. ^{1}H-NMR spectrum for compound (L_1).

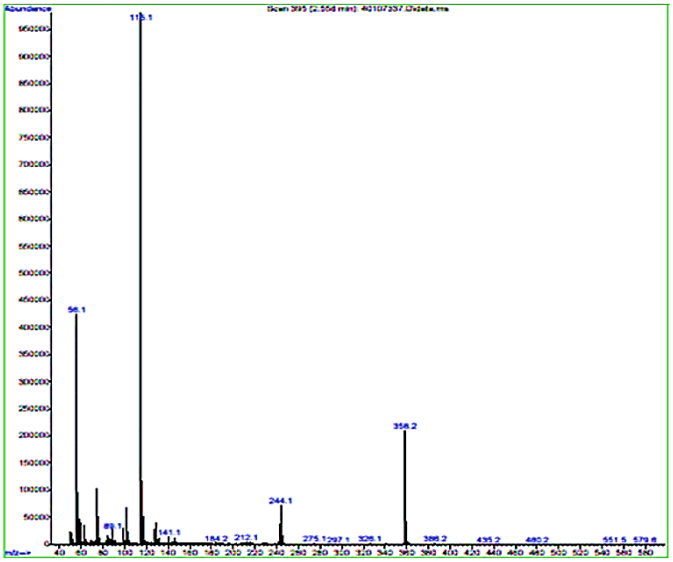

Fig. 10. Mass spectrum for compound (L_1).

MS (AEI) (M^+) (Fig. 10): the mass spectra show the base peak m^+ at $m/z^+ = 358.2$ corresponding to the original molecular weight of ligand molecular ion, where the mass spectrum was given to ligand a number of fragmentations. These fragmentations are represented in the mass spectra in term of relative abundance compared to m/z^+, and the main peak shown *via* mass spectrum is relatively to molecular weight of ligand $[C_{14}H_{14}N_8S_2]^+$ (Fig. 11) and explains the proposed mass fragmentation products for ligand (L_1).

4.4. 1,4[N,N-Bis(5-Methyl-1,3,4-Triazole-2-Thione)] Benzene (L_2)

FTIR spectrum of compound (L_2) showed disappearance of NH_2 absorption band and showed absorption bands at 3102 cm^{-1} due to C–H aromatic and absorption bands at 2948 cm^{-1} for C–H aliphatic, 2776 cm^{-1} for S–H group, 1635 cm^{-1} due to C=N group (Fig. 12).

MS (AEI) (M^+): the mass spectra show the base peak m^+ at $m/z^+ = 358.2$.

5. CONCLUSION

In this study, some of triazole derivatives (1,3[N,N-Bis(5-methyl-1,3,4-triazole-2-thione)] benzene and 1,4[N,N-Bis(5-methyl-1,3,4-triazole-2-thione)] benzene) were successfully synthesized and char-

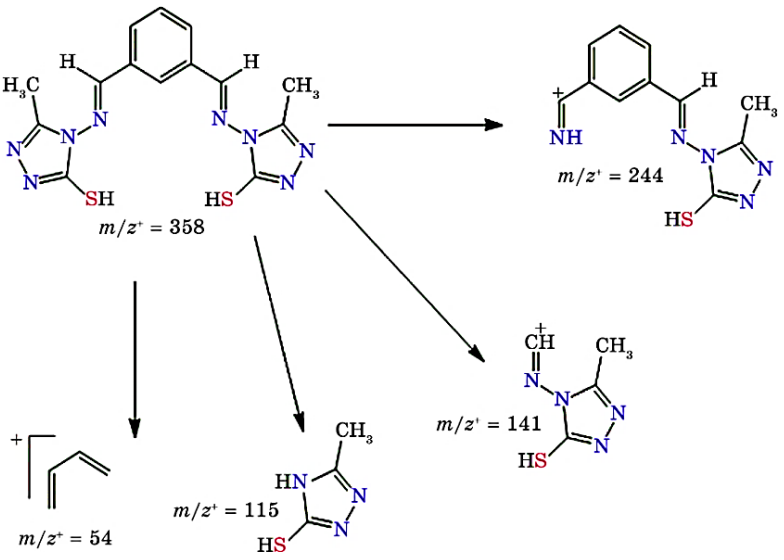

Fig. 11. Mass-fragmentation products for ligand (L_1).

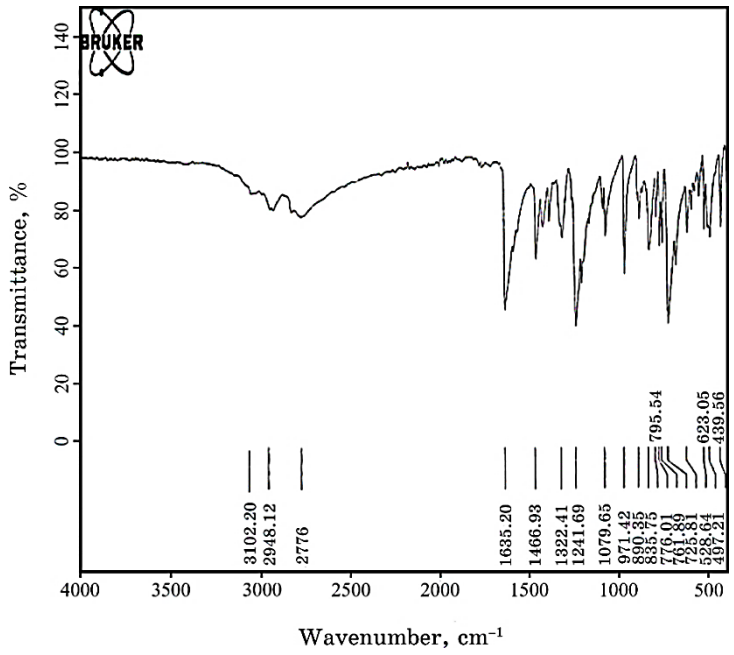

Fig. 12. FTIR spectrum for compound (L_2).

acterized quantitatively and qualitatively by using FTIR, ^{1}H NMR, UV-visible spectroscopy, mass spectrum.

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