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**SYNTHESIS OF SOME NEW HYDRAZIDES AND THEIR
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ÇANKIRI**

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SYNTHESIS OF SOME NEW HYDRAZIDES AND THEIR DERIVATIVES

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January 2023

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ABSTRACT

SYNTHESIS OF SOME NEW HYDRAZIDES AND THEIR DERIVATIVES

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Master of Science in Chemistry

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Hydrazones are a special class of organic compounds in the Schiff base family. Hydrazones constitute a versatile compound of organic class having basic structure ($R_1R_2C=NNR_3R_4$). The active centers of hydrazone, that is, carbon and nitrogen, are mainly responsible for the physical and chemical properties of the hydrazones and, due to the reactivity toward electrophiles and nucleophiles, hydrazones are used for the synthesis of organic compound such as heterocyclic compounds with a variety of biological activities. Hydrazones and their derivatives are known to exhibit a wide range of interesting biological activities like antioxidant, anti-inflammatory, anticonvulsant, analgesic, antimicrobial, anticancer, antiprotozoal, antioxidant, antiparasitic, antiplatelet, cardioprotective, anthelmintic, antidiabetic, antitubercular, trypanocidal, anti-HIV, and so forth. The present review summarizes the efficiency of hydrazones as potent anti-inflammatory agents.

2023, 85 pages

Keywords: Hydrazides, Hydrazones, Cyclization, Heterocyclic compounds

ÖZET

BAZI YENİ HİDRAZİTLERİN VE BUNLARIN TÜREVLERİNİN SENTEZİ

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Hidrazonlar, Schiff bazı ailesindeki özel bir organik bileşik sınıfıdır. Hidrazonlar, bazik yapıya sahip ($R_1R_2C=NNR_3R_4$) organik sınıfa ait çok yönlü bir bileşik oluştururlar. Hidrazonun aktif merkezleri, yani karbon ve nitrojen, esas olarak hidrazonların fiziksel ve kimyasal özelliklerinden sorumludur ve elektrofillere ve nükleofillere karşı reaktivite nedeniyle hidrazonlar, heterosiklik bileşikler gibi organik bileşiklerin sentezi için kullanılır. çeşitli biyolojik aktiviteler; Hidrazonlar ve türevlerinin antioksidan, antienflamatuar, antikonvülsan, analjezik, antimikrobiyal, antikanser, antiprotozoal, antioksidan, antiparaziter, antiplatelet, kardiyoprotektif, antelmintik, antidiyabetik, antitüberküler, tripanosidal, anti- HIV ve diğerleri. Bu inceleme, güçlü anti-enflamatuar ajanlar olarak hidrazonların etkinliğini özetlemektedir.

2023, 85 sayfa

Anahtar Kelimeler: Hidrazidler, Hidrazonlar, Siklizasyon, Heterosiklik bileşikler

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LIST OF SYMBOLS

-	Negative
%	Percentage
*	Multiplication
/	Division
+	Positive
±	Plus minus
°	Degree
cm ³	Cubic centimeter
g	Gram
mL	Millilitre
pH	Power of hydrogen
rpm	Round per minute
α	Alfa
β	Beta

LIST OF ABBREVIATIONS

DCC	Dicyclohexylcarbodiimide
IR	Infrared spectroscopy
NMR	Nuclear magnetic resonance



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1. INTRODUCTION

Hydrazide is a class of organic compounds characterized by at least one group of acyl and aryl (Figure 1.1):

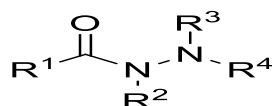


Figure 1.1 Hydrazide compound

Hydrazine is another class similar to Hydrazides, and unlike the first class, it does not contain Ayl or Arryl (Book 2014).



Figure 1.2 Hydrazine

Hydrazides are called in two ways: either the first method is substituted, or as the derivative of acyl or aryl hydrazine. A compensatory method is used for the name by adding the syllables hydrozin or carbohydrazide:

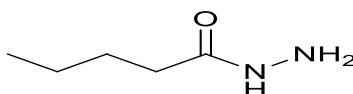


Figure 1.3 Nomenclature of Hydrazide

Aim of the study:1. Preparation of new hydrazides and study of their biological activity. 2. Using different reagents and reacting them with the prepared hydrazones in order to obtain compensations new.3. Conduct a biological study of the newly prepared hydrogen compounds and their derivatives to determine their efficacy and the relationship between their efficacy and composition.

2. LITERATURE REVIEW

2.1 Hydrazide Synthesis

2.1.1 Thermal dehydration of hydrazinium salts

Due to the severe conditions required by this method, the thermal drying of hydrazine salts is not commonly used for hydrazine preparation, but the result is good, as researchers conducted in 1958 athermal sublimation. As shown in Figure 2.1, this sublimation consists generally of acetic acid and this was yield by the existence of 1-methyl-2-fenylhydrazine with the presence of 1-acyl-1-methyl-2-fenylhydrazine (Figure 2.1) (Kratzl and Berger 1958, Katrizky *et al.* 1987).

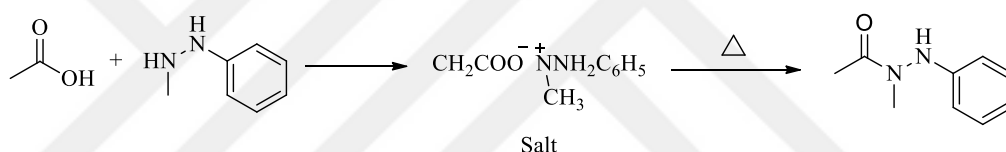


Figure 2.1 Sublimation of Acetic Acid

2.1.2 Carbodiimide method

By using the N,N-Dicyclohexylcarbodiimide, also known as (DCC) in the carboxylic acids with hydrogen reactions as a drying agent. The results were good comparing the results obtained from the reaction of esters with hydrazine (Licandro and Perdicchia 2004). In 1968, the researcher (Sheradsky 1968) was able to prepare a number of hydrazide substitutes (Figure 2.2) (Smith 1968).

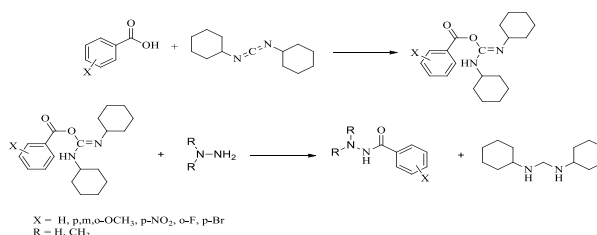


Figure 2.2 Prepare A Number of Hydrazide Substitutes

2.1.3 N-amination of amide schestakov's reaction

Through this reaction, hydrazide can be obtained in a manner similar to the reaction (Hofmann's amide degradation) as this reaction includes the conversion of mono-acyl urea compounds and with sodium hypochlorate within it. The sodium hypochlorate here works as a catalyst, as the scientist (Schestakov) in 1912 reacted with benzoyl urea to obtain benzoic hydrazide. The Conversion of Mono-Acyl Urea Compounds in the Presence of Sodium (Figure 2.3) (Kakkar *et al.* 2017).

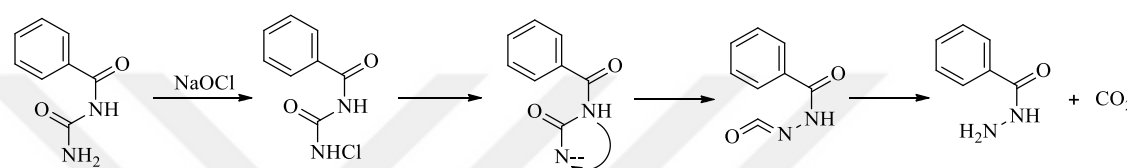


Figure 2.3 Hypochlorite as A Catalyst to Hydrazide

2.1.4 N-amination with sodamide

In this method, N-chloramide compounds obtained from secondary imides are used for the production of hydrazide, since sodium amide can be used to replace monohydrazine, but sodium salts such as sodium acetanilide are used to obtain diacyl hydrozine (Figure 2.4) (Walker and Whelan 1960).

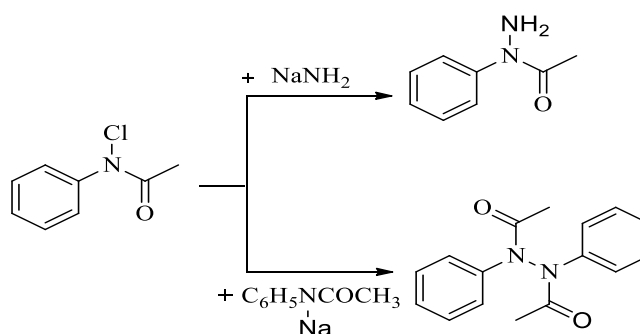


Figure 2.4 N-chloramide compounds obtained from secondary imides are used for the production of hydrazide

2.1.5 N-amination with o-(2,4-dinitrophenyl)hydroxylamine

The adsorption agents for nucleophilic nitrogen compounds are very effective, and in 1968 scientists (Sheradsky 1968) obtained 88% of N-aminophthalimide through the interaction of phthalateanion with the above-mentioned agent (Figure 2.5) (Sokolova and Zapevalova 1969).

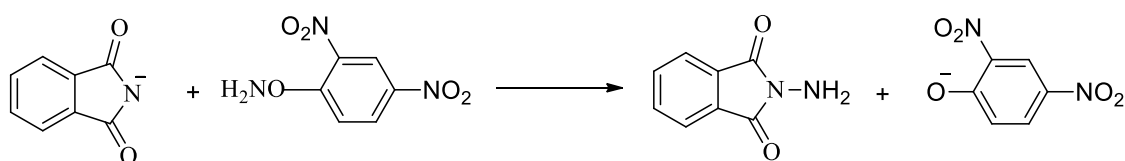


Figure 2.5 Interaction of phthalateanion with the above-mentioned agent

2.2 Acylation of Hydrazine

Hydrazine, a compound of aryl or alkylhydrazine with different acetyl reagents, is one of the most widely used methods for the preparation of Hydrazide (Sokolova and Zapevalova 1969).

2.2.1 Hydrazinolysis of amide

This method can be used to convert amides into hydroxides by heating them with water hydrogen. In 2009, a researcher made a compound of benzoic hydrazide from the compound of amide (Figure 2.6) (Siddiqui *et al.* 2009).

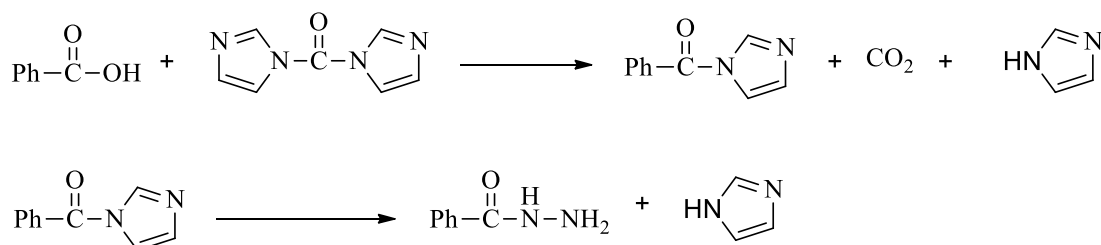


Figure 2.6 Compound of benzoic hydrazide

2.2.2 Acylation with ester

The methods used to prepare hydrazides by reaction of esters and aquatic hydroxides are the best methods because they can be produced without solvents, or in the presence of solvents such as ethanol or other organic solvents (Kumar *et al.* 2012, Srivastava *et al.* 2013). In 2012, the researcher prepared a series of benzoic hydrazide substitutes by grinding a mixture of benzoic acid substitute families with aqueous hydrazine (Figure 2.7) (Kumar *et al.* 2012).

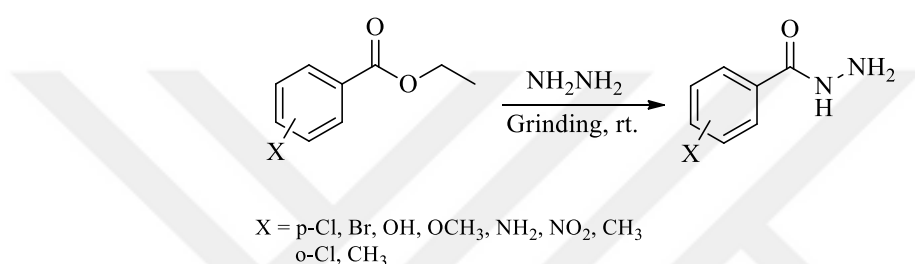


Figure 2.7 Benzoic hydrazide substitutes by grinding a mixture of benzoic acid substitute

In 2013, the researchers were able to prepare 4-pyrrylbenzohydrazide by sublimating the corresponding ester with aqueous hydrazine using ethanol as a solvent for the reaction as follows (Figure 2.8) (Joshi *et al.* 2013).

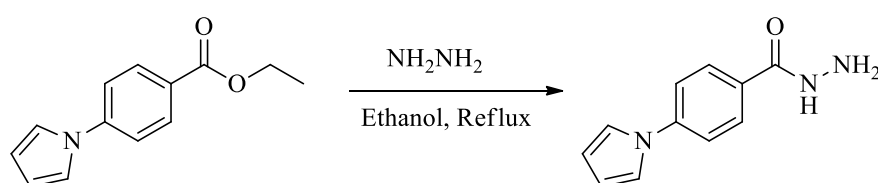


Figure 2.8 4-pyrrylbenzohydrazide

In 2009, researchers used ethanol as a solvent to produce 3-(3-cyano-4-phenyl-5,6,7,8-tetrahydroquinolin-2-yl) propanehydrazide by sublimating the corresponding ester with water hydrogen B (Figure 2.9).

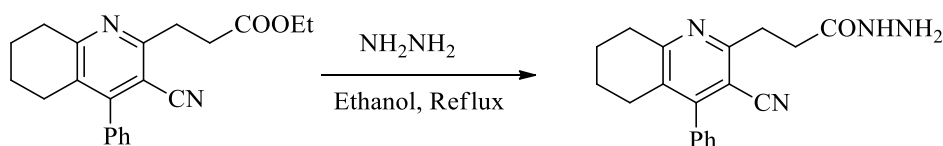


Figure 2.9 Produce 3-propanehydrazide

2.2.3 Hydrazide reactions

2.2.3.1 Alkylation and arylation

In 2007, two researchers were able to react under conditions that could react with tert-butylcarbazine with butyl lithium and then also different rewards with alkylhalide in different conditions (Figure 2.10) (Bredihhin and Mäeorg 2007).

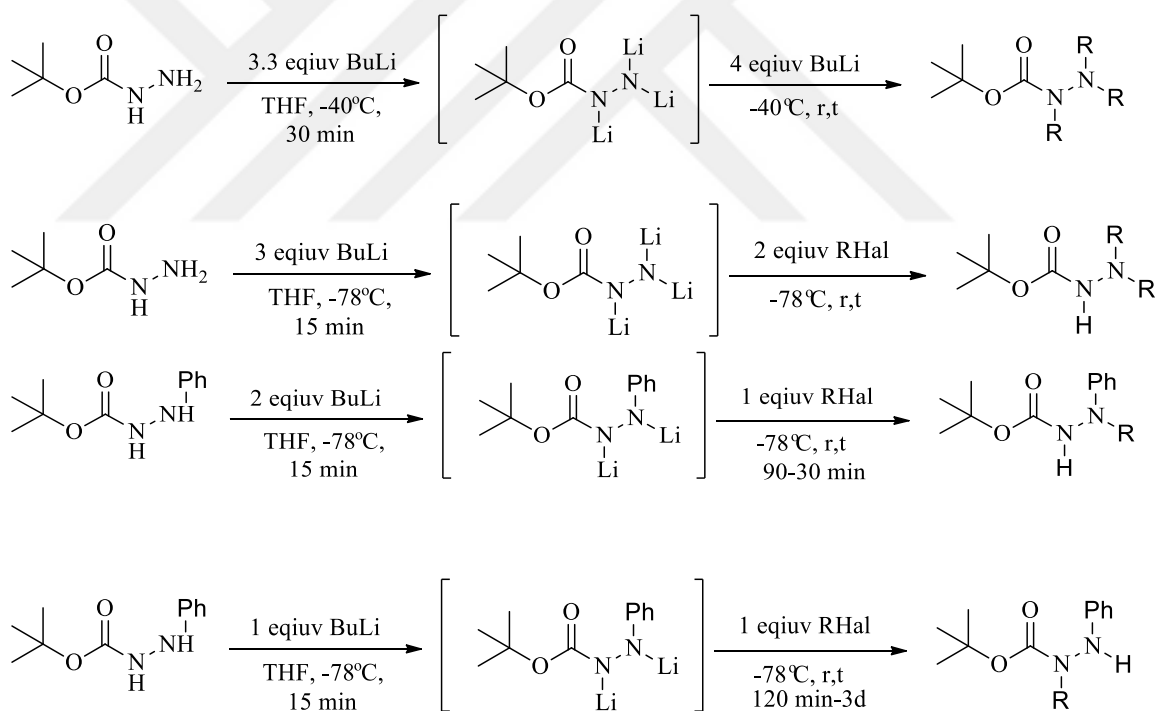


Figure 2.10 Alkylation and arylation

In 2012, researchers were able to react with hydroxides and a number of replacements of aryl iodine to generate large quantities of N-N compounds using dimethyl sulfide as a catalyst (Figure 2.11) (Benderly and Stavchansky 1988).

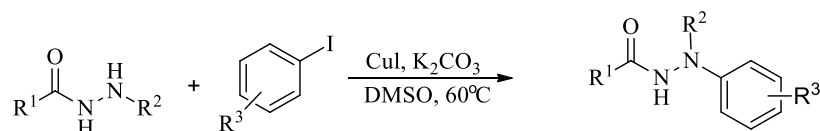
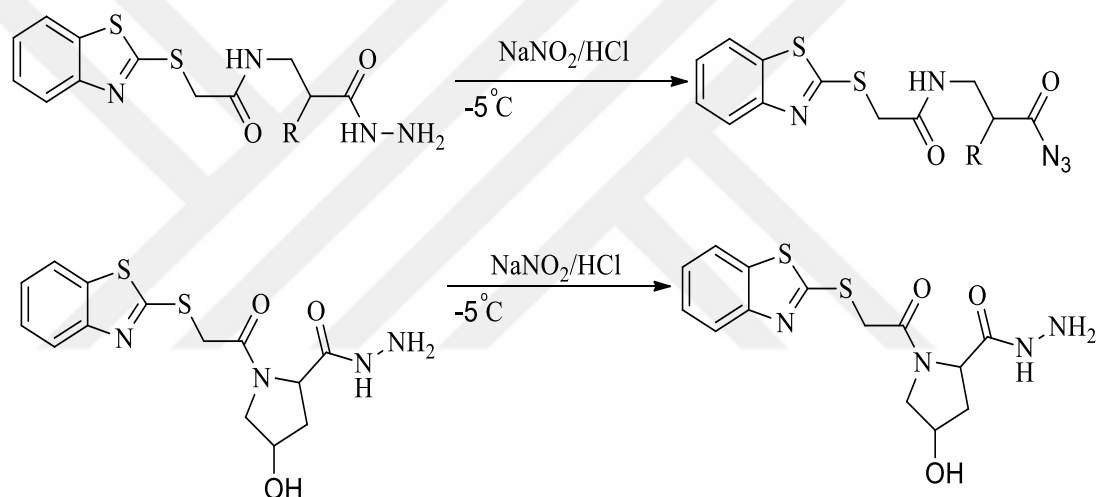


Figure 2. 11 Use dimethyl to generate sulfide N-N compounds

2.2.3.2 Nitrosation

In 2011, a group of researchers created a series of acid compounds by reacting hydroxides with nitrogenous acid, using the free-acid coupling technique (Figure 2.12) (Hofmann *et al.* 1957, Hofmann *et al.* 1960, Aboelmagd *et al.* 2011).



R = 4-OHC₆H₄CH₂, CH₃(OH)CH, CH₃SCH₂CH₂, OHCH₂

Figure 2.12 Nitrosation

2.3 Hydrazones

The definition of Hydrazones is simply class of organic compounds with the a structure of R₁R₂C=N-NH₂. Hydrazones are associated with ketons and aldehyde groups by replacing the oxygen =O with the functional group of =N-NH₂. Moreover, this group formed with the effect of hydrazine on either ketons and aldehyde groups (Figure 2.13) (Stork and Benaim 2003, Allred and Flynn 1975).

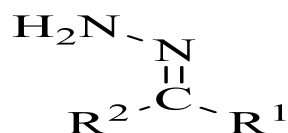


Figure 2.13 Hydrazones

The reaction between the aldehydes and ketons with each of Hydrazine, organohydrazines and 1,1-diorganohydrazine, usually concluded in the produce of the compound hydrazones (Fischer *et al.* 1894). Aldehydes and ketones react with hydrazine, organohydrazines, and 1,1-diorganohydrazines to produce hydrazones (Figure 2.14) (Fischer 1894).

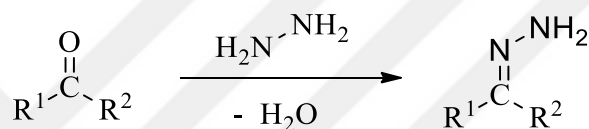
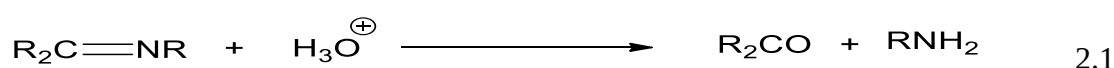


Figure 2.14 Aldehydes and ketones react with hydrazine, organohydrazines, and 1,1-diorganohydrazines to produce hydrazones

The two researchers found that azomethine compounds disintegrate rapidly in a water-soluble solution of metal acids, but stable in a water-soluble solution of bases. The basic properties of nitrogen are weak because of the double electron and double bond (Equation 2.1) (C=N) (Valverde *et al.* 2017).



Alkyls react with hydrazides or primary amines. As shown in the following equations illustrate the preperation of compound (Figure 2.15) (Castro-Blanco *et al.* 2020, Freifelder 1966).

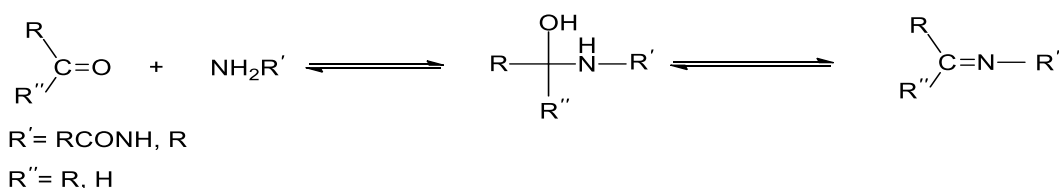


Figure 2.15 Alkyls react with hydrazides or primary amines

In 2011, Govindasami et al. Was able to produce a series of new hydrogenazones by increasing hydrogenazides using vanillin replacements with glacial acetic acid catalysts and absolute ethanol as solvents (Figure 2.16) (Govindasami et al. 2011).

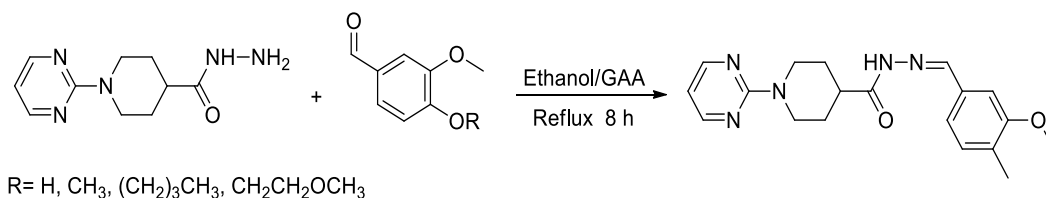


Figure 2.16 Hydrogenazones

In 2012, Ozdemir et al. were able to prepare a series of new hydrozones by escalating the hydrazide with a series of aromatic aldehyde substitutes using absolute ethanol as a solvent for the reaction without using any catalyst and as shown in the preparation of the compound below (Figure 2.17) (Özdemir et al. 2012).

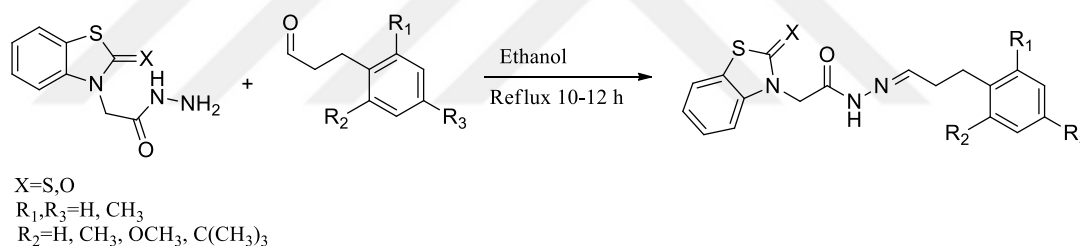


Figure 2.17 Escalating the hydrazide with a series of aromatic aldehyde substitutes

2.3.1 Hydrazone compounds as promising anti-infective agents

Rocha described some analogues of isoniazid-derived hydrazone. Later, he stated the results of testing them on the regarding their In-vitro in term of *Coccidioides posadasii* to the antifungal activity. Therefore, the results of the current identification revealed that in future, compound may be used against fungal infections (Figure 2.18) (Rocha *et al.* 2019).

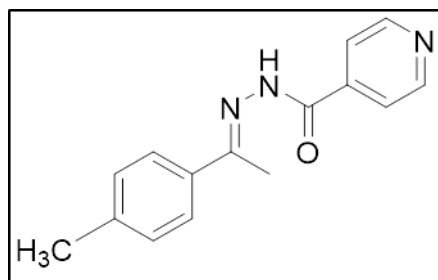


Figure 2.18 Analogues of isoniazid-derived hydrazone

The researchers reported a novel series of tetrahydroimidazo pyrimidine-2-carbohydrazone and evaluated for their antibacterial activity towards several bacterial strains (Figure 2.19) (Kethireddy *et al.* 2015).

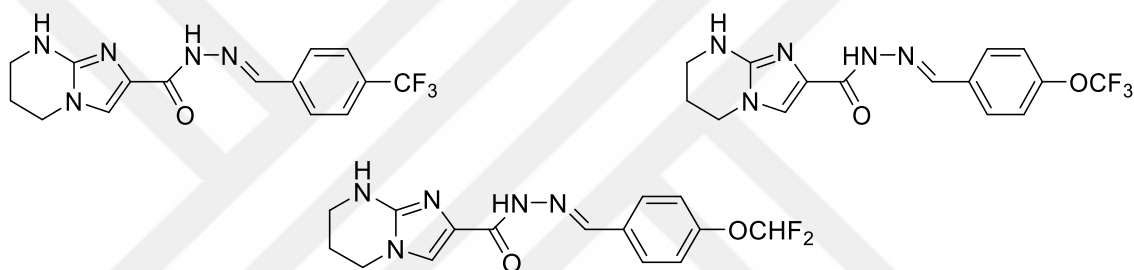


Figure 2.19 Tetrahydroimidazo pyrimidine-2-carbohydrazone

Below in Figure 2.20, are some examples prepared according to multi-component standards, which possessed distinct effectiveness and include the enamine unit within its structural composition:

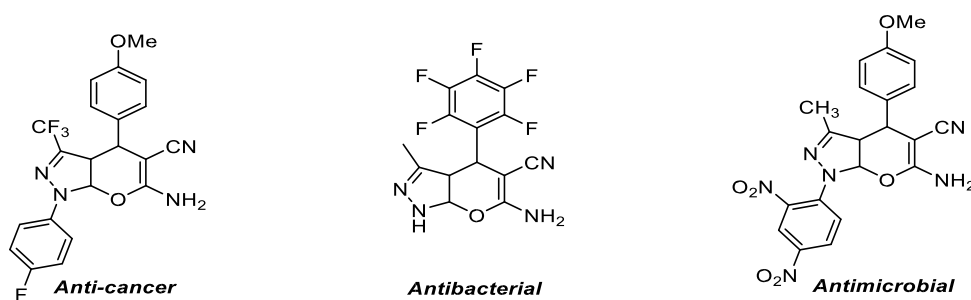


Figure 2.20 The enamine unit within its structural composition

Yogi and Parsini reactions considered as the most prominent 3-components reactions and most common in organic chemistry, as shown in the following graphs:

Boat 3 Combands Reactions:

1- Bingley reaction

With Binglelli reaction, created by Pietro Biginelli in 1893. The structure where a multiple component 3 to 4 dihydropyrimidin-2(1H)-ones which is extracted from ethyl acetoacetate 1 and aryl aldehyde and ureas. This reaction is important for synthesis of DNA and RNA (Figure 2.21) (Fujiwara and Kobayashi 2005).

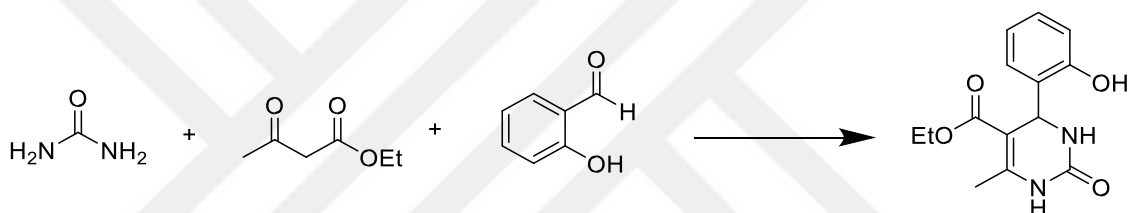


Figure 2.21 Bingley reaction

2.3.2 The multicomponent reactions of passerini and ugi

The Passerini adduct results from a rearrangement of the Passerini 3CR mechanism intermediate with the three components that has not yet been identified (Figure 2.22) (Miyagawa *et al.* 2013).

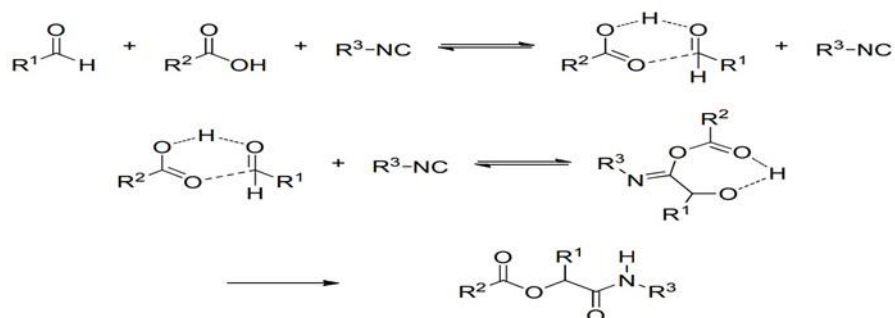


Figure 2.22 The multicomponent reactions of passerini and ugi

This method was attributable to the research that has been done by (Khoshneviszadeh *et al.* 2013) in his literature.

2.3.3 Heterocyclic compounds

The most common heteroatoms, nitrogen, oxygen, and sulfur, are cycles of organic compounds containing at least one heteroatom, and according to literature reviews, heterocyclic compounds are an important part of medical chemistry (Al-Mulla 2017, Saini *et al.* 2013).

2.3.4 Synthesis of heterocyclic compounds

Pyrimidine is an essential six-membered substance of heterocyclic chemistry (Phadnaik *et al.* 2017, Kumar and Aanandhi 2020) that belongs to the alkaloids family (Marotta *et al.* 2022).

2.3.5 The one-pot method

The idea of this method is proposing the synthesizing of pyrimidine Yeilding aldehyde and ketone derivatives with urea in the catalytic amount of sulfamic to produce the series of pyrimidine (Heravi *et al.* 2008). Additionally, a set of aminopyrimidine resulted from a similar one-pot solvent-free reaction of aromatic aldehydes and ketones with guindine carbonate in NaOH (Figure 2.23) (Zhuang *et al.* 2009).

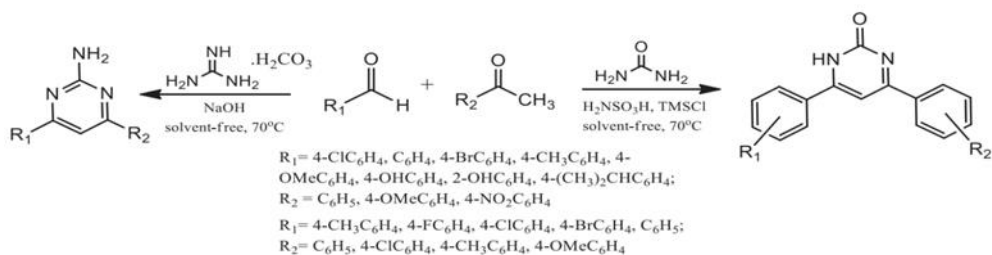


Figure 2.23 Pyrimidine Yeilding aldehyde and ketone derivatives

2.3.6 Two-pot method

This method is usually used for the formation of pyrimidine extracted from chalcone as a reactant, which is later synthesized and purified prior to the cyclization step. What made this method well-known is the usage of it by several researchers and this return to the fact of high stability nature of reactant chalcone (Figure 2.24) (Farooq and Ngaini 2019).

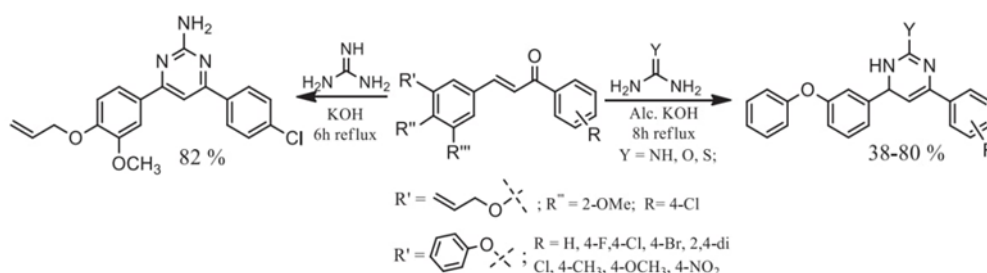


Figure 2.24 Pyrimidine extracted from chalcone as a reactant

2.3.7 Antifungal activity

A paper illustrates that Some of the fungus strains of *Fusarium graminearum*, *Aspergillus flavus*, *Aspergillus ochraceus*, and *Fusarium verticillioides* (Molnár et al., 2017) have been synthesized and some have antifungal effects (Figure 2.25).

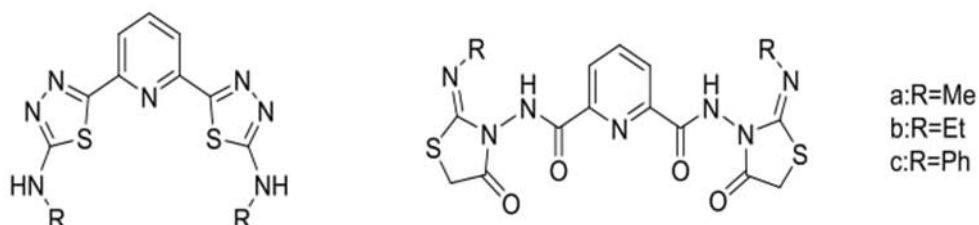


Figure 2.25 *Fusarium graminearum*, *Aspergillus ochraceus*, and *Fusarium verticillioides*

In addition, the work stated the synthesizing of it, which a 3-acetic based indole of biopolymeric hydrogels. The effect of this compound diverse but the main activity was notified on the fungal infections (Figure 2.26) (Chitra *et al.* 2017).

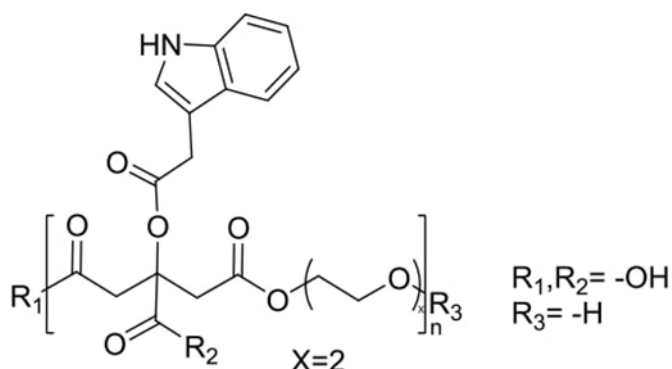


Figure 2.26 3-acetic based indole of biopolymeric hydrogels

The researchers synthesized a heterocyclic derivative based on the Chalcone, which contains five-membered rings, including pyrrole, furane, and thiophenol (Figure 2.27) (Al-Mulla 2017).

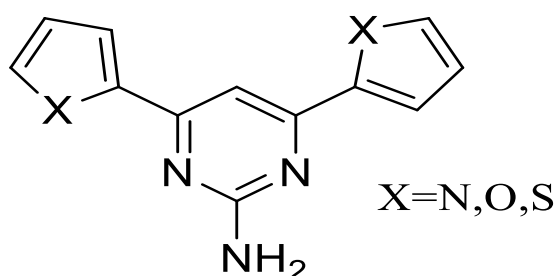


Figure 2.27 Heterocyclic derivative based on the Chalcone

2.3.8 Anti-inflammatory activity

Sawney and Bhutani (Al-Mulla *et al.* 2017) proposed new compounds, 2-(2-benzothiazolyl)-6-aryl-4,5-dihydro-3(2H)-pyridazinone, which differ in anti-inflammatory activities with a variation between low and moderate (Figure 2.28).

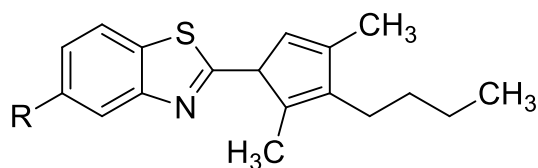


Figure 2.28 2-(2-benzothiazolyl)-6-aryl-4,5-dihydro-3(2H)-pyridazinone

Another paper (Li *et al.* 2017), prepared six compounds of *Nauclea officinalis* (Pierre ex Pit.) as an isolated compounds and proposing the activity of them (Figure 2.29).

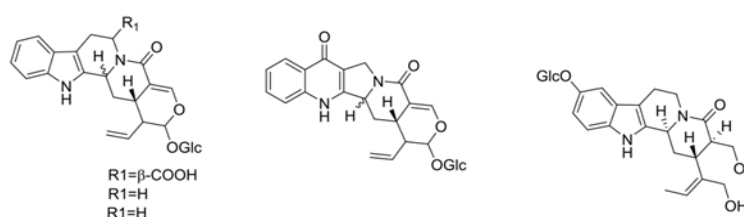


Figure 2.29 *Nauclea officinalis*

2.3.9 Perhydro-1,3-diazine-2-thione synthesis

In this section, β-chloro imines **1** are rearranged and solved in an alcoholic media using potassium thiocyanate. The results were: perhydro-1,3-diazine-2-thiones **6**, O-alkylamino acetals **4** (Figure 2.30) (Sulmon *et al.* 1987, Sulmon *et al.* 1988).

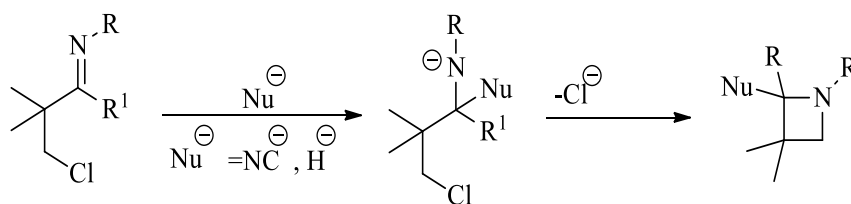


Figure 2.30 Perhydro-1,3-diazine-2-thione synthesis

(Zigeuner *et al.* 1970) proposed Perhydro-1,3-diazine-2-thiones' chemical makeup **6**. The outcome was produced by reacting lithium aluminum hydride with perhydro-1,3-diazine-2-thione **6d** compounds (R = i-Pr; R' = C₆H₅) (Figure 2.31).

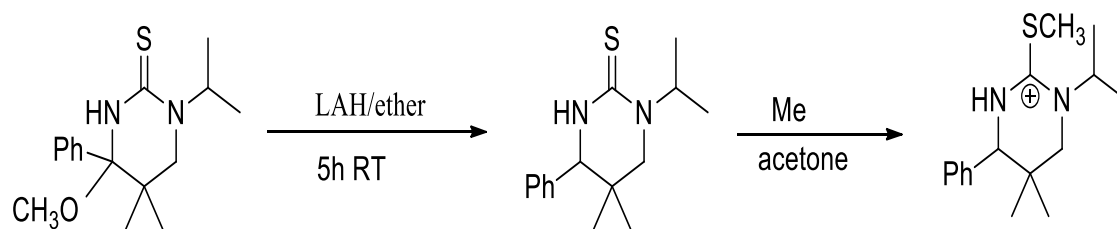


Figure 2.31 Perhydro-1,3-diazine-2-thiones

Researchers synthesized the dendritic ligand 2,4,6-tris (di4chlorobenzamido)-1.3 diazin and concatenation of events of 4, chlorobenzoyl chloride and the chain reaction of 2,4,6-triaminopyrimidine into anhydrous DMF at the temperature of 90°C. The period of the reaction lasted for 9 hours (Figure 2.32) (Islam and Khan 2019).

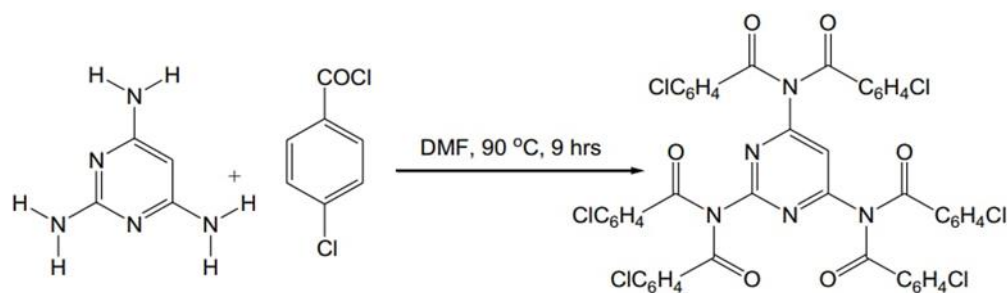


Figure 2.32 The dendritic ligand 2,4,6-tris

Many 1,3-Diazines and derivatives known from their biological features, especially their effects as an anticancer (Ghorab *et al.* 2016), antibacterial (Stolarczyk *et al.* 2021), anti-inflammatory, anti-anesthetic (Nofal *et al.* 2011), and antimicrobial (Figure 2.33) (Gupta *et al.* 2013).

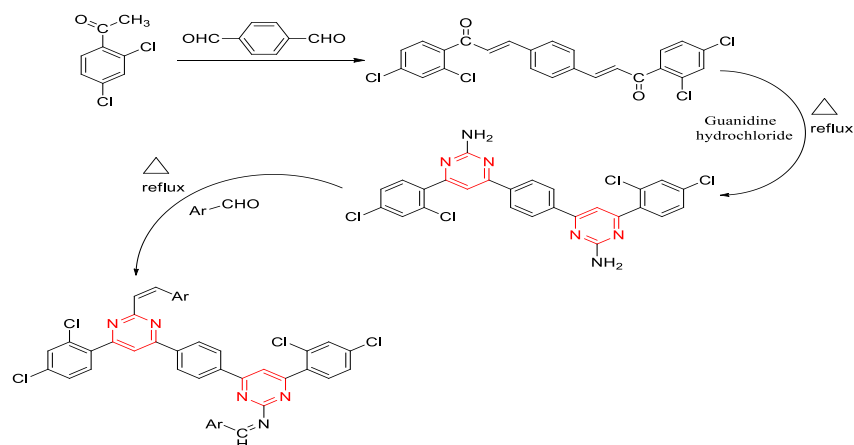
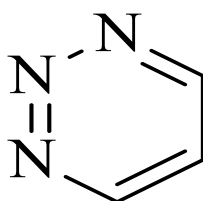


Figure 2.33 1,3-Diazines

2.4 Triazine

Triazine is a hybrid aromatic cyclic ring, similar to benzene, with three carbon atoms replaced by nitrogen, and the molecular formula is $C_3H_3N_3$. 1,2,3-triazine has been the least studied to date, but clinically its derivatives are the most acceptable due to their power and minimal side effects (Figure 2.34) (Raffa *et al.* 2010).



1,2,3-triazine

Figure 2.34 Triazine

2.4.1 Synthetic

2.4.1.1 Synthesis of 1,2,3-triazine

The 1,2,3-triazines are well known for their ring topology. Which has a low stability and this made them least investigated by researchers. Moreover, the limitation of the synthetic ways of producing them are limited (Figure 2.35) (Kumar *et al.* 2014).

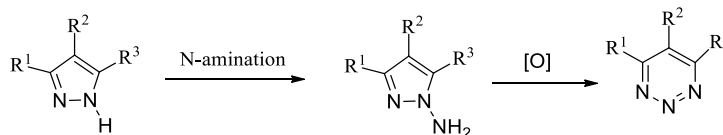


Figure 2.35 Triazines group is associated with the N-amination

1,2,3-triazines group is associated with the N-amination of pyrazoles, and linked to an oxidative ring expansion (Kumar *et al.* 2014, Rivera *et al.* 2022).

2.4.1.2 Scope of the 1,2,3-triazine formation

(Z)-2,4-diazido-2-alkenoates 1b-q exhibiting different electrical and sterile requirements under both reaction conditions (i.e., in both methods) was the main acquired result from the this demonstration (Figure 2.36) (Sugimura *et al.* 2018).

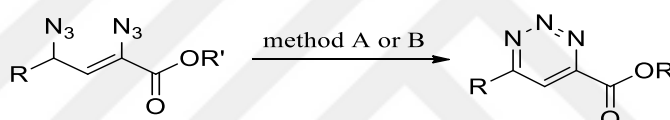


Figure 2.36 1,2,3-triazine formation

2.4.1.3 Structures and synthetic methods of 1,2,3-triazine

There were no significant contribution in its synthesis until concluded the method of creating the 1,2,3-triazine with an oxidative reshaping in the structure within 1-aminopyrazole (Figure 2.37) (Ohsawa *et al.* 1981, Ohsawa *et al.* 1985, ITOH *et al.* 1990).

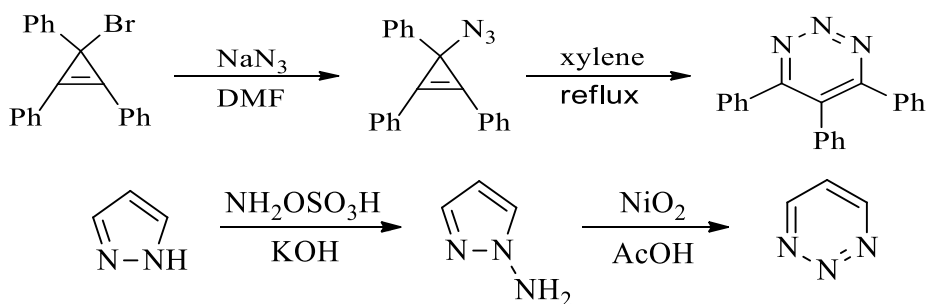


Figure 2.37 Creating the 1,2,3-triazine with an oxidative reshaping in the structure within 1- aminopyrazole

2.4.1.4 Triazine reactions

2.4.1.4.1 Aza-diels–alder cycloaddition of 1,2,3-triazine with 1-alkynyl-1-amines

A highly selective method for preparing pyridazin derivatives was developed through the reaction of aza-DielsAlder involving 1,2,3-triazines and within default requirements 1-propynylamines. With this method, the access to a variety of range differs and consist of 6 arylpyridazin-3-amines is possible with this method with high yields and fine compatibility with the associated groups. The main idea in this method covers a wide range of substrates with simple, metal-free(Kodama *et al.* 2021) and moderate level of reaction (Figure 2.38).

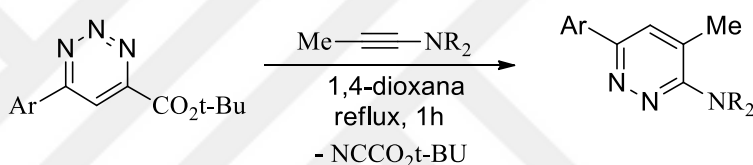


Figure 2.38 Arylpyridazin-3-amines

The C4/N1 mode was used entirely during the cycloaddition of 5-substituted 1,2,3-triazines to exclusively supply (Figure 2.39).

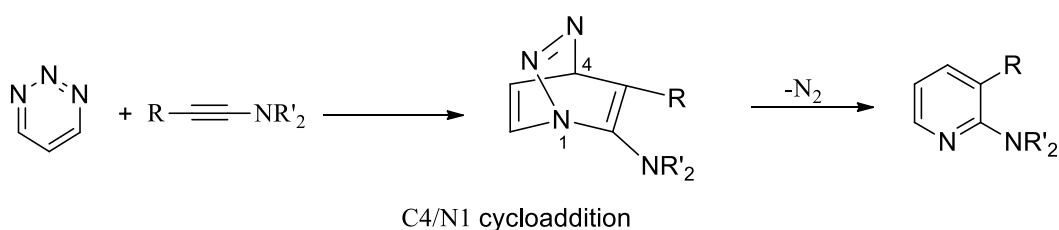


Figure 2.39 The cycloaddition of 5-substituted 1,2,3-triazines

The pyrazine compounds were primarily produced by reactions of 4- or 4,6-disubstituted 1,2,3-triazines and were formed via cycloaddition across C5/N2 (Figure 2.40) (Anderson and Boger 2011).

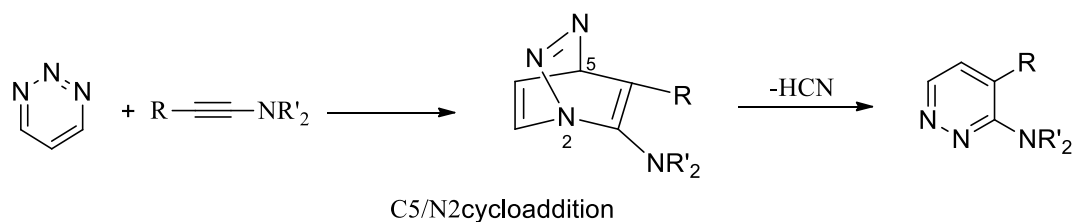


Figure 2.40 Pyrazine compounds

The process of preparing synthesis compounds is well recognized as anti-inflammatory pyridin 6. The reaction of this process with 1,2,3-triazine is also known as The Diels-Alder reaction of (Figure 2.41) (Glinkerman and Boger 2015).

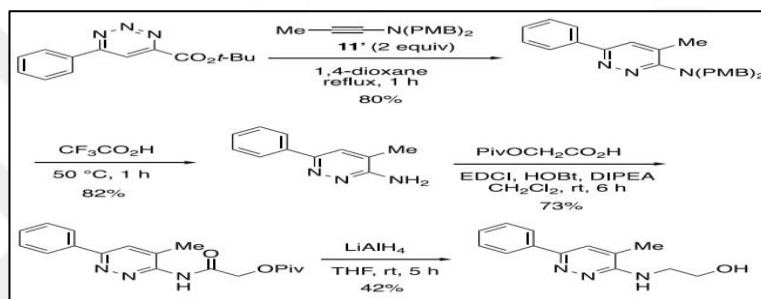


Figure 2.41 The Diels-Alder reaction

Among the planned structures, the derivation of the indolo[1,2-c]-1,2,3-benzotriazine nucleus with the features of an annelated triazine ring and a wide sets consist of aromatics (Figure 2.42) (Sugimura *et al.* 2018, Saravanan *et al.* 2010, Migawa *et al.* 2005, Lauria *et al.* 2014, Barone *et al.* 2013).

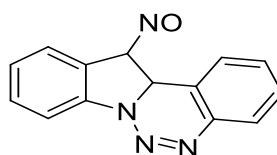


Figure 2.42 The indolo[1,2-c]-1,2,3-benzotriazine nucleus

Pyrrolo[2,1-c]-1,2,4-triazine Shows that it has a good antitumor within the micromolar density (Figure 2.43).

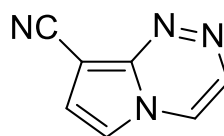


Figure 2.43 Pyrrolo[2,1-c]-1,2,4-triazine

benzothieno[3,2-d]-1,2,3-triazine-4(3H)-one derivatives was obtained by applying and synthetic method for structuring it (Figure 2.44) (Neunhoeffler and Wiley 2009, Chattaway and Walker 1927).

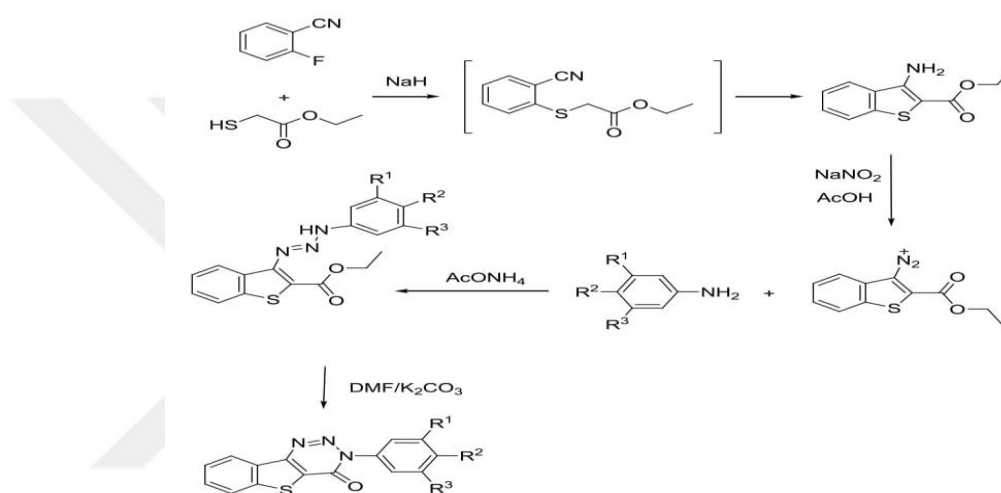


Figure 2.44 Benzothieno[3,2-d]-1,2,3-triazine-4(3H)-one

3. MATERIALS AND METHODS

Infrared spectrophotometer, NMR spectrophotometer, The solvent used is chloroform CDCl_3 and DMSO, Chemicals produced by (Fluka), (BDH), (Aldrich) As some liquid materials were distilled from it, in addition to recrystallizing some of the solid materials that were used.

3.1 Synthesis of 5-Ethoxycarbonyl-4-(aryl)-6- methyl-1,2,3,4-tetrahydropyrimidine-2-thione (M_{1-4})

Equivalent moles consisting of (0.001 mol) of aldehyde, (0.001 mol) of thioamide, and (0.001 mol) of ethyl acetoacetate are mixed with a margin amount of concentrated sulfuric acid, then the compound is stirred within a period of two minutes, after which the mixture is prepared under the heat at 90°C for one hour in a water bath. after the end of the heating period, the solution is concentrated from petroleum ether melting point ($40\text{-}60^\circ\text{C}$) (Khodja *et al.* 2014), published and a product ratio (79%) (Biginelli 1891). Physical constants as presenting in the Table 3.1 and Figure 3.1.

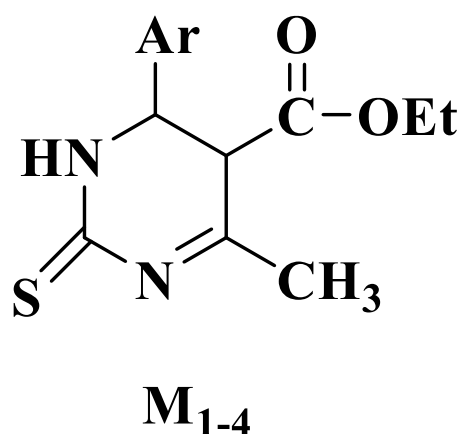
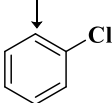
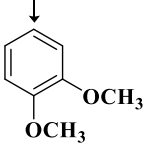


Figure 3.1 5-Ethoxycarbonyl-4-(aryl)-6- methyl-1,2,3,4-tetrahydropyrimidine-2-thione (M_{1-4})

Table 3.1 Physical properties of compounds (M1- M2)

Comp. No.	Ar	Molecular Formula	Colour	m.p °C	Yield %
M ₁		C ₁₄ H ₁₃ ClN ₂ O ₂ S	white	162-164	63
M ₂		C ₁₆ H ₂₀ N ₂ O ₄ S	yellow	144-146	51
M ₃		C ₁₃ H ₁₅ N ₃ O ₂ S	brown	101-103	43
M ₄		C ₁₃ H ₁₅ N ₃ O ₂ S	Faint brown	151-153	65

3.2 Synthesis of 5-Hydrazido-4-(aryl)-6-methyl-1,2,3, 4-tetrahydropyrimidine-2-thione (M₅₋₈)

A mixture containing (0.01 mol) of ester (M₁₋₄) and (2.5 gram or 0.05 mol) of aqueous hydrazine (99%) is ascended in (mL) of absolute ethanol for (3) hours, then the solution is concentrated and poured on 100 grams of crushed ice and its crystals are re-crystallized from ethanol-water to give a precipitate Orange in color with a melting point (114-116 °C) and percentage (85%) (Olagboye *et al.* 2022). Physical constants (Table 2.2, Figure 3.2).

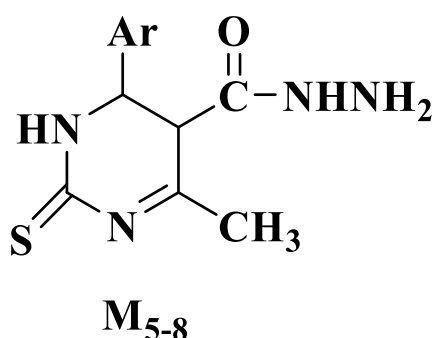
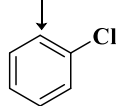
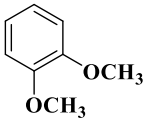
**Figure 3.2** 5-Hydrazido-4-(aryl)-6-methyl-1,2,3,4-tetrahydropyrimidine-2-thione(M5-8)

Table 3.2 Physical properties of compounds (M5- M8)

Comp. No.	Ar	Molecular Formula	Colour	m.p °C	Yield %
M ₅		C ₁₂ H ₁₃ ClN ₄ OS	Faint yellow	147-149	93
M ₆		C ₁₄ H ₁₈ N ₄ O ₃ S	Faint brown	153-155	87
M ₇		C ₁₁ H ₁₃ N ₅ OS	Faint yellow	141-144	75
M ₈		C ₁₁ H ₁₃ N ₅ OS	white	199-201	96

3.3 Synthesis of 2-Chlorophenyl [4-(aryl)-6-methyl-2-thioxo-1, 2,3,4-tetrahydropyrimidin-5-yl-5-carbo[hydrazone (M₉₋₁₁)

The mixture of stoichiometric moles (0.004 mol) of hydrazide (M₅) and one of the benzaldehyde substitutes and 25 ml of ethanol with high concentration for dissolving the compound, then the reaction mixture is escalated for 3 hours, and after the escalation is over, Moreover, in the last step the mixture need to get cooled and filtered to obtain the precipitate that is recrystallized from ethanol-water, and the physical constants installed in the table (Ali *et al.* 2011). Physical constants as shown in the following Table 3.2 and Figure 3.3.

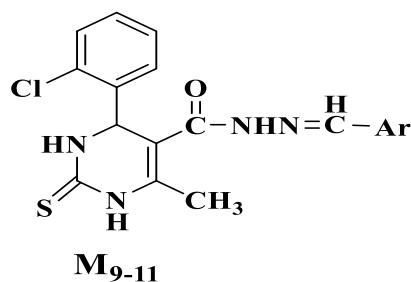
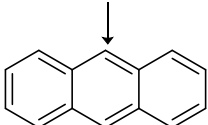
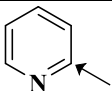
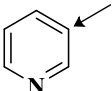


Figure 3.3 2-Chlorophenyl [4-(aryl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidin-5-yl-5-carbo[hydrazone (M₉₋₁₁)

Table 3.3 Physical properties of compounds (M9- M11)

Comp. No.	Ar	Molecular Formula	Colour	m.p °C	Yield %
M ₉		C ₂₇ H ₂₁ ClN ₄ OS	yellow	158-161	93
M ₁₀		C ₁₈ H ₁₆ ClN ₅ OS	Faint brown	165-167	95
M ₁₁		C ₁₈ H ₁₆ ClN ₅ OS	Faint yellow	135-137	91

3.4 Synthesis of 3,4-Dimethoxyphenyl anthranilate (M₁₂₋₁₄)

A mixture of stoichiometric moles (0.004 mol) of hydrazide (M₅) and one of the benzaldehyde substitutes 25 ml of ethanol with high concentration for dissolving the compound, then the reaction mixture is escalated for 3 hours then after the escalation is over, the mixture need to be cooled and get filtered to obtain the precipitate that is recrystallized from ethanol-water, and the physical constants installed in the table (Ali 2011). Physical constants in Table 3.4 and Figure 3.4.

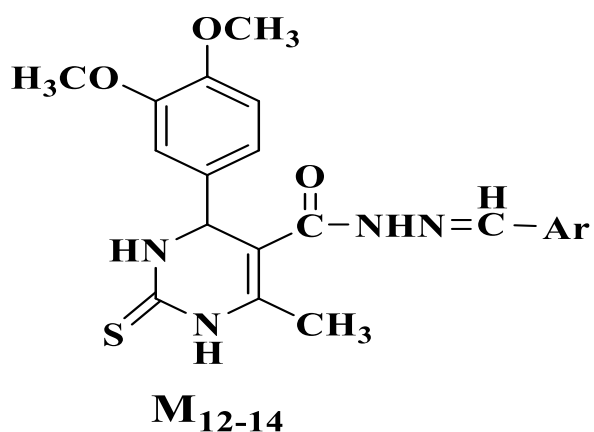
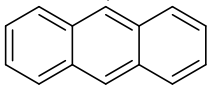
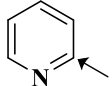
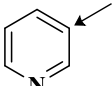
**Figure 3.4** 3,4-Dimethoxyphenyl anthranilate (M12-14)

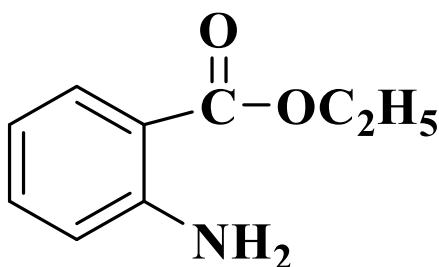
Table 3.4 Physical properties of compounds (M12- M14)

Comp. No.	Ar	Molecular Formula	Colour	m.p °C	Yield %
12		$C_{29}H_{26}N_4O_3S$	brown	261-263	96
13		$C_{20}H_{21}N_5O_3S$	Faint brown	154-156	95
14		$C_{20}H_{21}N_5O_3S$	Faint brown	156-158	86

3.5 Synthesis of Ethyl anthranilate (M_{15})

A new mixture is created that consists of 6.2 g and 0.05 molL anthranilic acid and (20.4 mL with 0.35 molL) of ethanol saturated with hydrochloric gas is risen on a steam bath for two hours, then the product is cooled, and then (100 grams) of ice that had been smashed. The ice need to be added to it gradually with stirring.

Then, the concentrated ammonia solution is added until the medium becomes weakly basic (pH 8-9), and the product is extracted using ether (15 x 3 mL), the organic layer is dried using anhydrous sodium sulfate, the solvent later need to evaporate and distilled under rarefied pressure to give a yellowish liquid substance by weight (5 grams) and by (74%), and its boiling point (214-215 °C) was published (216-217 °C) (Figure 3.5) (Wiklund and Bergman 2006).

**Figure 3.5** Ethyl anthranilate (M_{15})

3.6 Synthesis of Ethyl 2-(4-oxobenzo[d][1,2,3]triazine-3(4h)-yl) propanoate (M₁₆)

(0.04 mol) of ethyl anthranilate is dissolved in a solution at a temperature of 0 – 5 °C of dilute hydrochloric (35%), then add to the mixture drop by drop of (4.25 g) of dissolved sodium nitrite (10 mL) of water, then add to the above mixture (0.04 mol) of ethyl alanine hydrochloric acid, next, an hour of stirring for the mixture. At the end of the stirring, the new compound was neutralized with a saturated solution of sodium carbonate, then the product is extracted by means of ether, after which the ether was evaporated under rarefied pressure to obtain a brown liquid Boiling (90-92 °C) with a yield of (85%) (Figure 3.6) (Krishnan *et al.*2014).

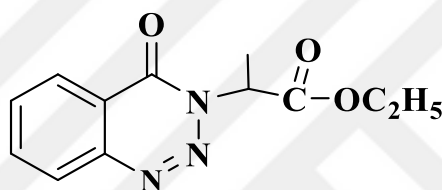


Figure 3.6 Ethyl 2-(4-oxobenzo[d][1,2,3]triazine-3(4h)-yl) propanoate (M₁₆)

3.7 Synthesis of 2-(4-Oxobenzo[d][1,2,3]triazine-3(4h)-yl) propanehydrazide (M₁₇)

A mixture that has (0.01 mol) of an ester (M₁₆) and (0.05 mol, 2.5 grams) of aqueous hydrazine (99%) was ascended in (50 mL) of absolute ethanol for (3) hours, Next, with the ethanol the mixture was recrystallized after it got filtered, to give A white precipitate with a melting point of (114-116 °C) and a yield of (90%) (Figure 3.7) (Krishnan *et al.* 2014).

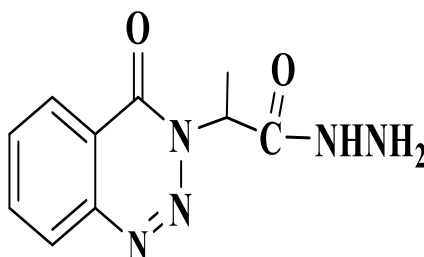


Figure 3.7 2-(4-Oxobenzo[d][1,2,3]triazine-3(4h)-yl) propanehydrazide (M₁₇)

3.8 Synthesis of 2-(4-Oxobenzo[d][1,2,3]triazino-3(4h)-yl-met hylcarbo)hydrazone (m₁₈₋₂₂)

A mixture of equivalent moles (0.004 molL) of hydrazide and one of the benzaldehyde substitutes is dissolved into 25mL of high-concentration ethanol water, then the resulted compound is escalated within a period of 3 hours (Krishnan *et al.* 2014) as shown in the Table 2.5, below for the physical constantns features of the compound (Figure 3.8).

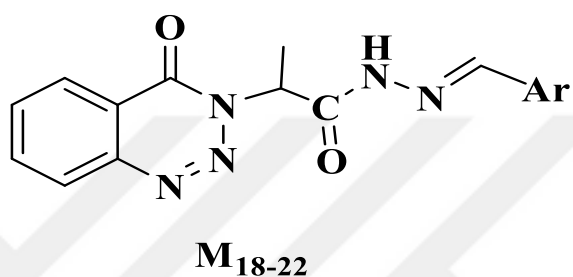


Figure 3.8 2-(4-Oxobenzo[d][1,2,3]triazino-3(4h)-yl-met hylcarbo)hydrazone (m₁₈₋₂₂)

Table 3.5 Physical properties of compounds (M₁₈- M₂₂)

Comp. No.	Ar	Molecular Formula	Colour	m.p °C	Yield %
M ₁₈		C ₂₅ H ₁₉ N ₅ O ₂	yellow	267- 269	95
M ₁₉		C ₁₇ H ₁₄ ClN ₅ O ₂	white	195 -197	90
M ₂₀		C ₁₉ H ₁₉ N ₅ O ₄	white	181 -183	93
M ₂₁		C ₁₆ H ₁₄ N ₆ O ₂	white	102 -104	90
M ₂₂		C ₁₆ H ₁₄ N ₆ O ₂	white	191 -193	95

4. RESULTS AND DISCUSSION

Several studies mentioned in chapter 1 and chapter 2 stated the importance of hydrazides due to the diversity within the biological impact in the medical, industrial, and chemical sectors. In addition, many other researchers proposed the importance of heterocyclic hydrazides, as they are used as materials in the medicals especially the antibiotics. Moreover, they have been used widely in the industrial fields such as dye industry. Also, the agriculture field took most of them to increase the growth stimulants process for plants and as a pesticide. In determination of this basis, a set of new hydrazides were prepared in this study as intermediates for the preparation of hydrazones for obtaining new substitutes that might be used in biological, industrial, and agricultural fields.

4.1 Preparation of 5-Ethoxycarbonyl-4-(aryl)-6-methyl-4,3,2,1-tetrahydropyrimidine-2-thione (M_{1-4})

The compound (M1) was prepared through a multicomponent reaction with acid as a catalyst. This reaction is known as Biginelli condensation, which occurs between aromatic aldehyde, thiourea or urea, and B-ketoester. This reaction is considered one of the rapid reactions that have biological and industrial importance, as it is used in the preparation of many heterocyclic compounds such as dihydropyrimidothione and dihydropyrimidinone (Khodja *et al.* 2014).

It is believed that the first step of the reaction mechanism involves a condensation process between 4-methoxybenzaldehyde and thiourea in a manner similar to (Mannich) condensation, leading to the formation of the intermediate compound known as iminium, which acts as an electrophilic agent in the nucleophile addition to the enol of the ketoester, and the second step involves a condensation process between the carbonyl group The addition compound with the second amine group of thiourea, leading to the formation of the hexacyclic compound, and this can be explained through the following mechanics (Figure 4.1) (Roy *et al.* 2011):

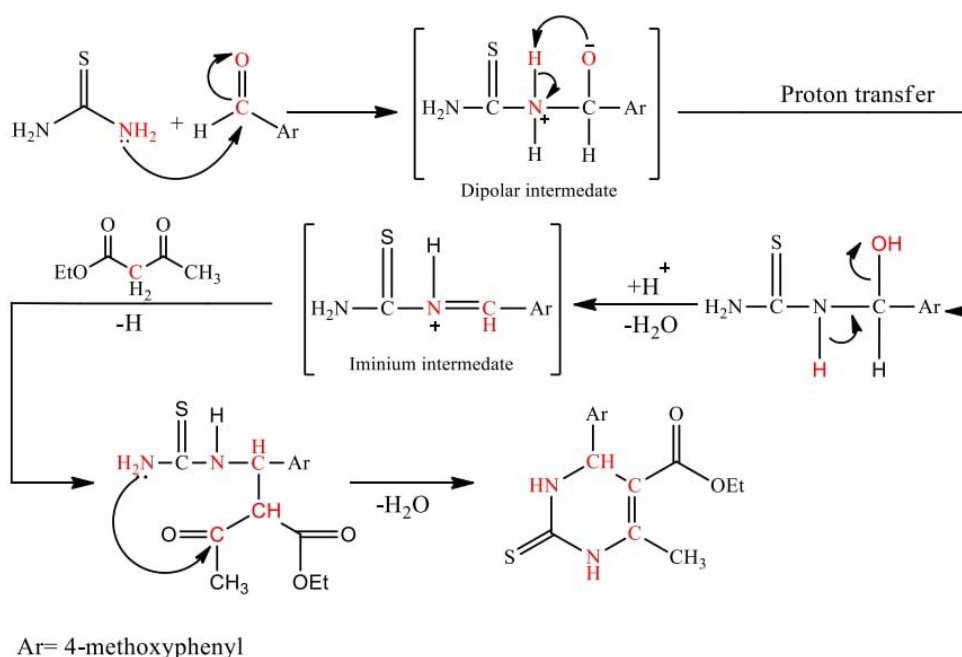


Figure 4.1 5-Ethoxycarbonyl-4-(aryl)-6-methyl-4,3,2,1-tetrahydropyrimidine-2-thione(M1-4)

The resulting compounds was detected by infrared spectrum, as the spectrum showed a medium band at the position (3308-3301-3278-3174) cm^{-1} which is due to stretching (NH) and showed a strong band at the position (1707 cm^{-1}) which is due to special feature of expanding for the esterified carbonyl group ($\text{C}=\text{O}$). The high-resolution mass spectrum showed a band at the location corresponding to the aster mass number.

4.2 Synthesis of 1,2,3,4-Tetrahydropyrimidine-2-thione-5-ethoxycarbonyl-4-(aryl)-6-methyl (M_1)

IR spectrum, o, cix-1: 3174 {NH str.}, 3091 (Ar-CH str.), 2985 (aliphatic-CH str.), 1707{ $\text{C}=\text{O}$ str.}, 1651 { $\text{C}=\text{C}$ str.} and { $\text{C}=\text{N}$, 1567{Ar- $\text{C}=\text{C}$ }. 1471(CH bead of CH_2) 1312726 ($\text{C}=\text{S}$) 726 (C-CL). ^1H NMR (CDCl₃), δ , ppm:1.03 (3H, t, CH_3) 2.41(3H, s, CH_3), 3.99 (2H, q, CH_2), 5.87 (1H, s, CH) 7.2-7.3 (4H, m, Ar-CH) 7.58 (1H, s, NH), 8.70 (1H, s, NH). ^{13}C NMR (CDCl₃): 13.99, 17.84, 52.65, 60.35, 100.80, 127.69. 128.57, 129.67. 129.86, 132.59, 138.55, 144.69, 164.90, 174.11.

4.3 4-(3,4-Dimethoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate of ethyl (M₂)

IR spectrum, ν , cm⁻¹: 3301 (NH str.), 3101 (Ar-CH str.), 2985 (aliphatic-CH str.), 1707 (C=O str.), 1660 (C=C str.), 1569 (Ar-CQ), 1458 (CH bend CH₂), 1370 (CH bend CH₃), 1333 (C=S). ¹H NMR (CDCl₃). δ , ppm: 1.14 (3H, t, CH₃), 2.32 (3H, s, CH₃), 3.06 (6H, s, (OCH₃)₂), 5.3 (1H, d, CH), 6.77 (3H, s, Ar-CH₃), 7.87 (1H, d, NH), 8.43 (1H, s, NH). ¹³C NMR (CDCl₃). δ , ppm: 14.13, 14.20, 18.14, 55.66, 55.86, 55.86, 55.91, 55.99, 60.36, 60.67, 61.22, 102.97, 109.36, 110.05, 111.23, 118.95, 121.77, 135.06, 142.71, 148.93, 149.02, 165.37, 174.12.

4.4 Ethyl 6-methyl-4-(pyridin-2-yl)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate(M₃)

IR spectrum, ν , cm⁻¹: 3308-3179 (NH str.), 3100 (Ar-CH str.), 2959 (aliphatic-CH str.), 1713 (C=O str.), 1628 (C=N str.), 1593, 1472 (C=C str.), 1435 (CH bend CH₂), 1347 (C=S). ¹H NMR (CDCl₃). δ , ppm: 1.16 (3H, s, CH₃), 2.30 (3H, s, CH₃), 4.02 (1H, s, CH₂), 4.59 (1H, s, CH), 7.22-7.75 (8H, m, Ar-CH), 8.48 (1H, s, CH), 9.51 (1H, s, NH), 9.73 (1H, s, NH). ¹³C NMR (CDCl₃). δ , ppm: 1.16, 2.30, 4.02, 4.59, 7.22, 7.46, 7.75, 8.48, 9.31, 9.73.

4.5 Ethyl 6-methyl-4-(pyridin-3-yl)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate(M₄)

IR spectrum, ν , cm⁻¹: 3278-3172 (NH str.), 3034 (Ar-CH str.), 2980-2933 (aliphatic-CH str.), 1705 (C=O str.), 1661 (C=N str.), and (C=C str.), 1524 (Ar-C=C bend), 1422 (CH bend CH₂), 1366 (CH bend CH₃), 1337 (C=S). ¹H NMR (CDCl₃). δ , ppm: 1.33 (3H, q, CH₃), 2.51 (3H, s, CH₃), 4.14 (2H, t, CH₂), 5.43 (1H, s, CH), 7.19-8.83 (4H, m, pyr), 9.07 (1H, s, NH), 10.1 (1H, s, NH). ¹³C NMR (CDCl₃). δ , ppm: 14.23, 22.65, 29.66, 40.09, 53.88, 60.78, 102.81, 123.56, 134.31, 148.76, 154.75, 152.10, 166.07, 190.72.

4.6 Synthesis of 5-Hydrazido-4-(aryl)-6-methyl-1,2,3,4-tetrahydropyrimidine-2-thione (M₅-)

Hydrazides are among the most important intermediate compounds for the preparation of hydrazones and are used as raw materials in the preparation of many heterocyclic compounds such as oxadiazoles and thiadiazoles. In addition, they have biological importance and effectiveness. They have been mentioned in the introduction part of this thesis. There are several methods for preparing Hydrazide, including the reaction of esters with aqueous hydrazine, which is the method used in the preparation process. On this basis, hydrazide (M₅₋₈) was prepared from the reaction of the corresponding ester (M₁₋₄) with aqueous hydrazine in absolute ethanol, as shown in the following Figure 4.2:

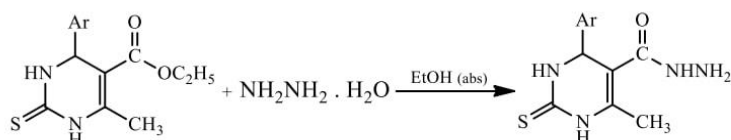


Figure 4.2 5-Hydrazido-4-(aryl)-6-methyl-1,2,3,4-tetrahydropyrimidine-2-thione (M₅-)

The reaction of hydrazine with the ester is a nucleophilic substitution on the carbon atom in the carbonyl group, as an intermediate compound is formed that attributable from the substitution of the ethoxide group, forming a hydrazide as a final product, as shown in the following mechanics as shown in Figure 4.3 :

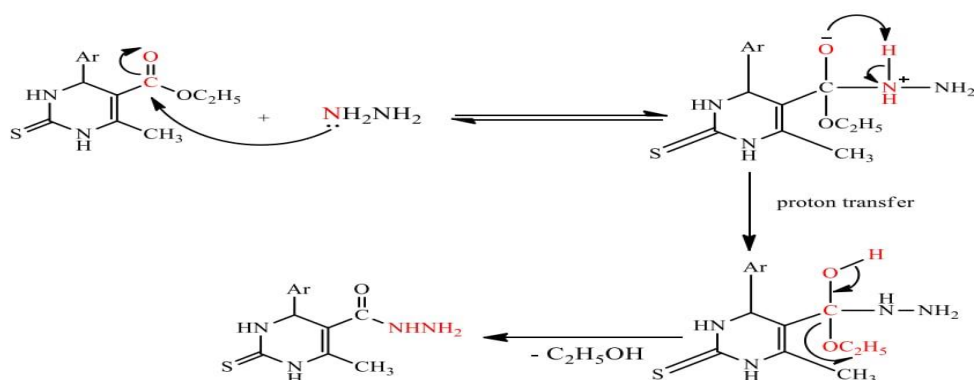


Figure 4.3 Hydrazine

When diagnosing the resulting hydrazide using the infrared spectrum, the spectrum showed, as shown in Appendix 1, a band at (3175 cm^{-1}) referring to stretching (-N) and a band at (1660 cm^{-1}) returning to the stretching of the carbonyl group, as it is noted that the absorption band of the carbonyl group of the hydrazide, It mitigated to a lower frequency compared to the absorption band of the carbonyl group in the ester. On the contrary, this is due to the presence of the resonance phenomenon in hydrazide, which leads to a decrease in the order of the double bond (CO), and then the strength constant of this bond decreases and its frequency decreases (Booth *et al.* 1992).

The proton NMR spectrum also showed a single beam belonging to the methyl group at the site (ppm 2.3) and a single beam belonging to the methoxy group at the site (ppm 3.9). The spectrum also showed a single beam belonging to (2) belonging to the hydrazide group at the site (12.0 ppm). While the nuclear magnetic resonance spectrum showed the isotope of carbon 13, it was noted that the carbonyl group carbon appeared at ppm (165.55), while the carbon atoms of the pyrimidine ring carbon appeared at the range (59.11-171.60 ppm), while the carbon atoms of the aryl ring appeared at the range (113.08-155.60 ppm). As for the high-resolution mass spectrum, it showed a beam at the location that represents the number of masses to hydrazide.

4.7 4-(2-Chlorophenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M_5)

IR spectrum, ν , cm^{-1} : 3401-3177 (NH str.), 3119 (Ar-CH str.), 2978 (aliphatic-CH str.), 1692 (C=O str.), 1647, (C=C str.) and (C=N str.), 1567 (Ar-G=C), 1350 (CH bend of CH₃) 1315 (C=S), 718 (C-Cl). H NMR (CDCl₃), δ , ppm. 1.33 (3H, q, CH₃), 2.51 (3H, s, CH₃), 4.14 (2H, t, CH₂). 5.83 (1H, s, CH). 7.21 (2H, s, NH). 8.12 (1H, s, NH). ¹³C NMR (CDCl₃), δ , ppm: 13.90, 17.86, 29.66, 52.64, 60.34, 100.75, 129.86, 132.58, 138.57, 144.74, 164.91, 174.20 (Figure 4.4).

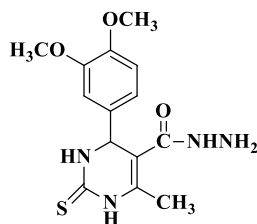


Figure 4.4 4-(2-Chlorophenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M5)

4.8 4-(3,4-Dimethoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide(M₆)

IR spectrum. v. cm⁻¹. 3306-3173 (NH str.). 3119 (Ar-CH str.). 2961 (aliphatic-CH str.), 1687 (G=O str.), 1659 (C=N str.), and (C=C str.), 1572 (Ar-C=C, 1371(CH bend of CH₃) 1330 (C=S). ¹H NMR (CDC13). δ. ppm: 2.3(3H. t. CH₃).3.80 (2H, 1. CH₂). 5.31 (1H. s, CH). 6.7 (2H. s. Ar-CH). 7.98 (1H. s,NH), 8.51 (1H. s.NH). ¹³C NMR (CDC13), δ. ppm. 14.13. 18.10. 55.90. 60.37. 102.95. 110.06. 118.94. 135.07. 142.76. 149.01. 165.38. 174.6 (Figure 4.5).

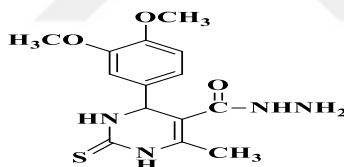


Figure 4.5 4-(3,4-Dimethoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide(M₆)

4.9 6-Methyl-4-(pyridin-2-yl)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M₇)

IR spectrum, v, cm⁻¹: 3150 (NH str.), 3067 (Ar-CH str.), 2917 (aliphatic-CH str.), 2857 (CH str.), 1707 (C=O str.), 1623 (C=N str.), 1461 (Ar-C=C str.), 1386 (CH bend, CH₃), 1355 (C=S). ¹H NMR (CDC13), δ, ppm: 1.5(3H, s, CH₃), 4.25 (2H, s, NH₂), 6.5(1H, s, CH). 6.7-7.69 (4H. M. Ar-CH). 7.7 (1H. s. NH) 8.4 (1H. s, NH) 8.7(1H. s, NH}. ¹³C NMR (CDC13): 60.17 102.36, 112.53, 118.40, 19.99, 122.37, 125.27, 127.79 132.67, 135.98, 148.91, 150.50, 167.07 (Figure 4.6).

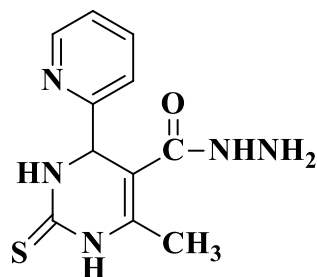


Figure 4.6 6-Methyl-4-(pyridin-2-yl)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M7)

4.10 6-Methyl-4-(pyridin-3-yl)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide(M8)

IR spectrum, ν , cm^{-1} : 3308 (NH str.), 2939 (aliphatic-CH str.), 2827 (CH str.), 1651 (C=O str.) 1628 (C=N str.), 1475 (Ar-C=C str.), 1375 (CH bend, CH₃), 1355 (C=S) ¹H NMR:2.37(4H, s, CH₃) 4.1(2H, s, NH₂) 5.4(1H, s, CH), 7.2-7.6(4H, m, Ar-CH) 7.7(1H,s, NH), 8.5 (1H, s, NH) 8.7(1H, s, NH). ¹H NMR.2.37(4H, s, CH₃) 4.1(2H, s, NH₂) 5.4(1H, s, CH), 7.2-7.6(4H, m, Ar-CH) 7.7(1H, s, NH). 8.5 (1H, s, NH) 8.7(1H, s, NH) (Figure 4.7).

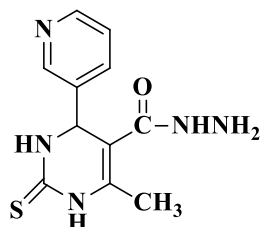


Figure 4.7 6-Methyl-4-(pyridin-3-yl)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M8)

4.11 Synthesis of 2-Chlorophenyl [4-(aryl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidin-5-yl-5-carbo[hydrazone (M₉₋₁₁)

(M₉₋₁₁) Compounds were prepared from the condensation of the prepared hydrazide compound (M₅₋₈) with benzaldehyde substitutes using absolute ethanol as a solvent for the reaction and as shown below, as the reaction mixture was escalated for a period of (3) hours and the reaction occurred through the following mechanism (Figure 4.8):

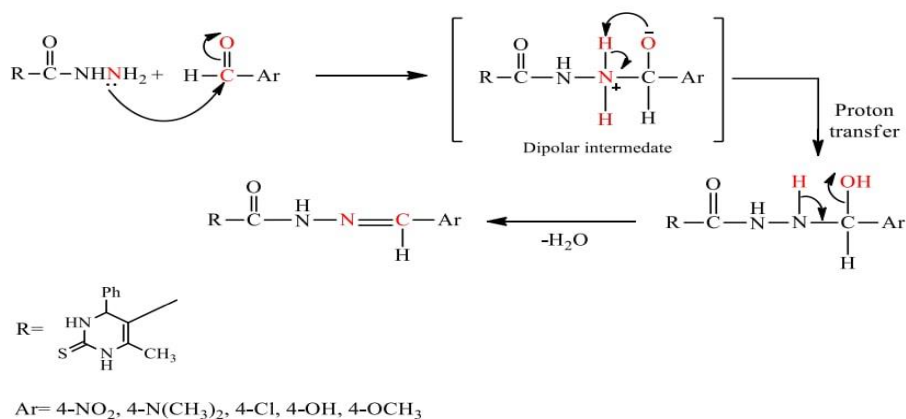


Figure 4.8 2-Chlorophenyl]4-(aryl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidin-5-yl-5-carbo[hydrazone (M9-11)

Hydrazone compounds (M₉₋₁₁) were identified by means of the infrared spectrum, as the spectrum showed, as shown below, distinct bands at the frequency range (161,670,660 cm) and this return to the stretching ability of the carbonyl group (C=O) and the appearance of absorption bands of the stretching group (C=N) at the location (1628 cm⁻¹), while the aromatic (C=C) bond stretching bands, which are usually very close to the (C=N) absorption values above, appeared at the range (1601, 408 cm⁻¹), as well. Osra in the range (3164-3335 cm⁻¹). The compounds were diagnosed using the proton nuclear magnetic resonance spectrum, as the spectrum gave, as shown in Appendix 2, a single band belonging to the (H, N = CH) group at the range (8.4-9.0 ppm), which proves the formation of the imine group, which is the active group in hydrazone compounds.

4.12 (E)-n'-(anthracen-9-ylmethylene)-4-(2-chlorophenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M₉)

IR spectrum, ν , cm⁻¹ : 3292 (NH str.), 3065 (Ar-CH str.), 2976 (aliphatic-CH str.), 2835 (CH str.), 1690 (C=O str.), 1630 (C=N str.), 1567, 1463 (Ar-C=C str.), 1380 (CH bend, CH₃), 1316 (G=S). 727 (C-Cl) . ¹H NMR (CDCl₃), δ , ppm: 4(3H, s, CH₃), 5.8(1H, s, CH), 6.8(1H, d, CH), 7.2-8.7 (12H, m, Ar-CH), 8.9(1H, s, NH), 9.9(1H, s, NH). 10.5(1H, s, NH). ¹³C NMR (CDCl₃), δ , ppm: 13.89, 18.01, 49.96, 52.72, 60.37, 100.71, 123.54, 132.14, 143.43, 159.23, 162.08, 164.84, 174.33, 193.08, 200.06 (Figure 4.9).

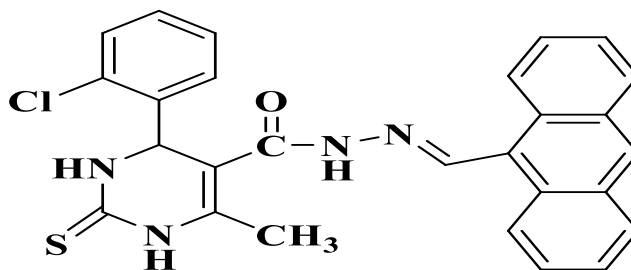


Figure 4.9 (E)-n'-(anthracen-9-ylmethylene)-4-(2-chlorophenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M9)

4.13 (E)-n'-(anthracen-9-ylmethylene)-4-(3,4-dimethoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M₁₀)

IR spectrum, ν , cm⁻¹: 3313 (NH str.), 3040 (Ar-CH str.), 2987 (aliphatic-CH str.), 2879 (CH str.), 1682 (C=O str.), 1634 (C=N str.), 1515, 1441 (Ar-C=C str.), 1376 (CH bend, CH₃), 1350 (C=S). ¹H NMR (CDCl₃), δ , ppm: 4 (1H, s, CH₃), 5.88 (1H, s, CH), 7.3(1H, s, NH), 7.4(1H, s, NH), 8.4(1H, s, NH), 8.6 (1H, s, NH), 10.1(1H, s, NH). ¹³C NMR (CDCl₃), δ , ppm. 13.89, 17.95, 52.69, 60.37, 100.75, 127.71 128.47, 129.89, 132.59, 138.44, 144.58, 164.86, 174.26 (Figure 4.10).

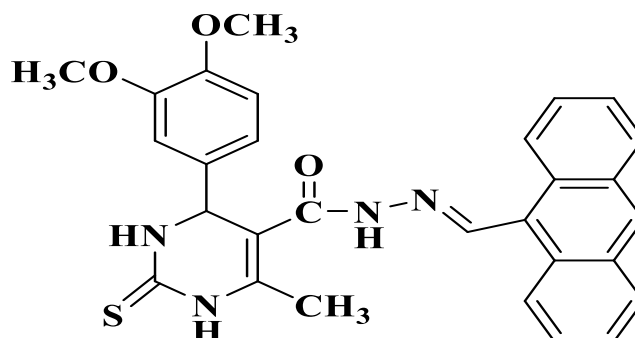


Figure 4.10 (E)-n'-(anthracen-9-ylmethylene)-4-(3,4-dimethoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M₁₀)

4.14 (E)-4-(2-chlorophenyl)-6-methyl-n'-(pyridin-2-ylmethylene)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M₁₁)

IR spectrum, ν , cm⁻¹: 3251-3169 (NH str.), 3072 (Ar-CH str.), 2983 (aliphatic-CH str.), 2824 (CH str.), 1705 (C=O str.), 1651 (C=N str.), 1571, 1469 (Ar-C=C str.), 1380 (CH bend, CH₃), 1314 (C=S), 753 (C-Cl). ¹H NMR(CDCl₃), δ , ppm: 4(3H, s, CH₃), 5.8(1H, s, CH), 7.22-8.8(1H, m, Ar-CH), 8.9 (8H, s, NH), 9.07(1H, s, NH), 10.1(1H, s, NH), 10.4(1H, s, NH). ¹³C NMR(CDCl₃), δ , ppm: 13.89, 17.95, 52.69, 60.37, 100.75, 123.81, 127.71, 128.47, 129.89, 132.59, 138.44, 144.58, 150.49, 154.75, 159.02, 164.88, 174.30, 190.78 (Figure 4.11).

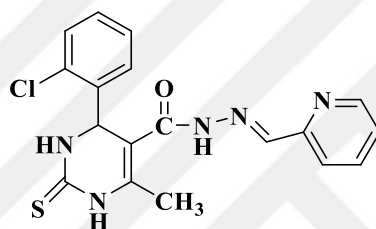


Figure 4.11 (E)-4-(2-chlorophenyl)-6-methyl-n'-(pyridin-2-ylmethylene)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M₁₁)

4.15 Synthesis of 3,4-Dimethoxyphenyl anthranilate (M₁₂₋₁₄)

3,4-Dimethoxyphenyl anthranilate was prepared from the sublimation of anthranilic acid with ethanol saturated with HCl conditions of gravity in the following Figure 4.12:

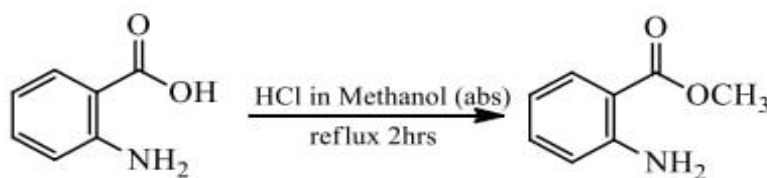


Figure 4.12 3,4-Dimethoxyphenyl anthranilate (M₁₂₋₁₄)

The resulting ester was identified using the hydroxamate assay, which gave a positive detection indicates the presence of the ester group. The compounds, whose spectral

properties were identical to what was published in this field, was also diagnosed in the infrared spectrum, as the spectrum gave two bands at (3559 cm^{-1}) and (3403 cm^{-1}) that belong to the stretch of the (NH) group, and the spectrum gave a band at (1759 cm^{-1}). It refers to the stretching of the esterified carbonyl group (CO), while the aromatic (C=C) double bonding bands appeared at frequencies ($1600\text{--}1493\text{ cm}^{-1}$).

This also proved the validity of the composition of the compound by means of the high-resolution mass spectrometry, as the spectrum gave a band at the location that corresponds to the mass number of the ester.

4.16 (E)-n'-(anthracen-9-ylmethylene)-4-(3,4-dimethoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M_{12})

IR spectrum, ν , cm^{-1} : 3313 (NH str.), 3040 (Ar-CH str.), 2987 (aliphatic-CH str.), 2879 (CH str.), 1682 (C=O str.), 1634 (C=N str.), 1515, 1441 (Ar-C=C str.), 1376 (CH bend, CH₃), 1350 (C=S). ¹H NMR (CDCl₃), δ , ppm: 3.8 (3H, s, CH₃), 4 (1H, s, CH), 6.9–8.7 (12H, m, Ar-CH). 8.8 (1H, s, CH), 8.9 (1H, s, NH), 10.1 (1H, s, NH). ¹³C NMR (CDCl₃), δ , ppm: 56.00, 108.94, 110.71, 129.12, 129.28, 130.38, 130.63, 130.84, 130.90, 131.08, 131.35, 131.40, 132.13, 135.22, 149.46, 152.08, 160.73, 162.15, 162.52, 193.00 (Figure 4.13).

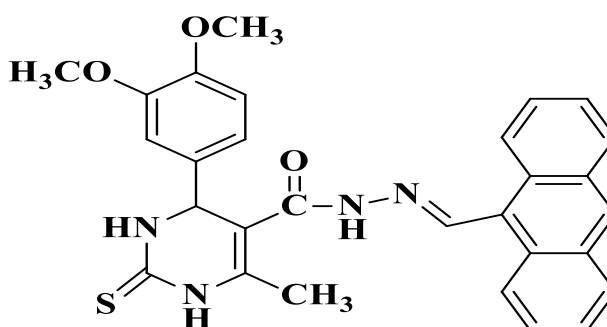


Figure 4.13 (E)-n'-(anthracen-9-ylmethylene)-4-(3,4-dimethoxyphenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M_{12})

4.17 (E)-4-(3,4-dimethoxyphenyl)-6-methyl-n'-(pyridin-2-ylmethylene)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M₁₃)

IR spectnim, ν , cm^{-1} : 3307-3170 (NH str.), 3086 (Ar-CH str.), 2975 (aliphatic-CH str.), 2864 (CH str.), 1686 (C=O str.), 1659 (C=N str.), 1506, 1461 (Ar-C=C str.), 1376 (CH bend, CH₃), 1350 (C=S). ¹H NMR (CDCl₃), δ , ppm: 2.3 (3H, s, CD). 3.8 (6H, s, OCD), 5.3 (1H, s, Cil). 6.78 (8H, m, Ar-CH), 7.4(1H, s, NH), 7.7 (1H, s, NH), 8.3 (1H s, NH), 8.6 (1H, s, NH). ¹³C NMR (CDCl₃), δ , ppm: 14.14, 15.23, 18.20, 22.58, 55.74, 55.87, 55.92, 60.40, 103.03, 110.03, 111.25, 118.97, 135.04, 142.58, 148.98, 149.05, 161.21, 165.35, 174.20 (Figure 4.14).

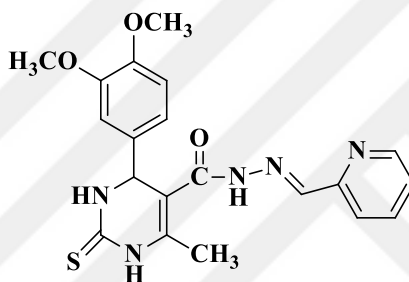


Figure 4.14 (E)-4-(3,4-dimethoxyphenyl)-6-methyl-n'-(pyridin-2-ylmethylene)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide

4.18 (E)-4-(3,4-dimethoxyphenyl)-6-methyl-n'-(pyridin-3-ylmethylene)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M₁₄)

IR spectnim, ν , cm^{-1} : 3305-3168 (NH str.), 3087 (Ar-CH str.), 2973 (aliphatic-CH str.), 2887 (CH str.), 1695 (C=O str.), 1659 (C=N str.), 1504, 1450 (Ar-C=C str.), 1372 (CH bend, CH₃), 1333 (C=S). ¹H NMR(CDCl₃). δ , ppm: 2.3 (5H, s, CH₃) 3.8 (6H, s, OCH₃) 5.3(1H, s, CH) 6.8-8.7(7H, m, Ar-CH) 8.9 (1H, s, NH) 9.05(1H, s, NH). 9.83 (1H, s, NH) 10.09 (1H, s, NH). ¹³C NMR (CDCl₃), δ , ppm: 14.14, 15.23, 18.18, 55.71, 55.87, 55.91, 60.39, 103.01, 110.03, 111.25, 118.97, 135.04, 142.63, 148.98, 149.05, 159.73, 161.21, 165.35, 174.20, 190.79 (Figure 4.15).

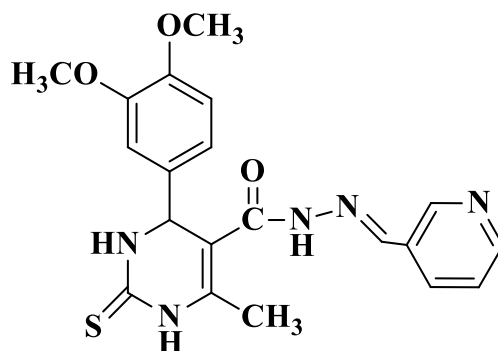


Figure 4.15 E)-4-(3,4-dimethoxyphenyl)-6-methyl-n'-(pyridin-3-ylmethylene)-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carbohydrazide (M14)

4.19 Synthesis of Ethyl anthranilate (M₁₅)

Compound was prepared through the following Figure 4.16:

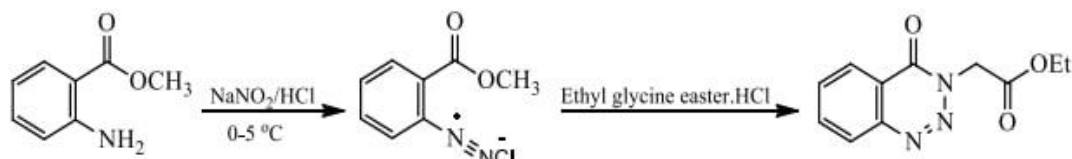


Figure 4.16 Ethyl anthranilate (M15)

Its preparation includes two steps, as shown above, since the first step includes the process of dialysis of the aromatic primary amine group of the compound (M₁₂₋₁₄) using nitrous acid (which is prepared instantaneously with sodium nitrite combined with the hydrochloric acid in the aqueous medium) to form diazonium salt, As for the second step, it includes the process of nucleophile substitution on the carbon atom in the carbonyl group, as an intermediate compound is formed that suffers from the replacement of the methoxide group, after which the compound suffers a self-cyclizing to form triazine, as shown in the following Figure 4.17

Suggested:

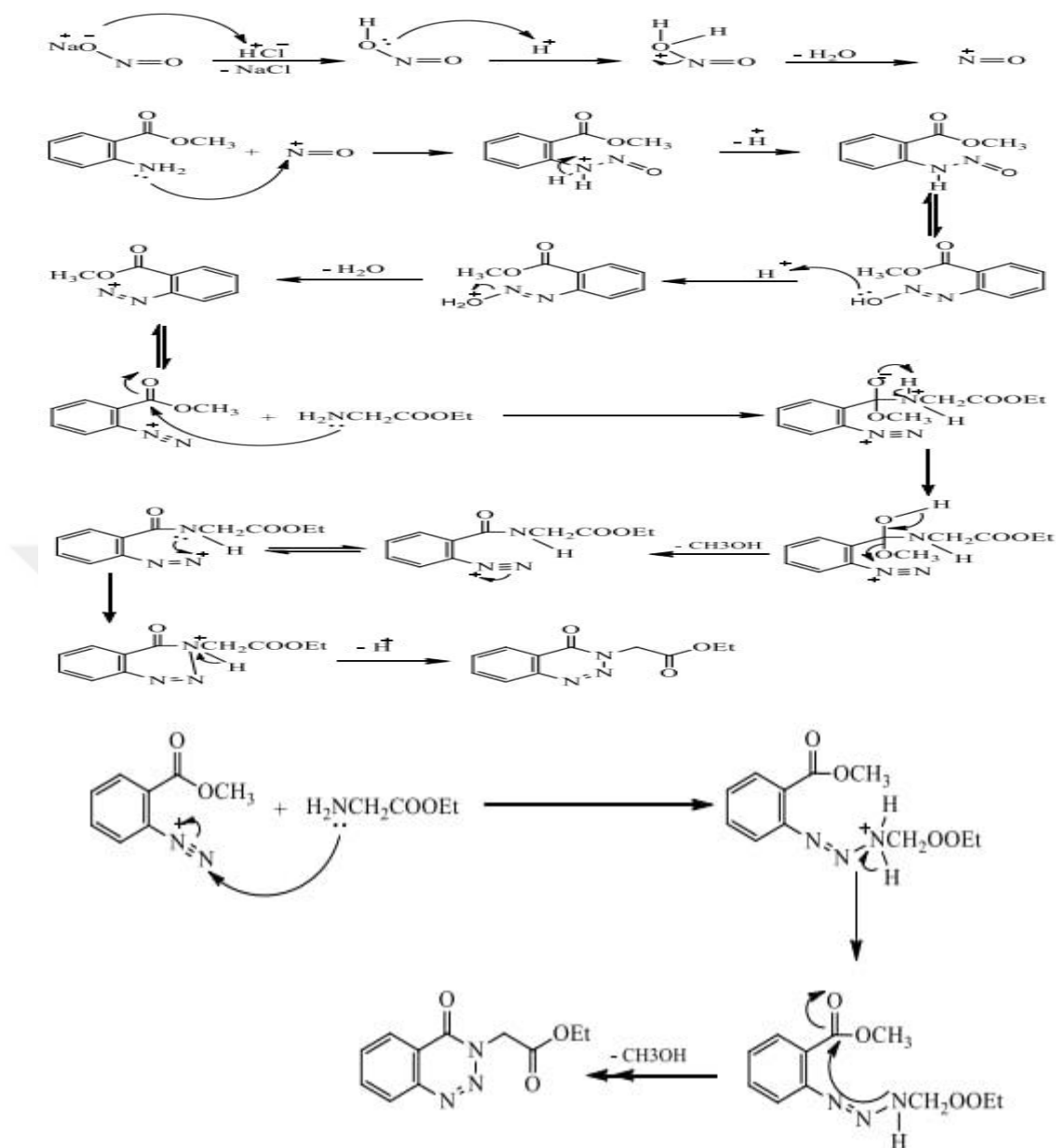


Figure 4.17 Synthesis of Ethyl anthranilate (M15)

The compound was identified by the infrared spectrum, as the spectrum gave two strong bands at the locations (1747 cm^{-1}) and (1685 cm^{-1}) due to the stretching of the ester and amide carbonyl groups ($\text{C}=\text{O}$), respectively, while the double bonding bands ($\text{C}=\text{C}$) appeared aromatics at frequencies ($1615\text{--}1488\text{ cm}^{-1}$). The high-resolution mass spectrometer gave a band at the location corresponding to the aster mass number.

4.20 Synthesis of Ethyl anthranilate (M15)

IR spectnim, ν , cm^{-1} : 3173 (NH str.), 3096 (Ar-CH str.), 2983 (aliphatic-CH str.), 1713 (C=O str.), 1602, 1450 (C=C str.), 1269 (C-N str.). ^1H NMR (DMSO) δ , ppm: 1.26(3H, t, CH₃), 4.26 (2, q, CH₂), 7.46 (2H, ddd, NH₂), 7.58-7.93(3H, m, Ar-CH), 7.93(2H, s, CH) ^{13}C NMR (DMSO) δ , ppm: 14.45, 61.02, 129.22, 130.36, 133.48, 18.08 (Figure 4.18).

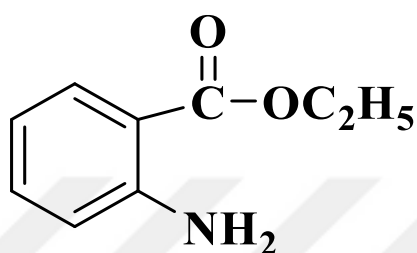


Figure 4.18 Ethyl anthranilate (M15)

4.21 Synthesis of Ethyl 2-(4-oxobenzo[d][1,2,3]triazine-3(4h)-yl) propanoate (M₁₆)

Hydrazide was prepared from the reaction of ester (M) with aqueous hydrazine in absolute ethanol. The mixture was escalated for (3) hours as per the following Figure 4.19:

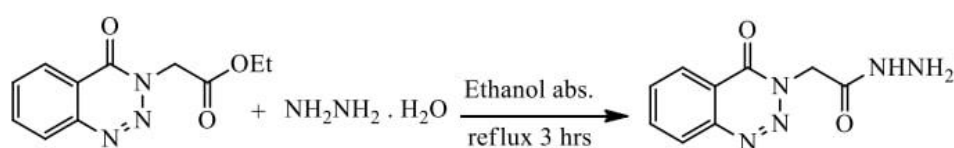


Figure 4.19 Ethyl 2-(4-oxobenzo[d][1,2,3]triazine-3(4h)-yl) propanoate (M₁₆)

The reaction takes place in two steps: the first is a nucleophile reaction of hydrazine on the carbonyl group, in which case the hybridization of the carbonyl carbon atom turns and the formation of an unstable intermediate compound. And the second step in which the intermediate compound suffers from the deletion of the methoxy group to give hydrazide as in the following mechanism (Figure 4.20):

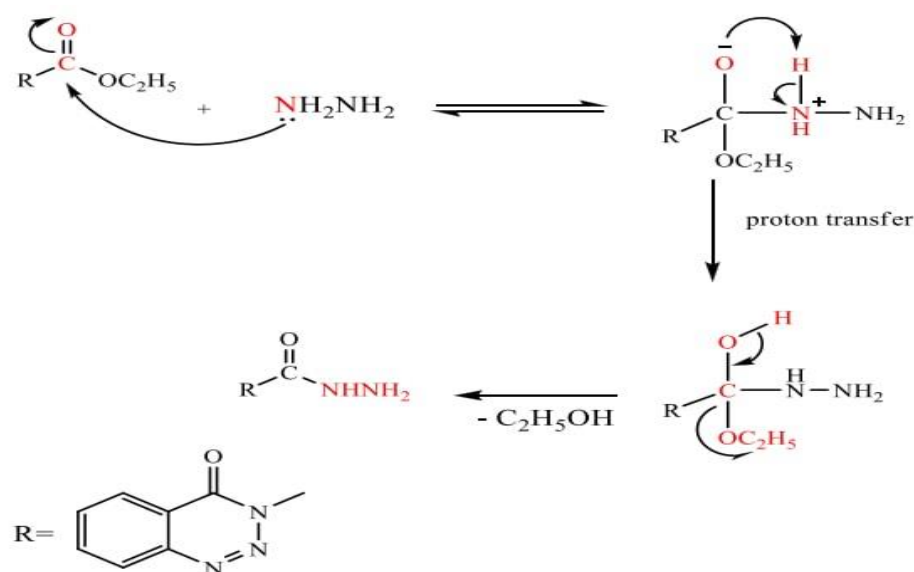


Figure 4.20 Nucleophile reaction of hydrazine on the carbonyl group

The resulting hydrazide was identified using the infrared spectrum as shown in Appendix 3, which showed a distinct and strong band at (3309 cm^{-1}) belonging to stretch (NH_2) and two bands at 1678 cm^{-1} and 1659 cm^{-1} belonging to the two carbonyl groups. Noting that the absorption of the carbonyl group of the hydrazide shifted it to a lower frequency compared to the absorption of the carbonyl group in the ester, and this is due to the presence of the resonance phenomenon in the hydrazide that leads to a reduction in the order of the double bond ($\text{C}=\text{O}$), and then the strength constant of this bond decreases and its frequency decreases.

The proton NMR spectrum also showed a single beam at the site (4.3 ppm) belonging to the hydrazide group, and the spectrum showed another single band at the location (5.0 ppm) belonging within methylene group.

Whereas the NMR spectrum of the isotope of carbon 13, as shown in appendices (Appendix 3, Appendix 4, Appendix 5, Appendix 6, Appendix 7, Appendix 8, Appendix 9, Appendix 10) a band at the site (13.51 ppm) belonging to the two carbon atoms of the methylene group, and also showed two bands for the two carbon atoms of the carbonyl groups at the two sites (166.12 and 170.13 ppm).

As for the high-resolution mass spectrum, it showed a beam at the location that represents the number of masses to hydrazide.

4.22 Ethyl 2-(4-oxobenzo[d][1,2,3]triazine-3(4h)-yl) propanoate (M₁₆)

IR spectnim, ν , cm^{-1} : 3173 (NH str.), 3096 (Ar-CH str.), 2983 (aliphatic-CH str.), 2865 (CH 1713 (C=O str.), 1572, 1450 (Ar-C=C str.), 1367 (G bend CH3 str.)1269 (C-N str.). ¹H NMR (DMSO), δ , ppm: 1.15(3H, d, CH₃)1.26 (3H, t, CH₃), 4.26 (2H, q, CH), 7.46-7.93 (5H, m, Ar-CH), 7.58(1H, q, CH) ¹³C NMR (DMSO), δ , ppm: 14.45. 39.89, 51.13, 119.85, 124.96, 128.54, 133.51,136.00,144.27,166.12,170.13 (Figure 4.21).

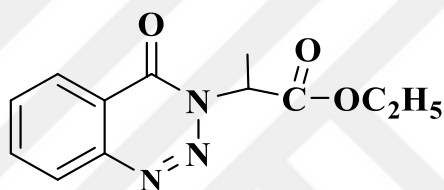


Figure 4.21 Ethyl 2-(4-oxobenzo[d][1,2,3]triazine-3(4h)-yl) propanoate (M₁₆)

4.23 2-(4-Oxobenzo[d][1,2,3]triazine-3(4h)-yl) propanehydrazide (M₁₇)

IR spectnim, ν , cm^{-1} : 3297-3196 (NH str.), 3078 (Ar-CH str.), 2987 (aliphatic-CH str.), 2824 (CH str.) 1700, (C=O str.), 1659, 1411 (C=C str.), 1388 (C-H bend), 1334 (C-N str.). ¹H NMR (DMSO), δ , ppm: 4.50 (2H, s, NH₂), 7.41-7.81 (5H, m, Ar-CH), 9.77(1H, s, NH). ¹³C NMR (DMSO), δ , ppm: 40.39, 127.39, 128.73, 131.48, 133.74, 166.41 182.9 (Figure 4.22).

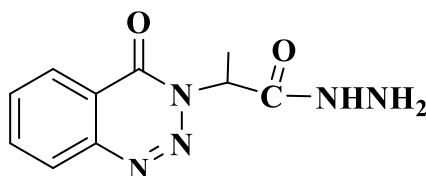


Figure 4.22 2-(4-Oxobenzo[d][1,2,3]triazine-3(4h)-yl) propanehydrazide (M₁₇)

4.24 2-(4-Oxobenzo[D][1,2,3]triazino-3(4h)-yl-met hyl carbo)hydrazone (M18-22)

Compounds (11-15) were prepared from the condensation of the prepared hydrazide compound with benzaldehyde substitutes using absolute ethanol as a solvent for the reaction and as shown in Figure 4.23, as the mixture increments and 3 hours passed, the reaction will take place as follow:

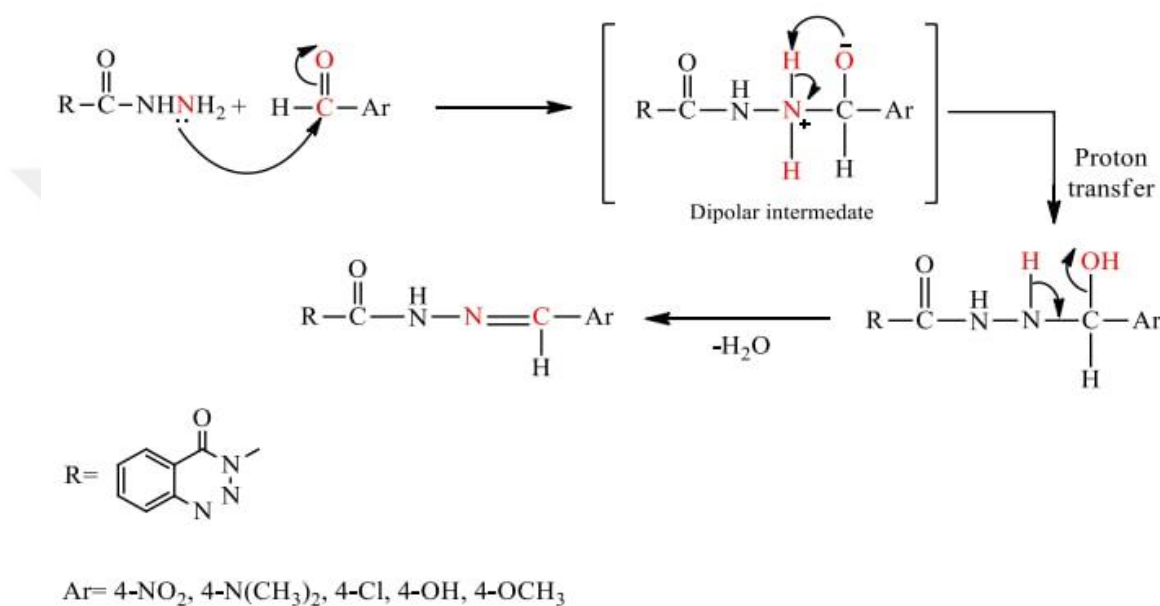


Figure 4.23 2-(4-Oxobenzo[D][1,2,3]triazino-3(4h)-yl-met hyl carbo)hydrazone (M18-22)

Hydrazone compounds (15-A11) were identified by means of the infrared spectrum, as shown in appendices 4, as it showed bands due to the stretching of the vibration of the (N-H) bond in the range (3250-3156 cm^{-1}), and the spectrum showed distinct bands at the frequency range (1665-1714 cm^{-1}) refers to the stretching of the two carbonyl groups (CO) and the appearance of absorption bands of the stretching group (CN) in the frequency domain (1654-1600 cm^{-1}), while the aromatic (C=C) bonding bands appeared at the range 1411-1604 cm^{-1} , which Sometimes it is nested with the sum of the group (C=N). As shown appendices (Appendix 11, Appendix 12, Appendix 13, Appendix 14).

The compounds were diagnosed using the proton nuclear magnetic resonance spectrum, as the spectrum gave a single band dating back to (1H, N=CH) at (8.6-8.5 ppm) and a single band dating back to (1) at the range (ppm 11.9-12.2).

While the nuclear magnetic resonance spectrum of the carbon-13 isotope, as shown in appendices 5, showed the following bundles of compound carbon atoms (A13), where the carbon atoms of the triazine ring, including the carbon of the cyclic carbonyl group, appeared at the following positions (121.79, 121.67)163.77 ppm). 128.64, 130.88, 136.22, 148.74, and the carbon atoms of the aromatic ring bearing the nitro group appeared at the following sites (124.78, 125.05 42.80) (155.37 ppm). As for the carbon atom of the carbonyl group, it appeared at (168.74 ppm), which was in the hydrazide compound at (170.13 ppm). as shown in appendices (Appendix15, Appendix 16, Appendix 17, Appendix 18).

4.25 N'-(anthracen-9-ylmethylene)-2-(4-oxobenzo[d][1,2,3]triazin-3(4h)-yl)propanehydrazide (M₁₈)

IR spectrum, ν , cm⁻¹: 3189 (NH str.), 3082 (Ar-CH str.), 2986 (aliphatic- CH str.), 2862 (CH str.) 1700 (C=O str.), 1647 (C=N str.), 1622 (G=N str.), 1542 (C=C str.), 1369 (C-H bend), 1333 (C-N str.). ¹H NMR (DMSO), δ , ppm: 2.95(3H, q, CH) 7.57-8.74 (13H, m, Ar-CH), 8.74 (1H, s, CH), 9.65 (1H, s, NH) ¹³C NMR (DMSO), δ , ppm: 40.44, 125.34, 126.03, 127.66, 128.09, 129.05, 130.10, 147.4d, 163.51 (Figure 4.24).

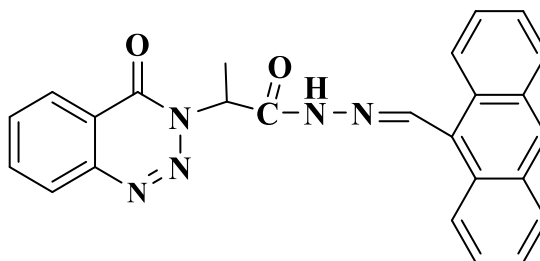


Figure 4.24 N'-(anthracen-9-ylmethylene)-2-(4-oxobenzo[d][1,2,3]triazin-3(4h)-yl)propanehydrazide (M₁₈)

4.26 N'-(2-chlorobenzylidene)-2-(4-oxobenzo[d][1,2,3]triazin-3(4h)yl)propanehydrazide (M19)

IR spectrum. ν , cm^{-1} : 3220 (NH str.), 3088 (Ar-CH str.), 2986 (aliphatic-CH str.), 2810 (CH str.) 1714. (C=O str.). 1643 (C=N str.). 1556, 1468 (C=C str.). 1358 (CH bend CH₃), 1283 (C-N str.). 758 (C-Cl). ¹H NMR (DMSO). δ , ppm: 1.03 (3H, d, CH₃) 7.41-8.01 (8H, m, Ar-CH), 8.86 (1H, q, CH) 12.07 (1H, s, NH), ¹³C NMR (DMSO), δ , ppm: 19.00 127.33, 128.08, 128.94, 130.36, 131.90, 132.06, 132.36, 133.63, 144.13, 163.63 (Figure 4.25).

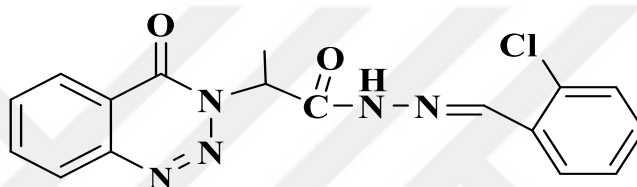


Figure 4.25 N'-(2-chlorobenzylidene)-2-(4-oxobenzo[d][1,2,3]triazin-3(4h)yl)propanehydrazide (M19)

4.27 N'-(3,4-dimethoxybenzylidene)-2-(4-oxobenzo[d][1,2,3]triazin-3(4h)-yl)propanehydrazide (M₂₀)

IR spectrum, ν , cm^{-1} : 3223 (NH str.). 3092 (Ar-CH str.), 2970 (aliphatic-CH str.), 1717 (C=O str.), 1642 (C=N str.), 1598, (C=C str.), 1370 (CH bend CH₃), 1331 (C-N str.). ¹H NMR (DMSO), δ , ppm: 1.05 (3H, d, CH₃) 3.78 (6H, s, OCH₃), 6.98-7.91 (8H, or, Ar-CH), 8.39 (1H, q, CH), 11.77 (1H, s, NH). ¹³C NMR (DMSO), δ , ppm: 40.40, 55.92, 108.65, 111.89, 122.39, 127.50, 128.02, 128.88, 132.07, 148.56, 149.55, 151.24, 163.55 (Figure 4.26).

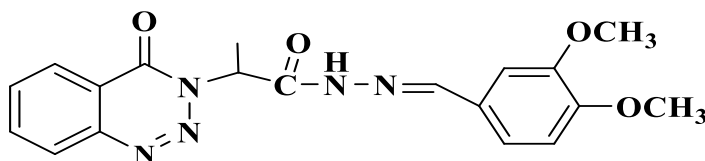


Figure 4.26 N'-(3,4-dimethoxybenzylidene)-2-(4-oxobenzo[d][1,2,3]triazin-3(4h)-yl)propanehydrazide (M₂₀)

4.28 4-Hydroxyphenyl-(4-oxobenzo[d][1,2,3]triazino-3(4h)-y-l-3-carbo)hydrazone (M₂₁)

IR spectrum, ν , cm⁻¹: 3226 (NH str.) 3070 (Ar-CH str.), 2988(aliphatic- CH str.), 1658 (C=O str.), 1620 (C=N str.), 1559, 1468 (C=C str.), 1352 (CH bend CH₃), 1332 (C-N str.). H NMR (DMSO), δ , ppm: 7.51-8.47 (8H, m, Ar-CH), 8.59(1H, q, CH) 12.04 (1H, s, NH). ¹³C NMR (DMSO), δ , ppm: 40.49, 120.36. 124.84. 128.15. 132.40, 133.63, 137.31, 148.50, 149.96, 153.73, 163.85 (Figure 4.27).

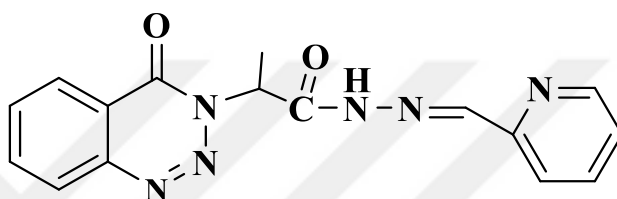


Figure 4.27 4-Hydroxyphenyl-(4-oxobenzo[d][1,2,3]triazino-3(4h)-y-l-3-carbo)hydrazone (M₂₁)

4.29 4-Methylphenyl-(4-oxobenzo[d][1,2,3] triazino-3(4h)-y-l-3-carbo)hydrazone (M₂₂)

IR spectrum, ν , cm⁻¹: 3407 (NH str.), 3084 (Ar-CH str.), 2986 (aliphatic- CH str.), 1656 (C=O str.), 1632 (C=N str.), 1592 (C=C str.), 1366 (CH bend CH₃), 1294 (C-N str.). H NMR (DMSO), δ , ppm: 7.45-8.58 (9H, m, Ar-CH), 8.84 (1H, s, CH), 12.01 (1H, s, NH). ¹³C NMR DMSO). δ , ppm: 124.43, 128.11, 128.94, 130.59, 132.33, 133.75 145.52, 149.17, 151.14, 163.75 (Figure 4.28, Figure 4.29, Figure 4.30).

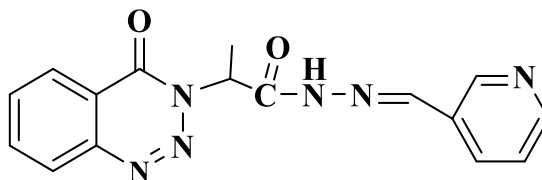
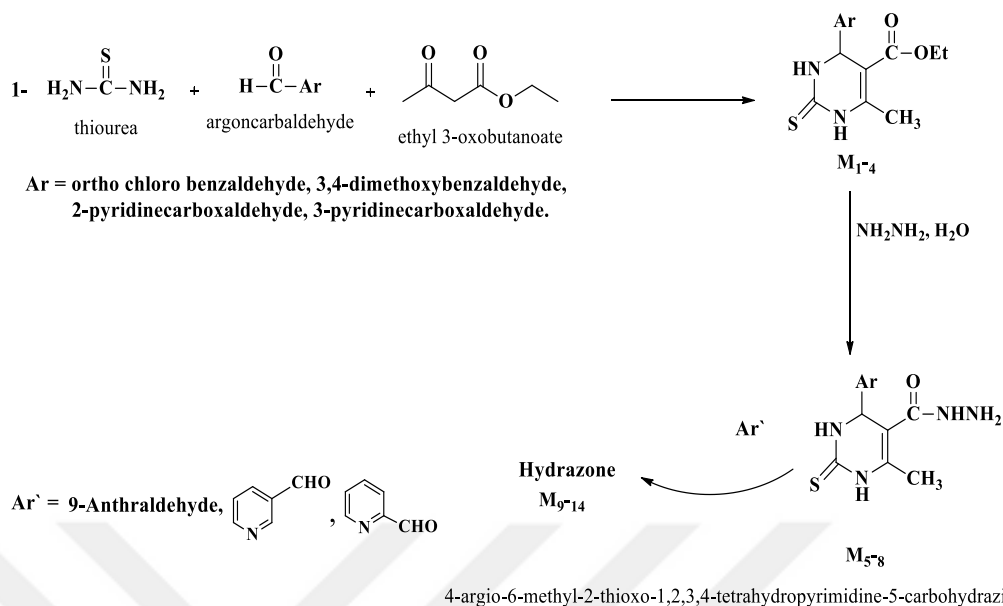
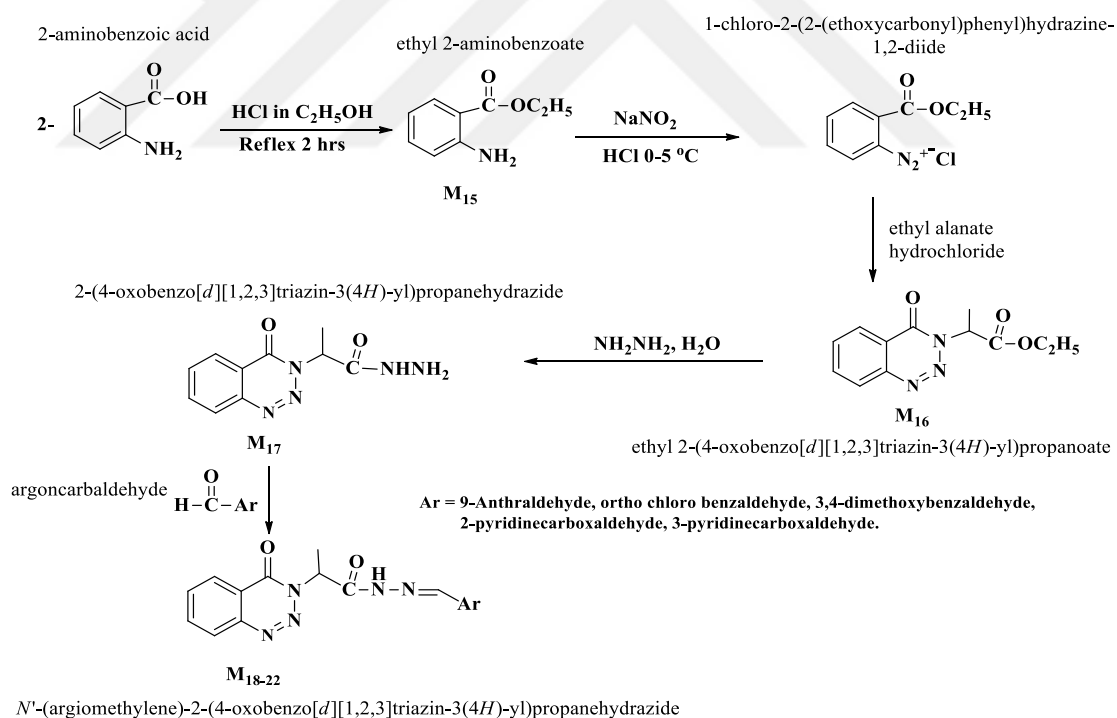


Figure 4.28 4-Methylphenyl-(4-oxobenzo[d][1,2,3] triazino-3(4h)-y-l-3-carbo)hydrazone (M₂₂)

**Figure 4.29** Synthesis of hydrozones M(1-17)**Figure 4.30** Synthesis of hydrozones M(18-22)

5. CONCLUSIONS AND RECOMMENDATION

The Hydrazone and its derivated groups are known in the medical sectors due to the effects against inflammation and in this paper we covered the compounds and the associated feature regarding the importance in using them for the anti-inflammatory potential. Additionally, the paper covered the effects of the substitutions from the reaction and their effects as an anti-inflammatories.

As a summarization, the study giuded in the direction of using the feature of anti-inflammatory and covering the safety of the usage of the Hydrazone derivatives and substitutions with the least risks of allergic effects in the future.

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APPENDICES

APPENDIX 1. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 2. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 3. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 4. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 5. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 6. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 7. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 8. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 9. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 10. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 11. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 12. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 13. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)

APPENDIX 14. A Infrared (IR) Spectrum (M 1), B Infrared (IR) Spectrum

APPENDIX 15. A Infrared (IR) Spectrum, B Infrared (IR) Spectrum

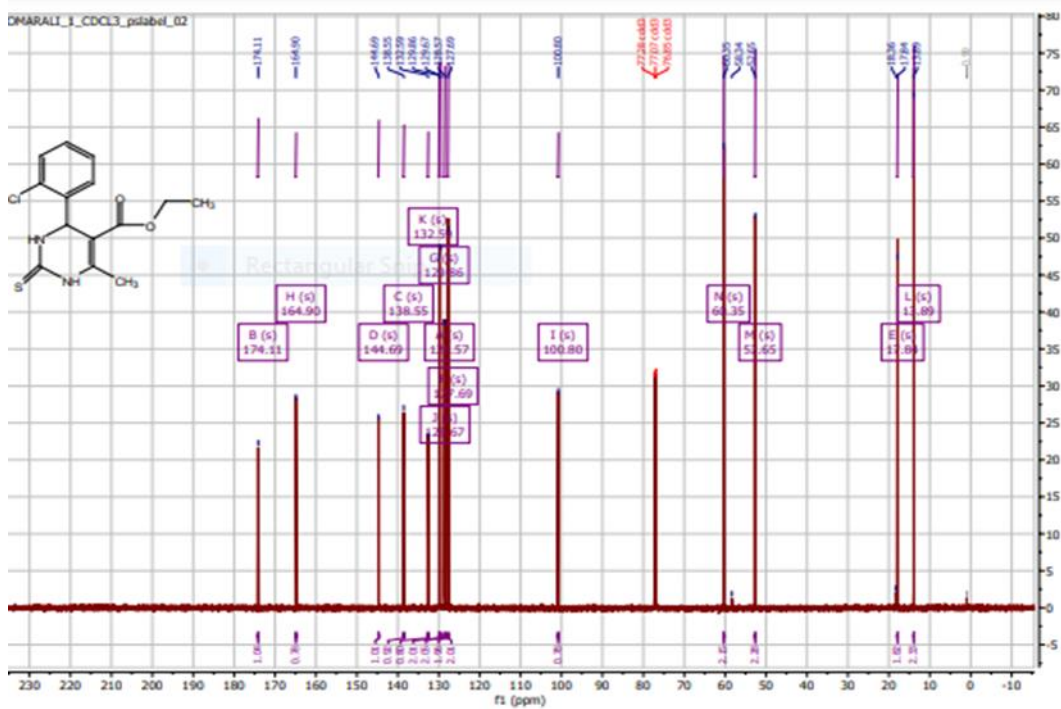
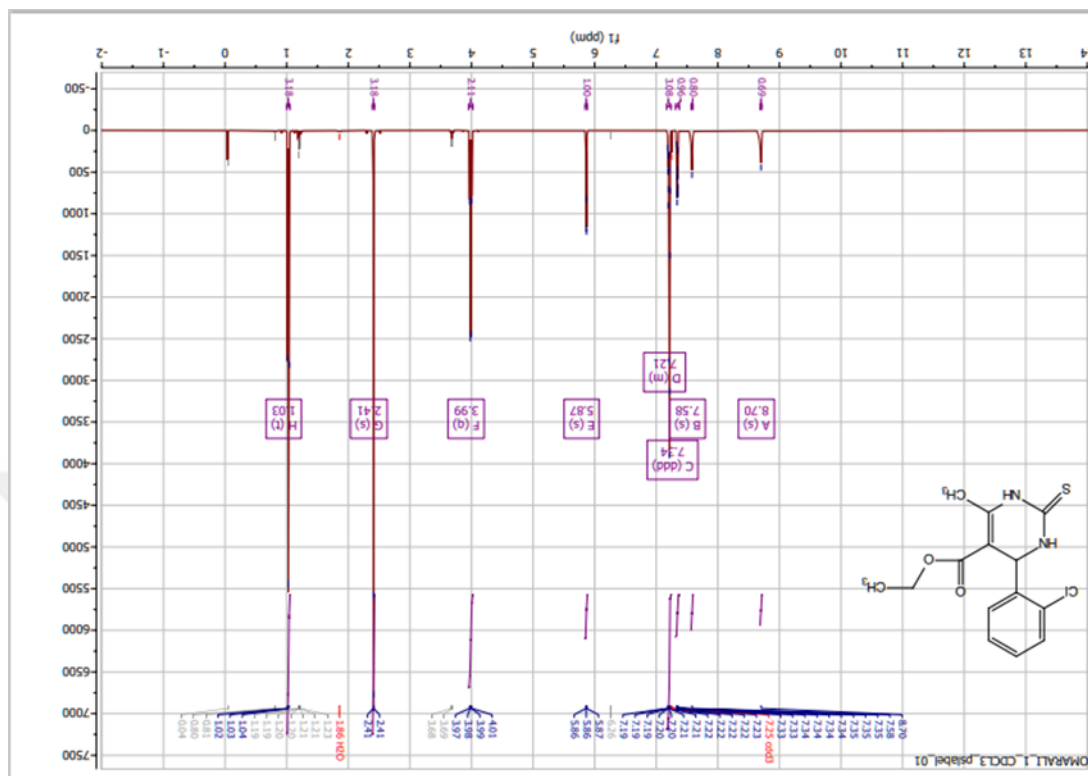
APPENDIX 16. Infrared (IR) Spectrum

APPENDIX 17. (NMR spectrum of APT-APT-'H)

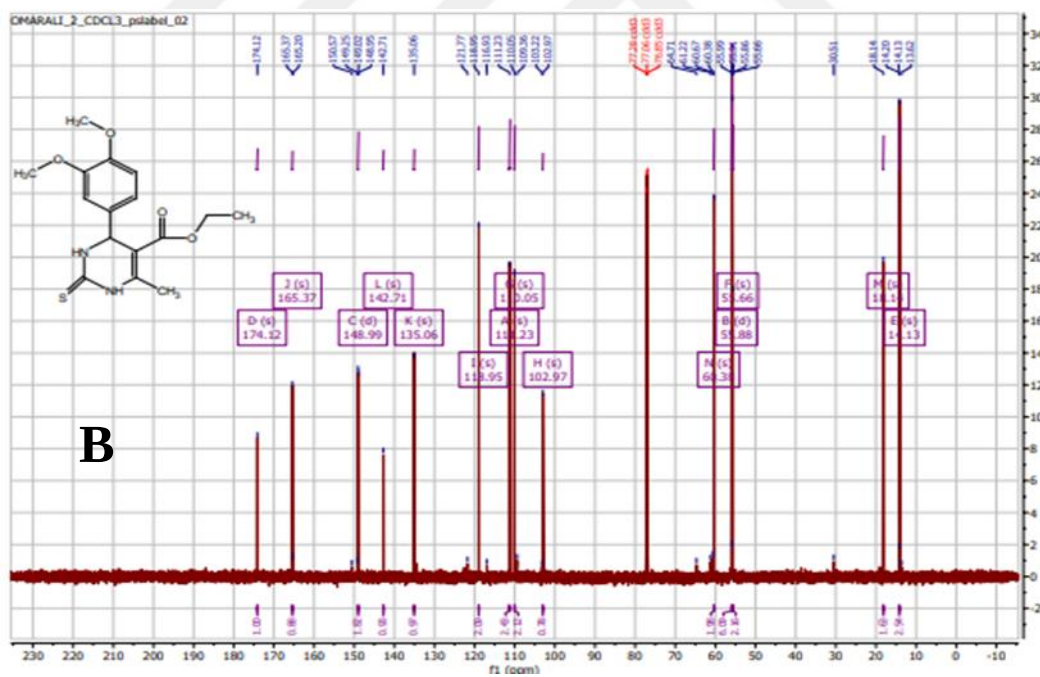
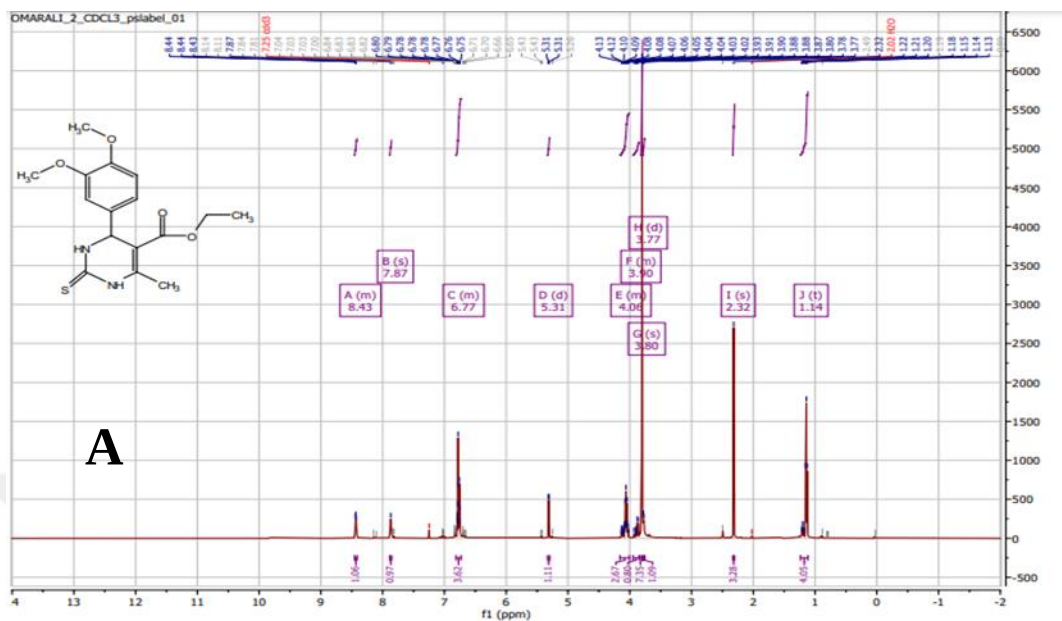
APPENDIX 18. (NMR spectrum of APT-APT-13C)



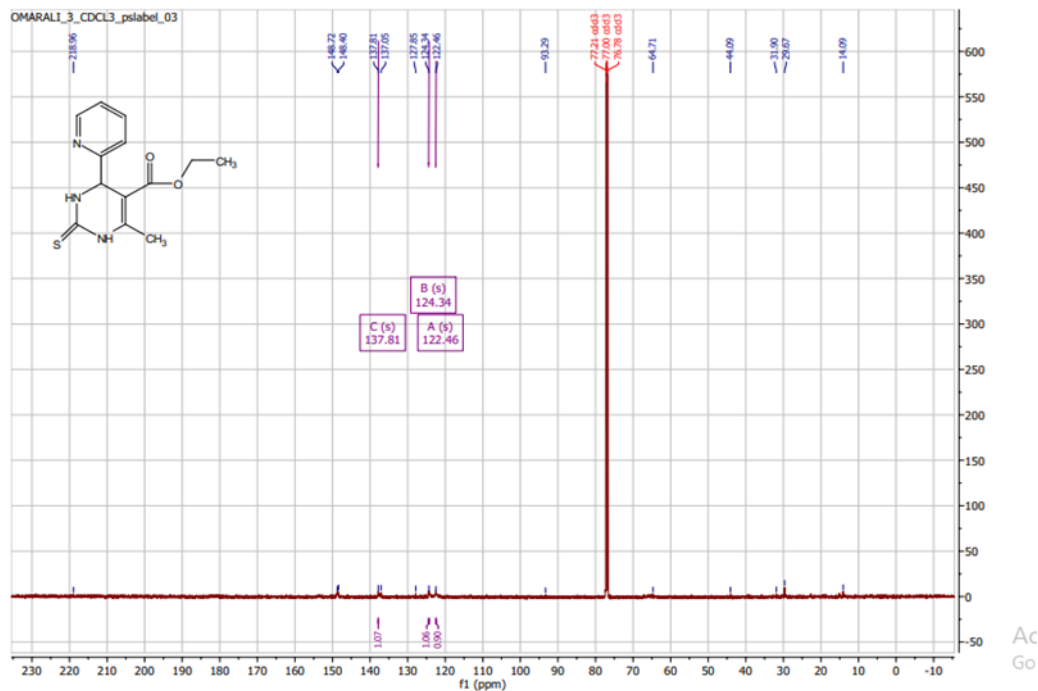
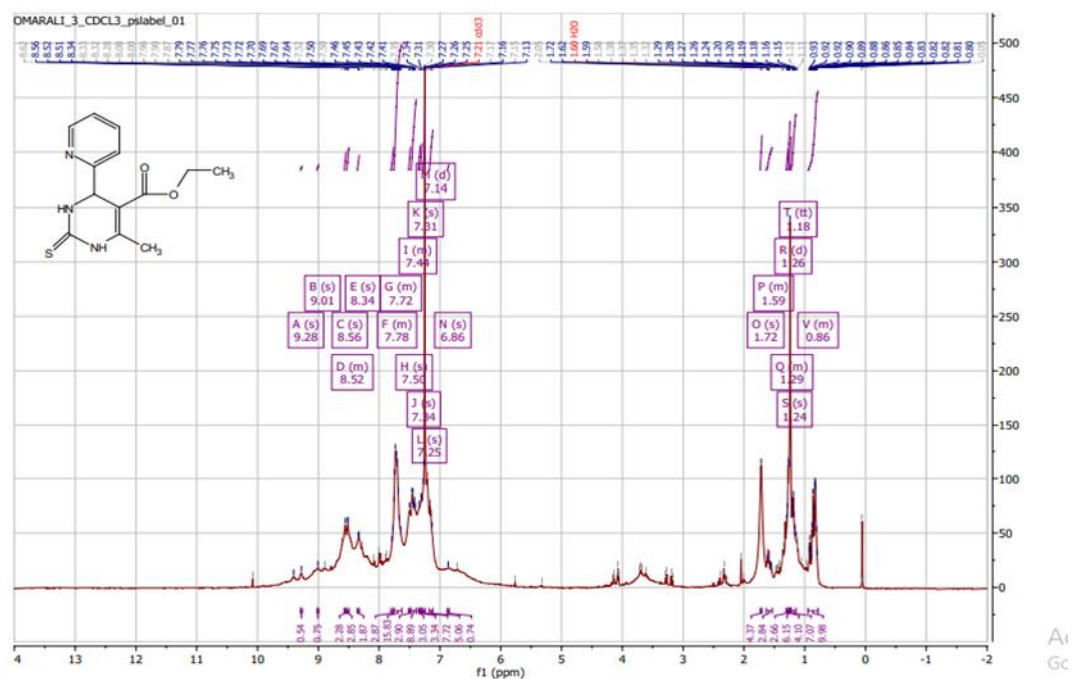
APPENDIX 1. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



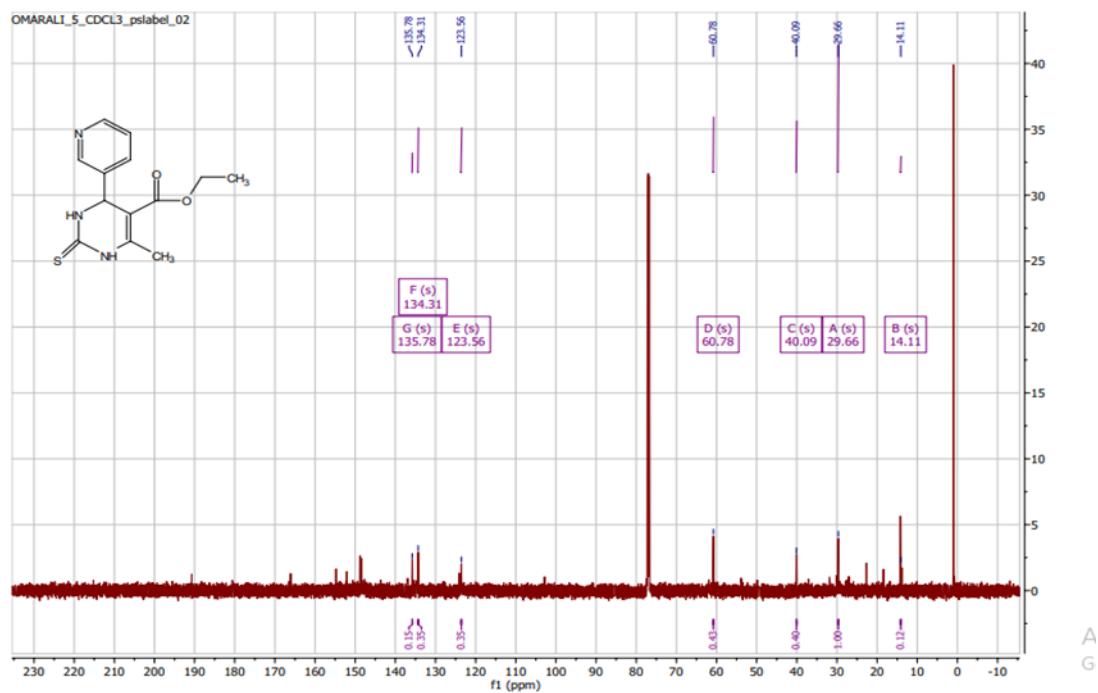
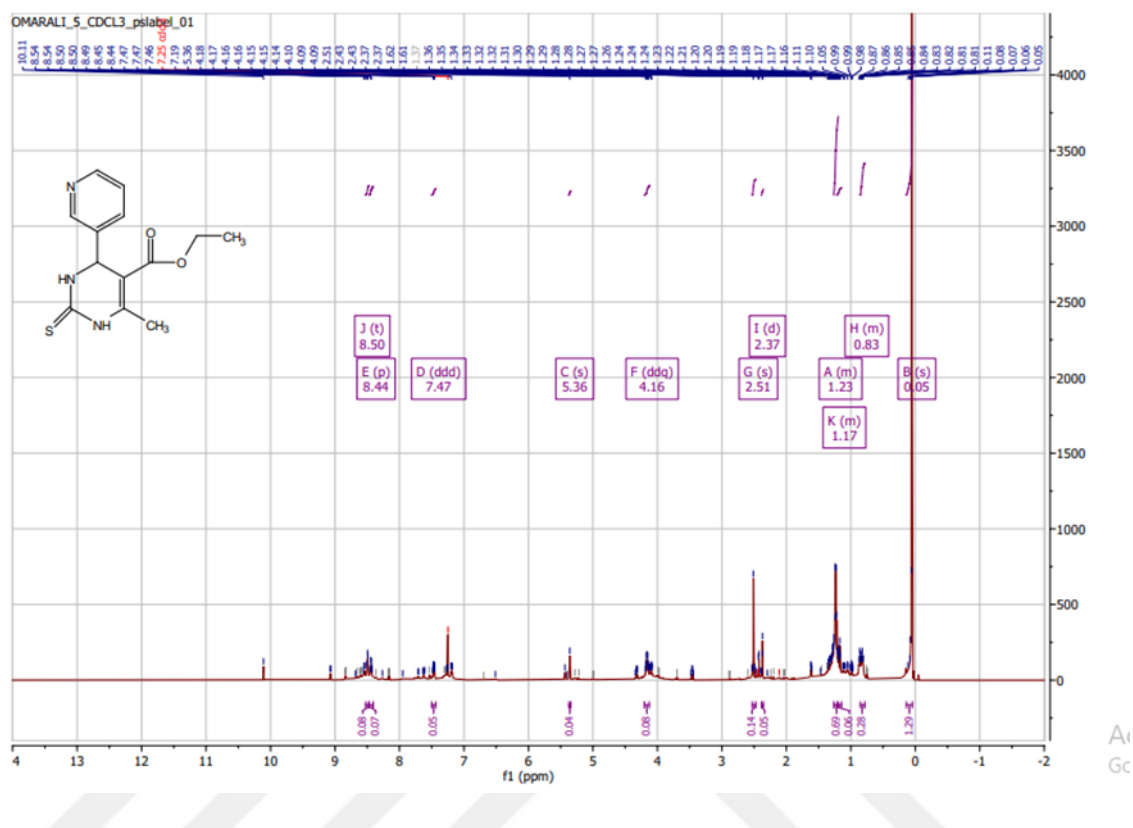
APPENDIX 2. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



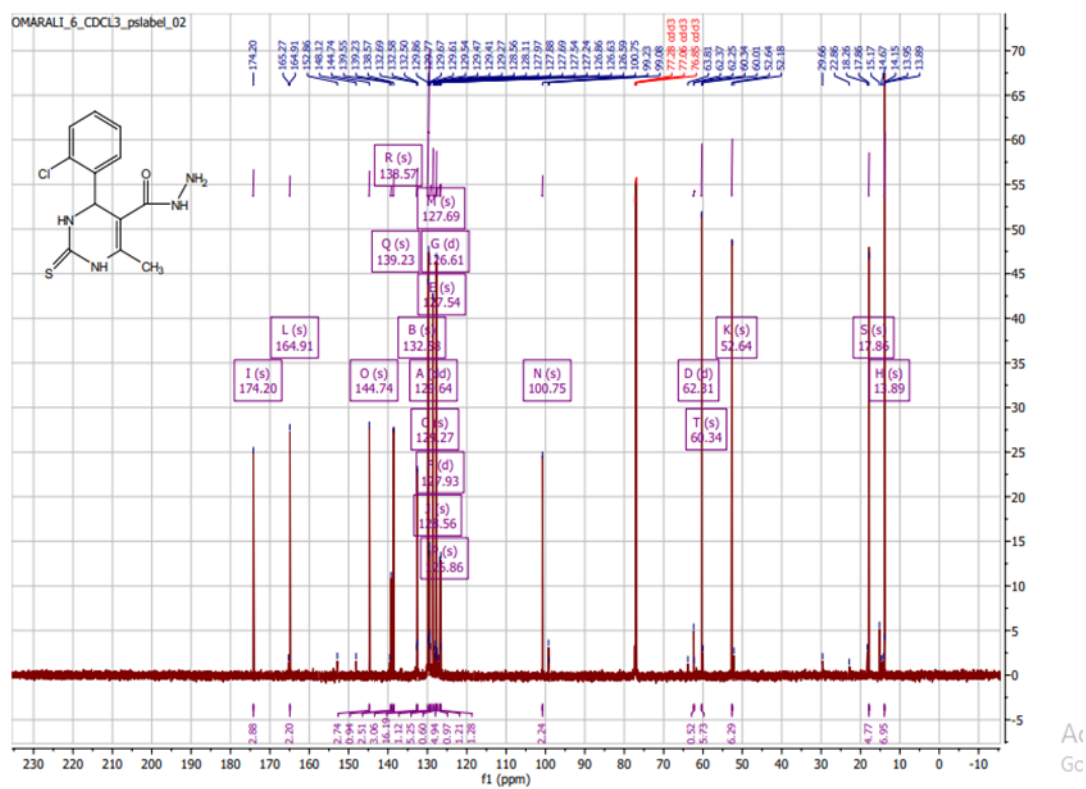
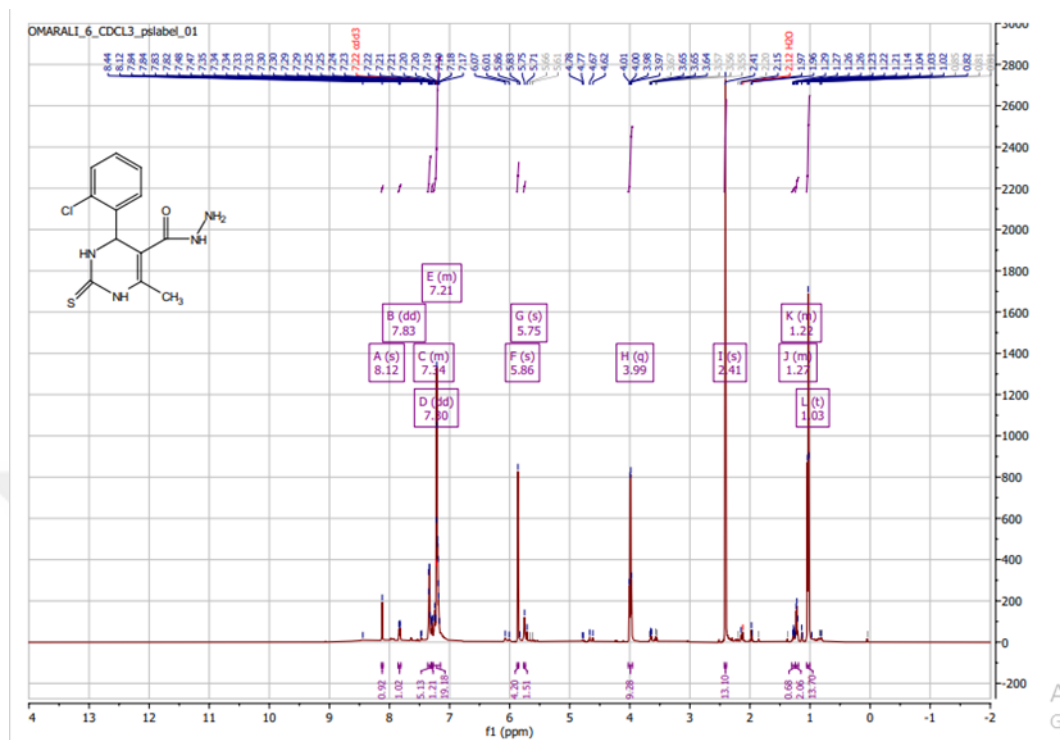
APPENDIX 3. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



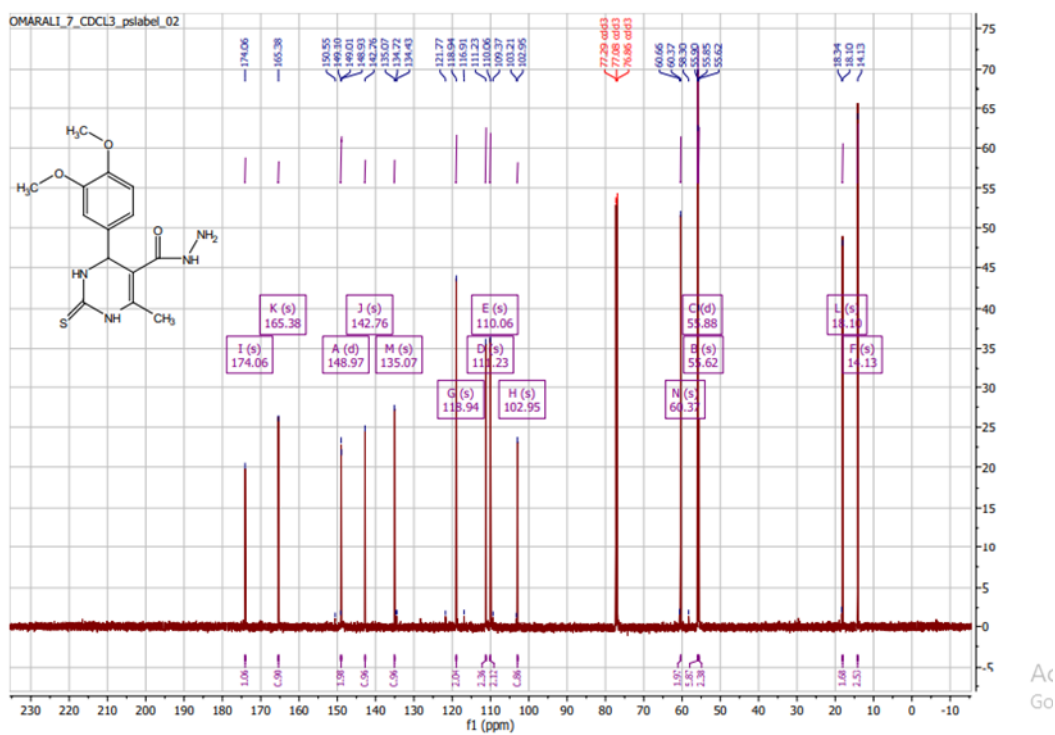
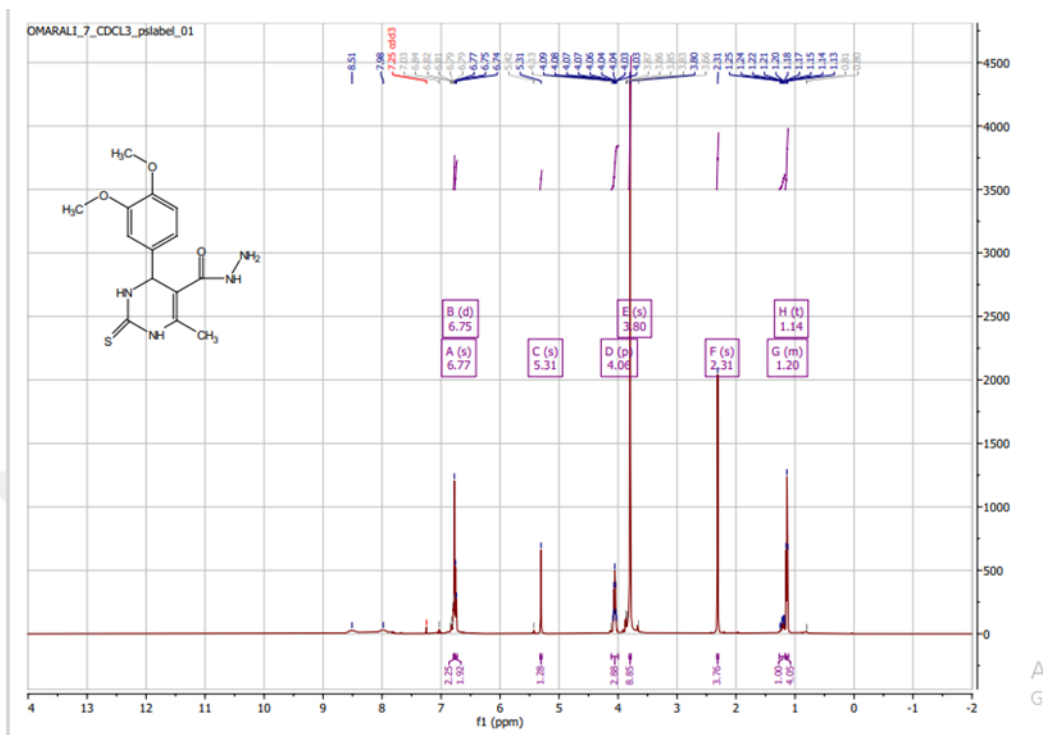
APPENDIX 4. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



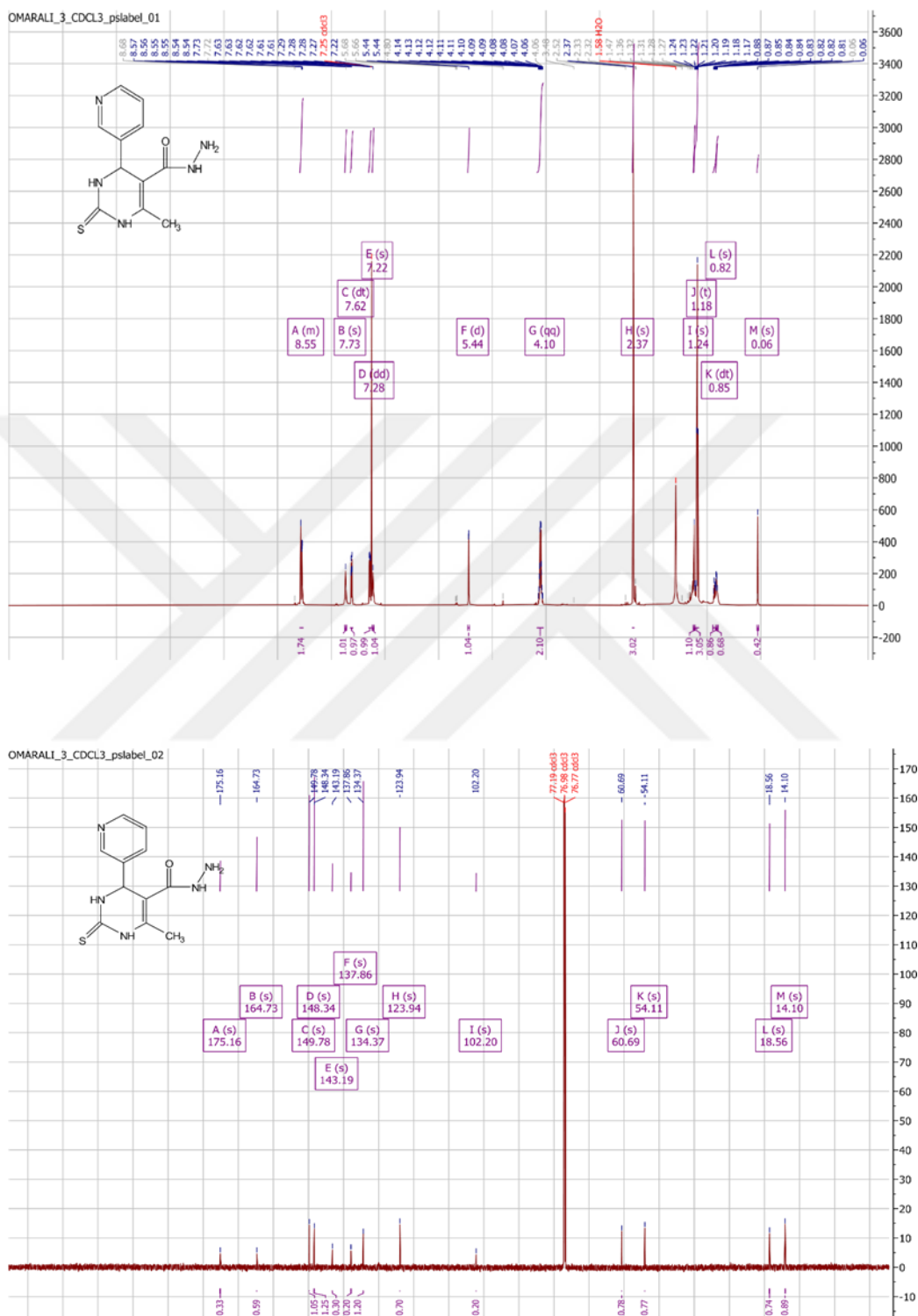
APPENDIX 5. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



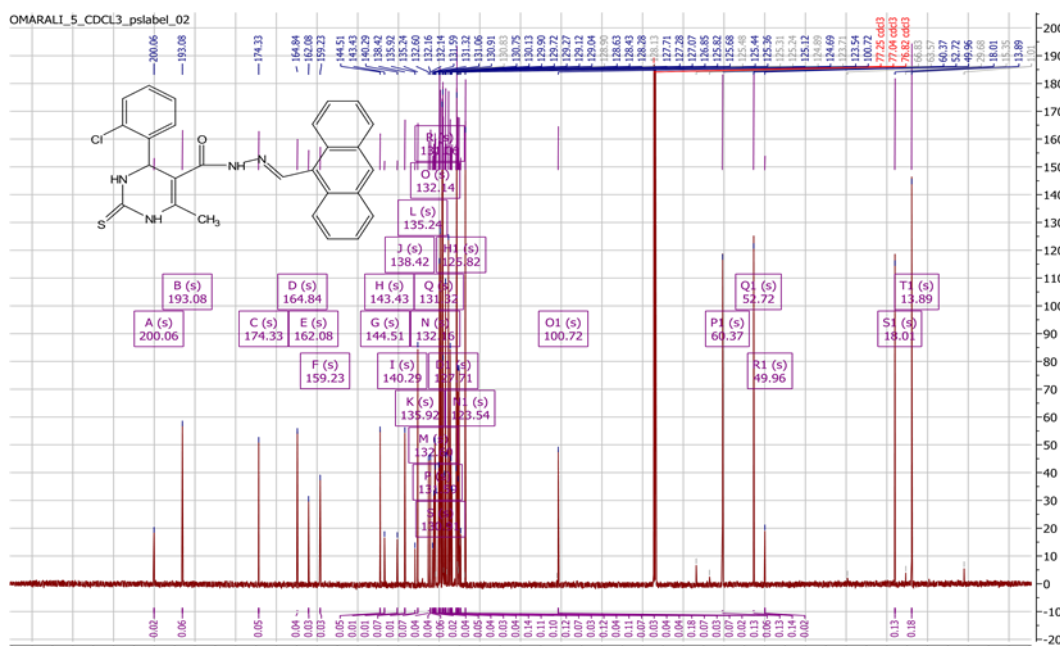
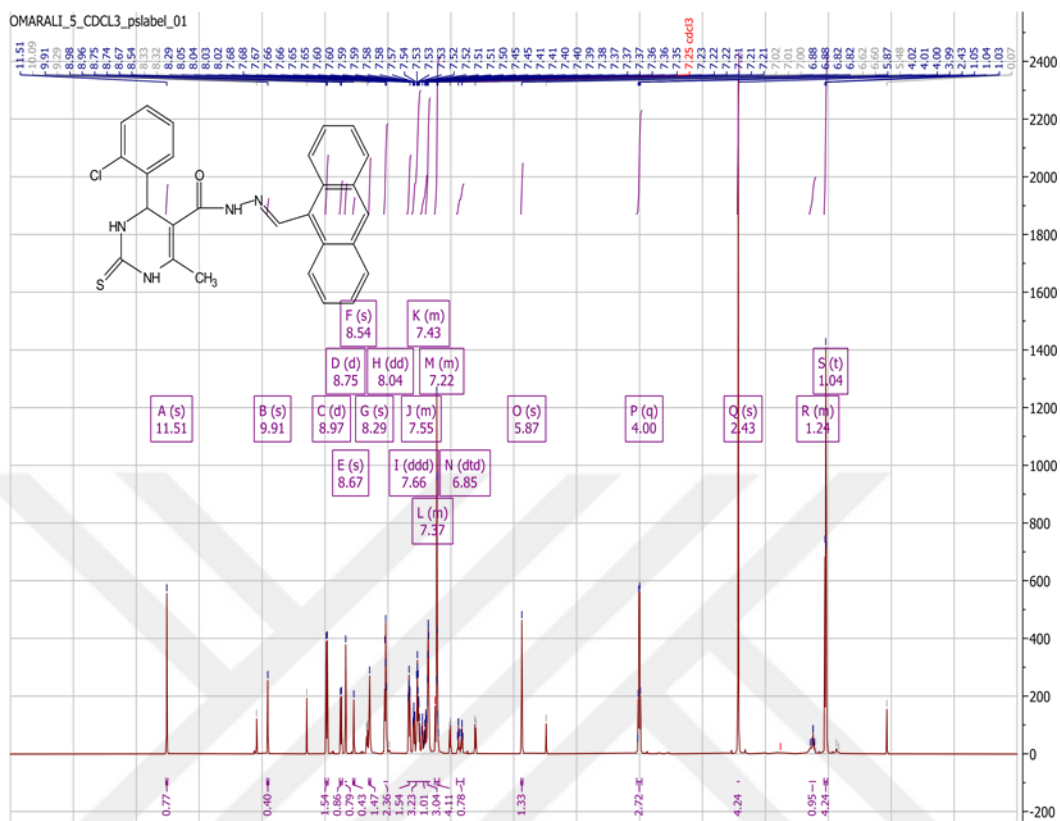
APPENDIX 6. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



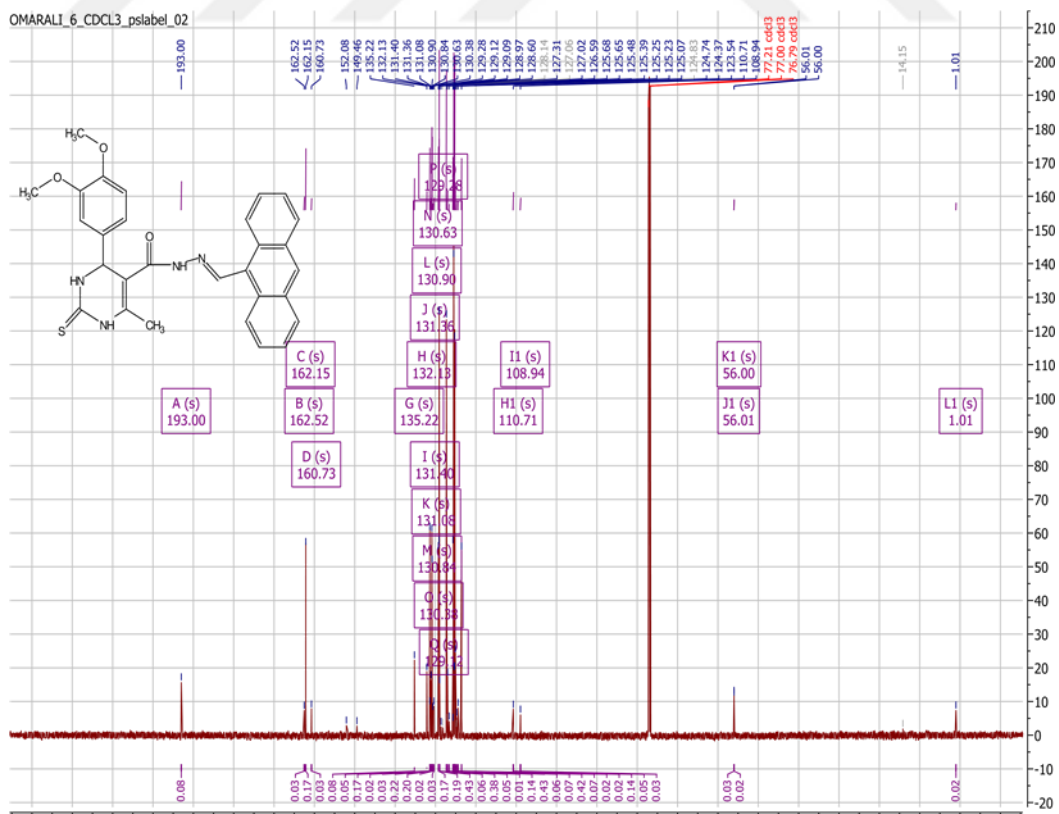
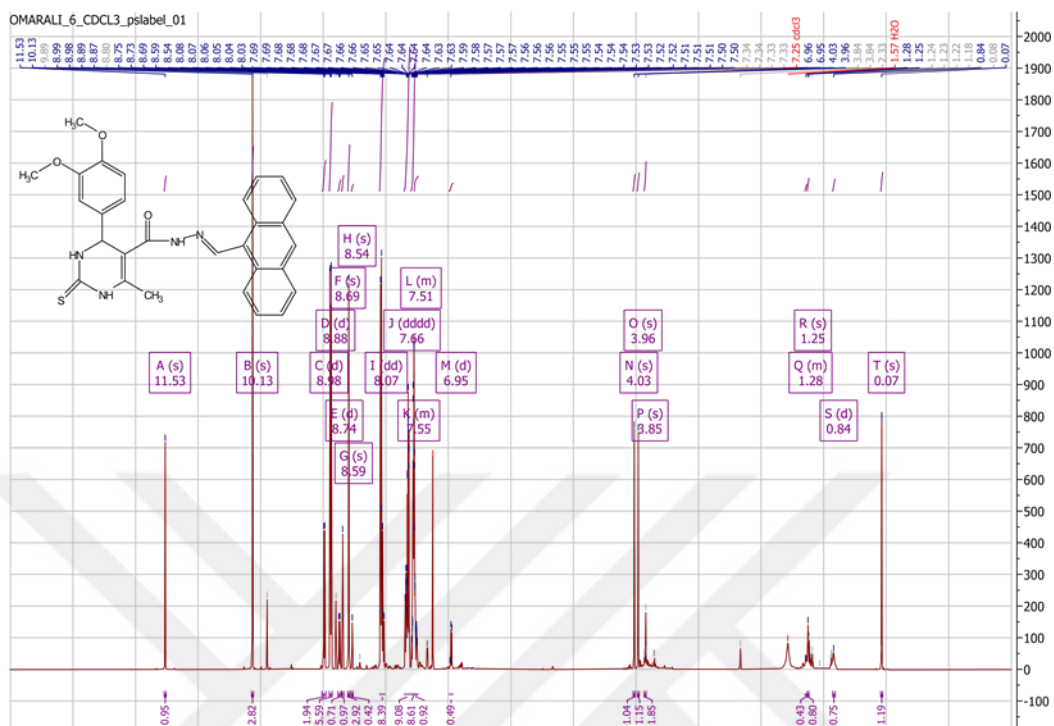
APPENDIX 7. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



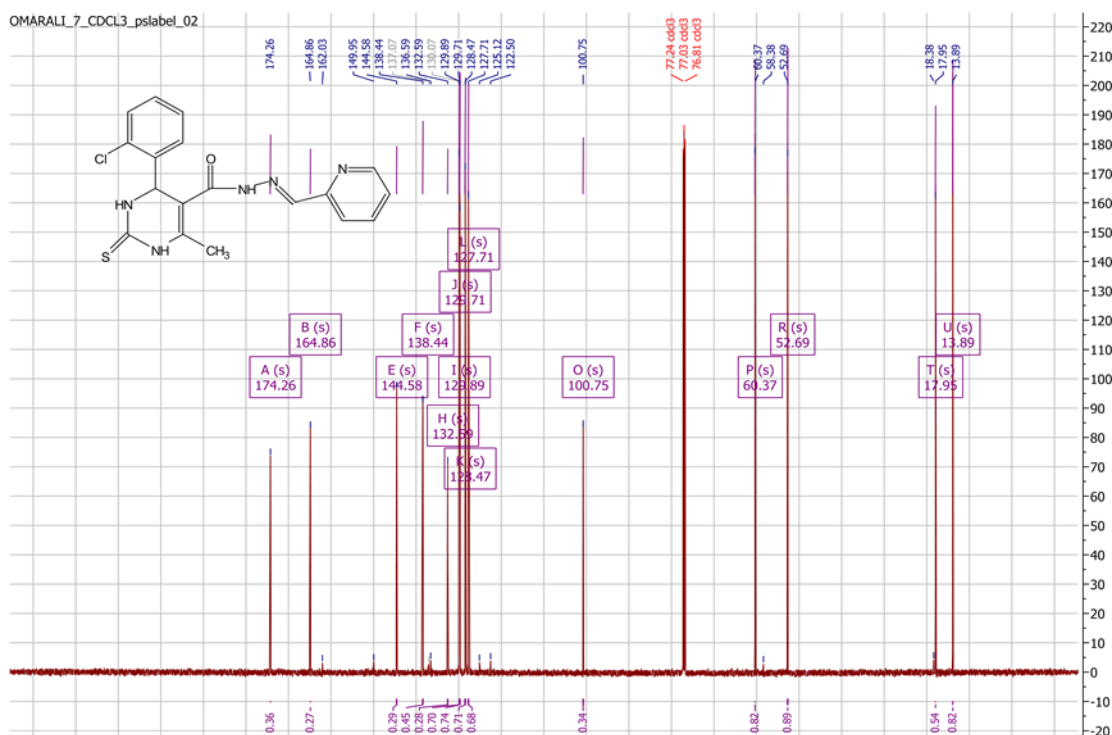
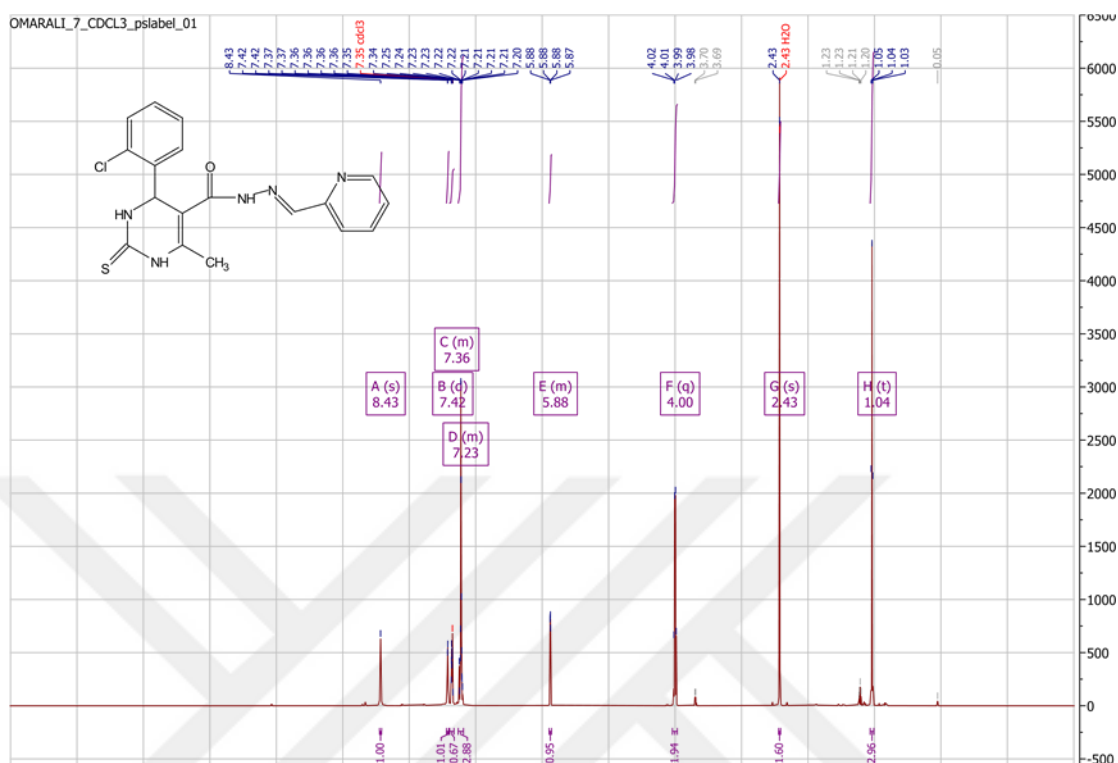
APPENDIX 8. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



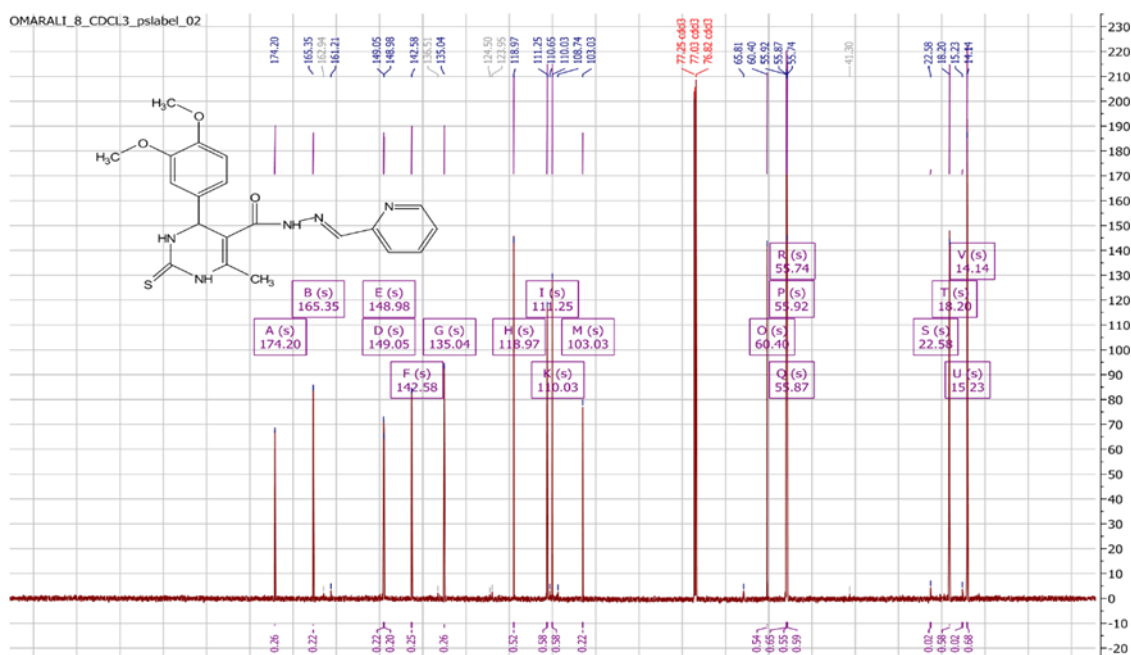
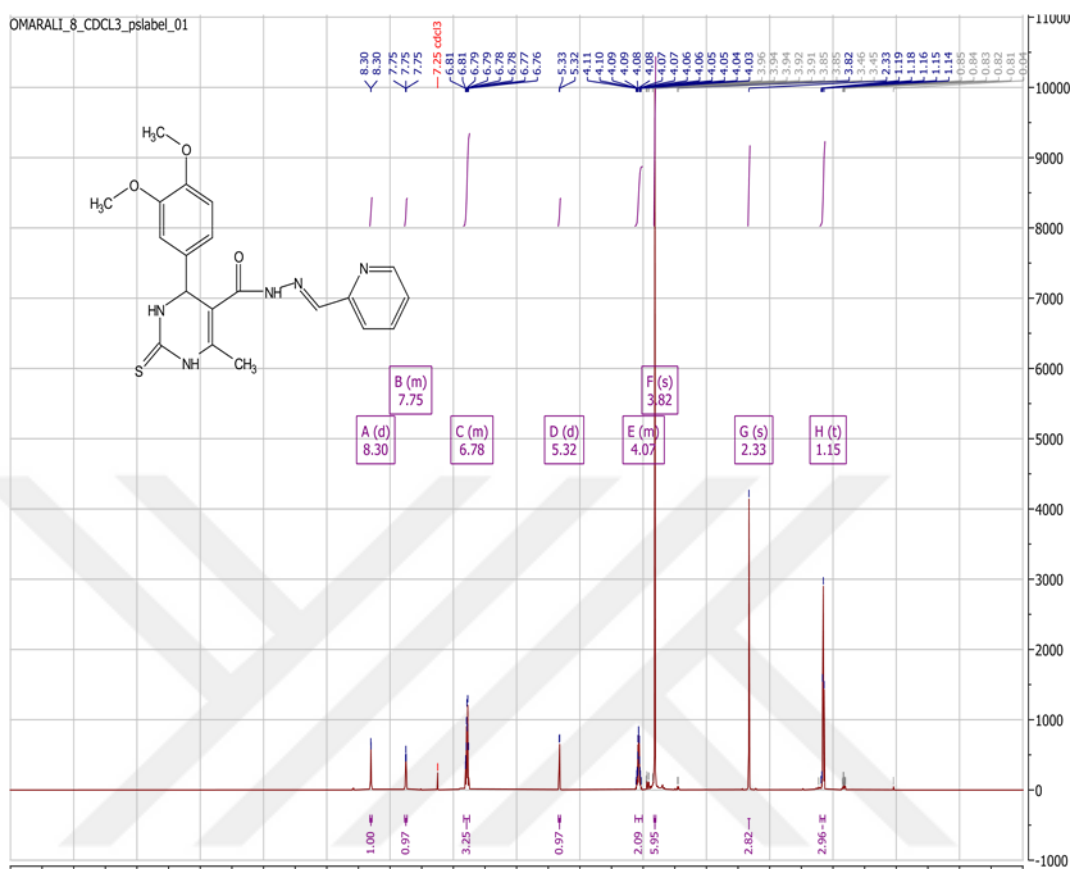
APPENDIX 9. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



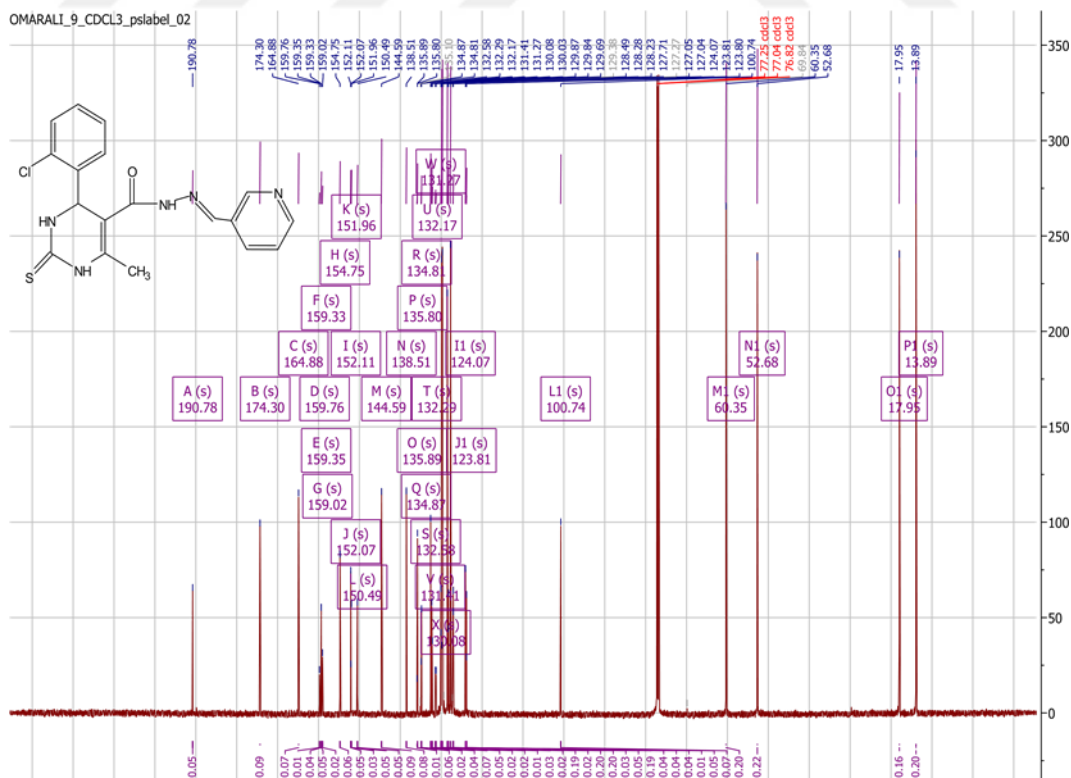
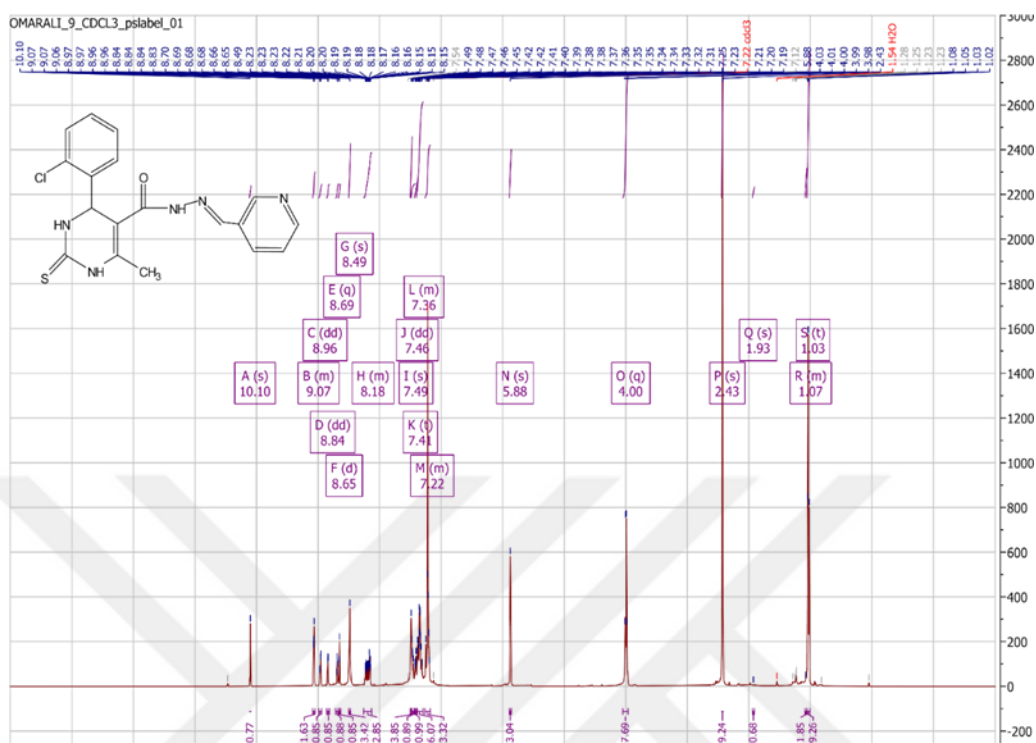
APPENDIX 10. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



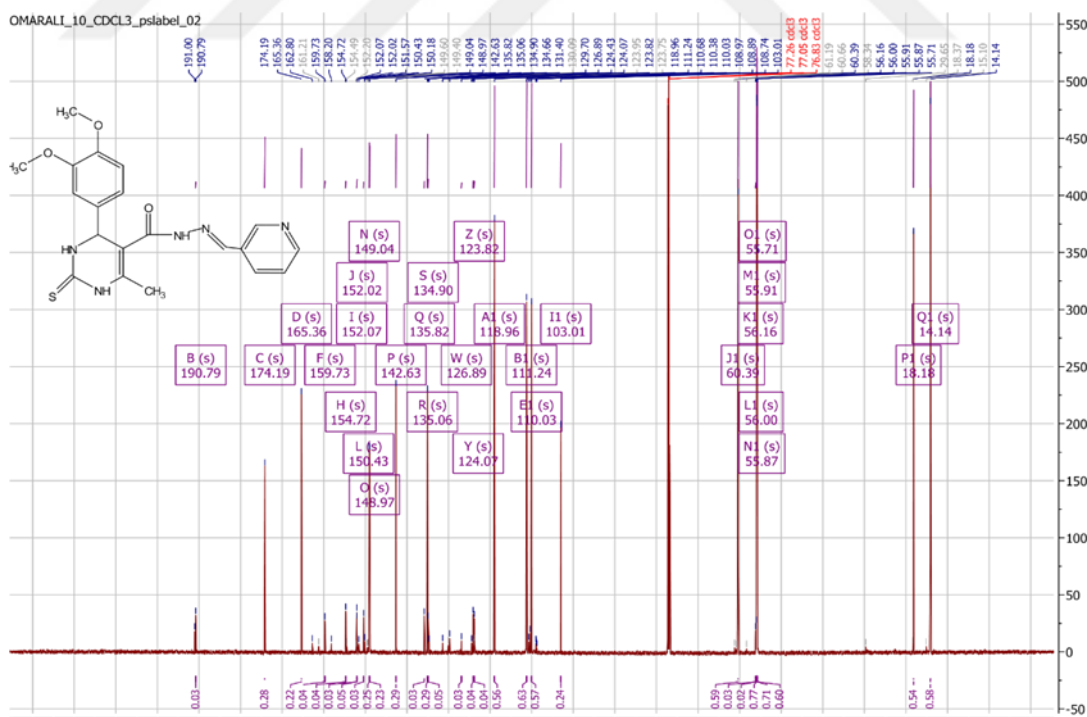
APPENDIX 11. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



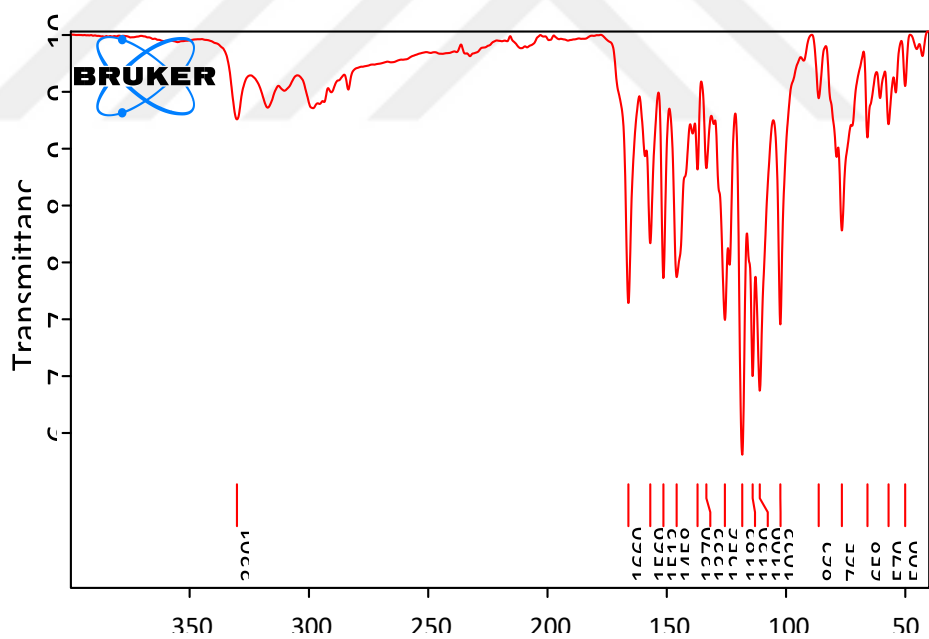
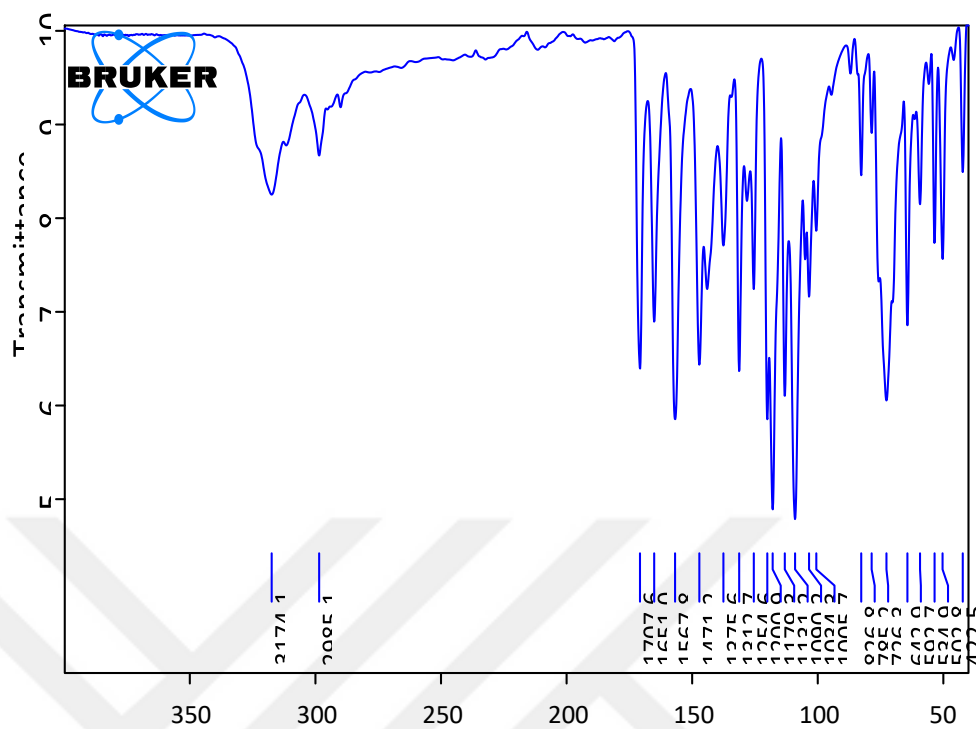
APPENDIX 12. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



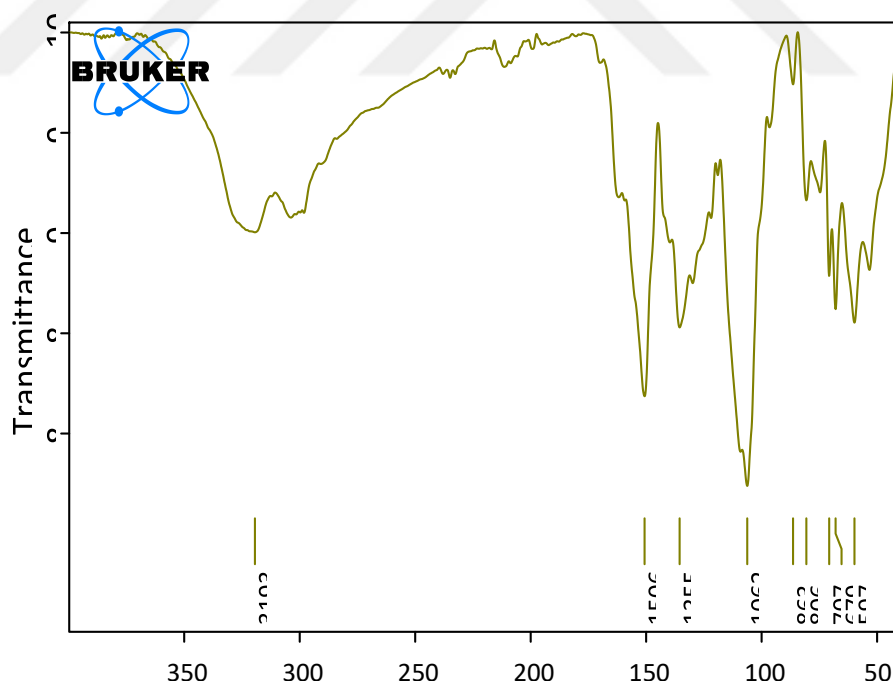
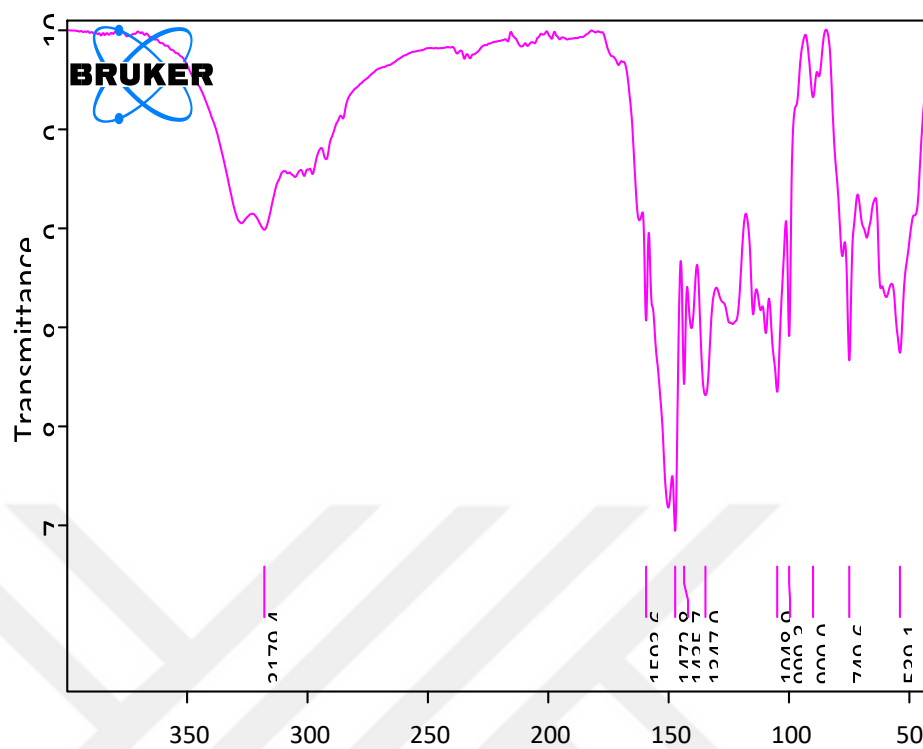
APPENDIX 13. A (NMR spectrum of APT-APT-'H), B (NMR spectrum of APT-APT-13C)



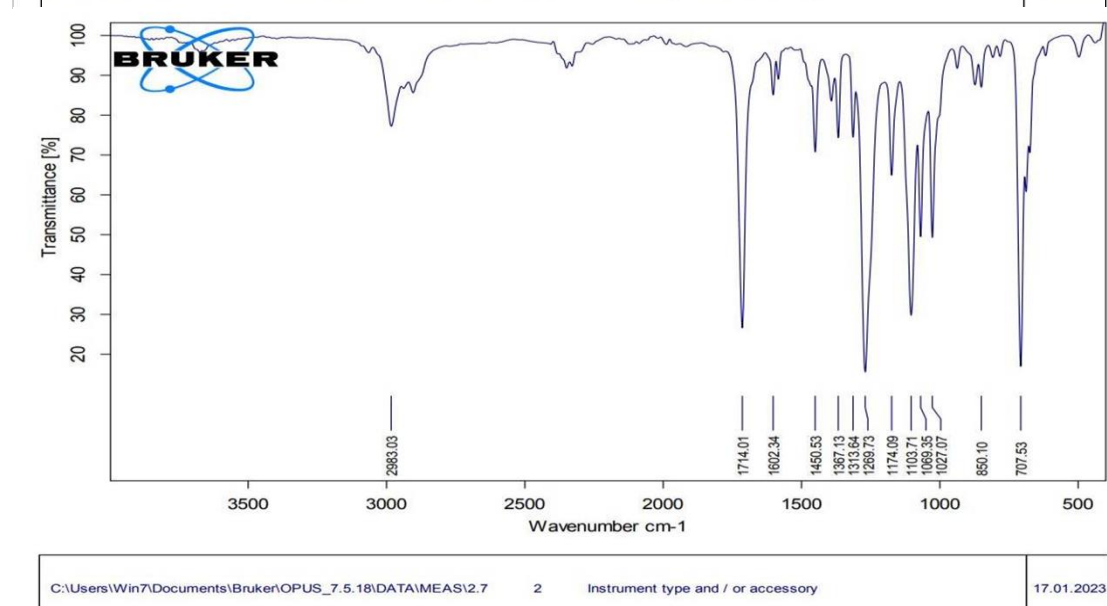
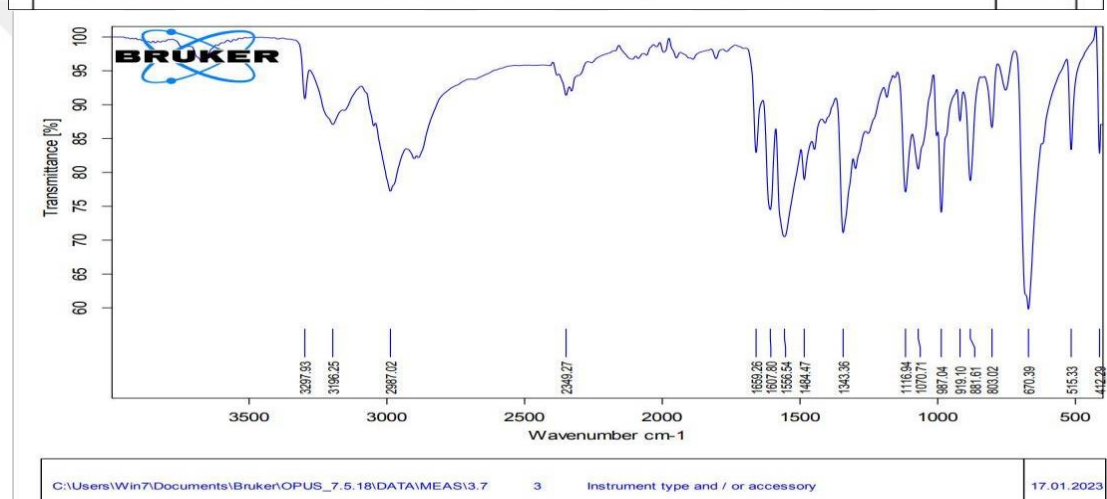
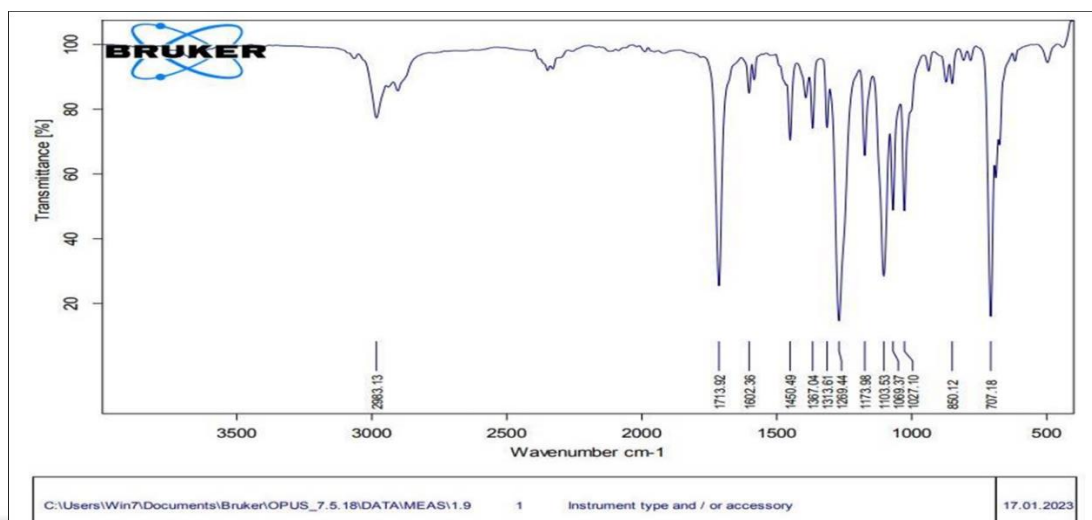
APPENDIX 14. A Infrared (IR) Spectrum (M 1), B Infrared (IR) Spectrum

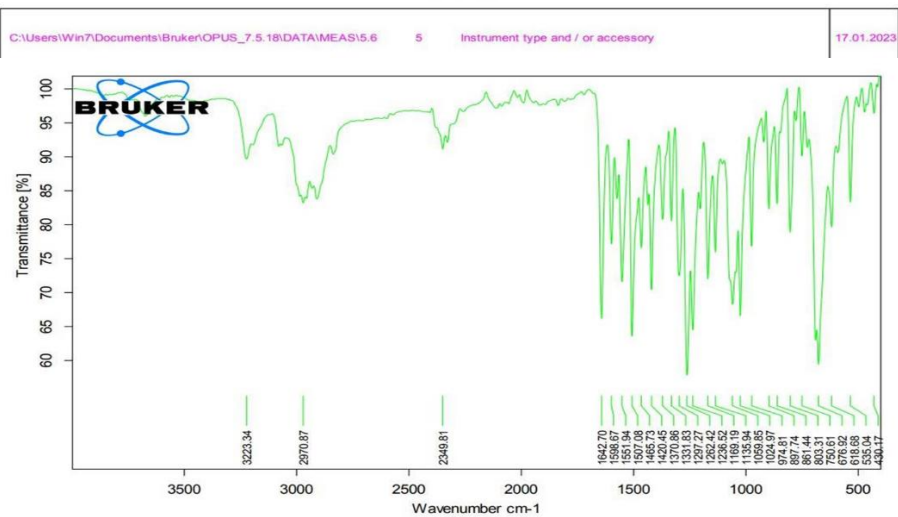
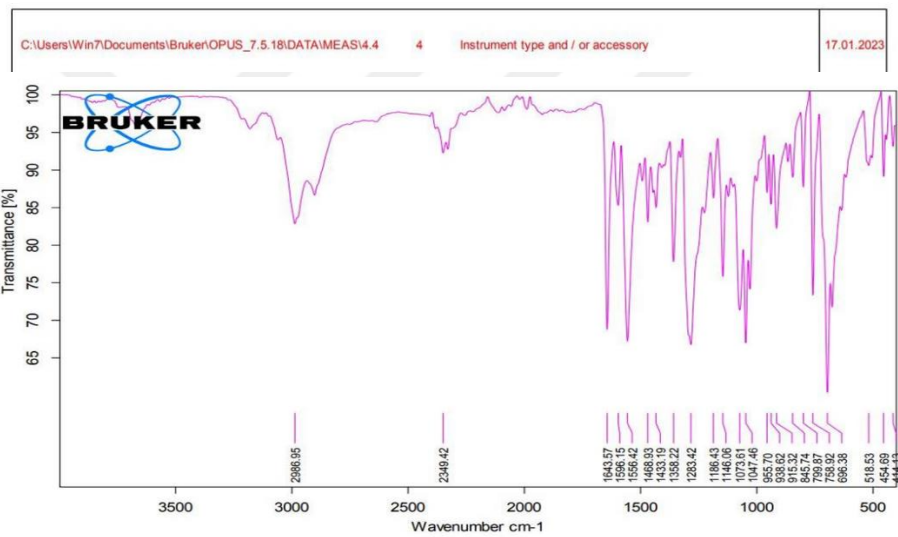
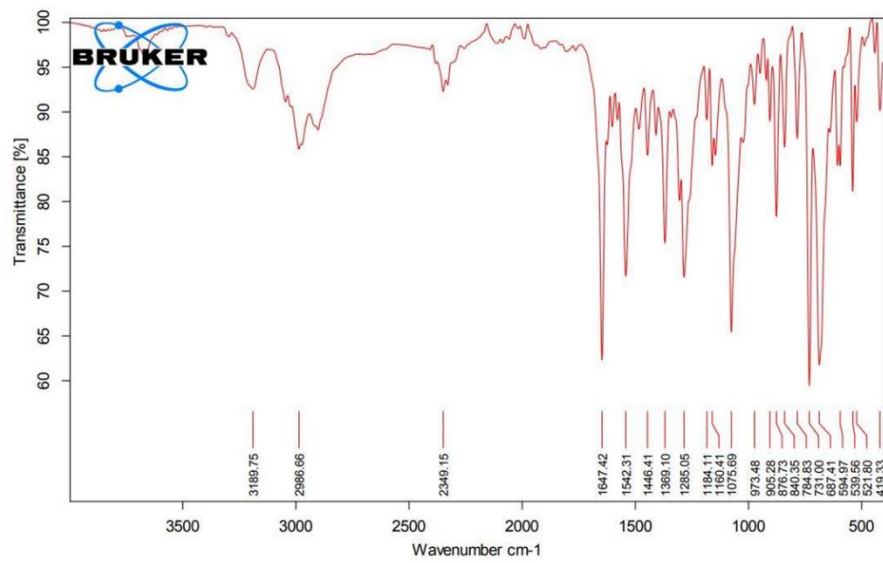


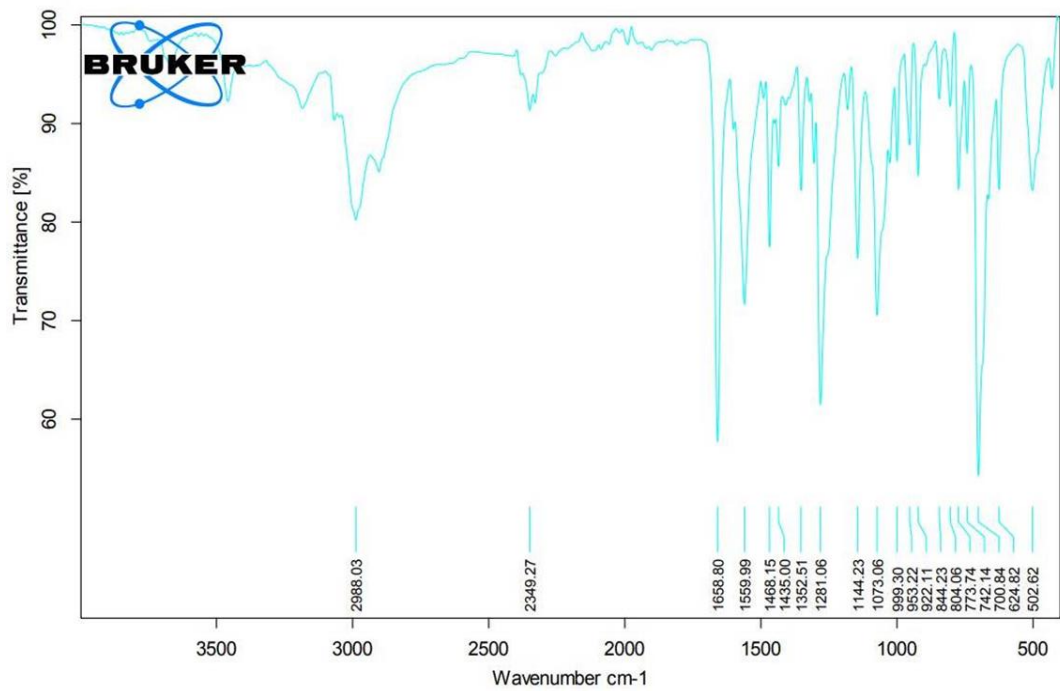
APPENDIX 15. A Infrared (IR) Spectrum, B Infrared (IR) Spectrum



APPENDIX 16. Infrared (IR) Spectrum





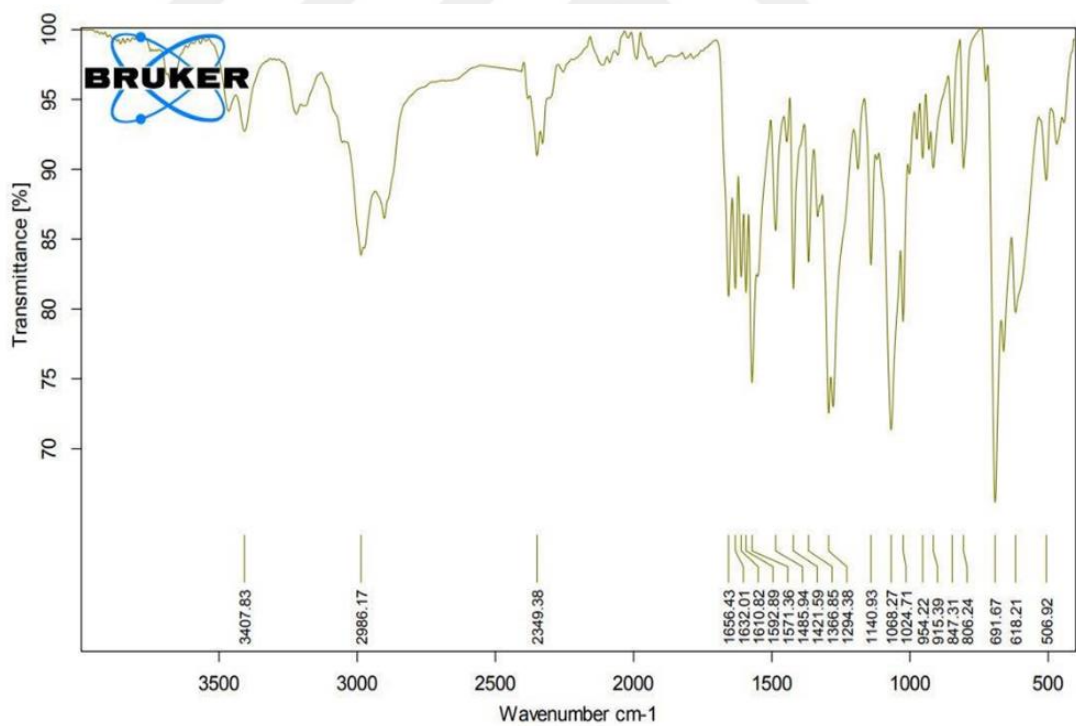


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Instrument type and / or accessory

17.01.2023



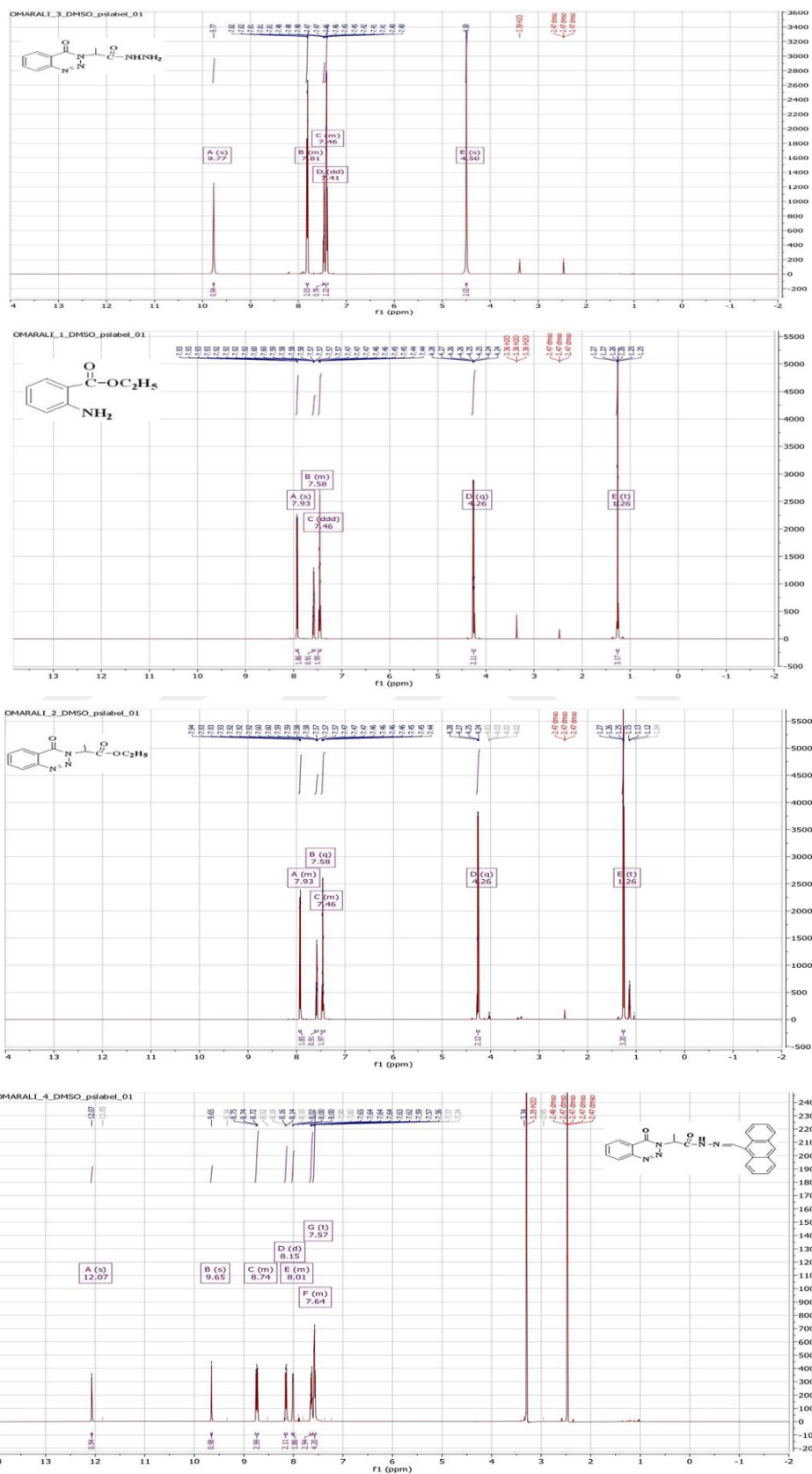
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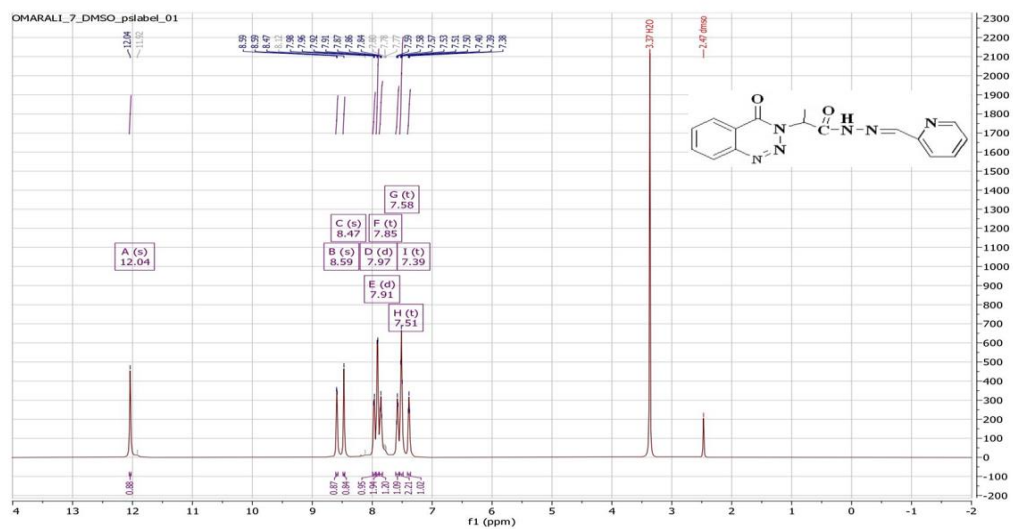
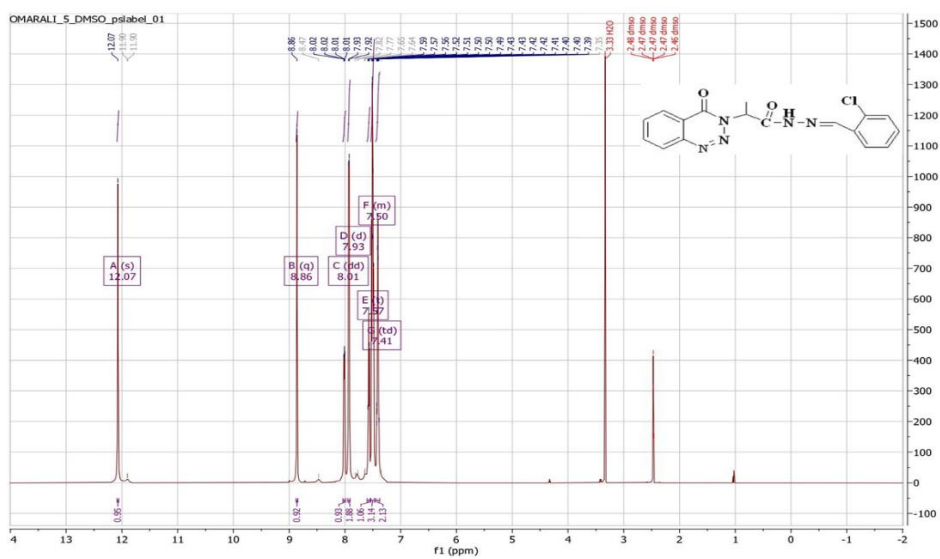
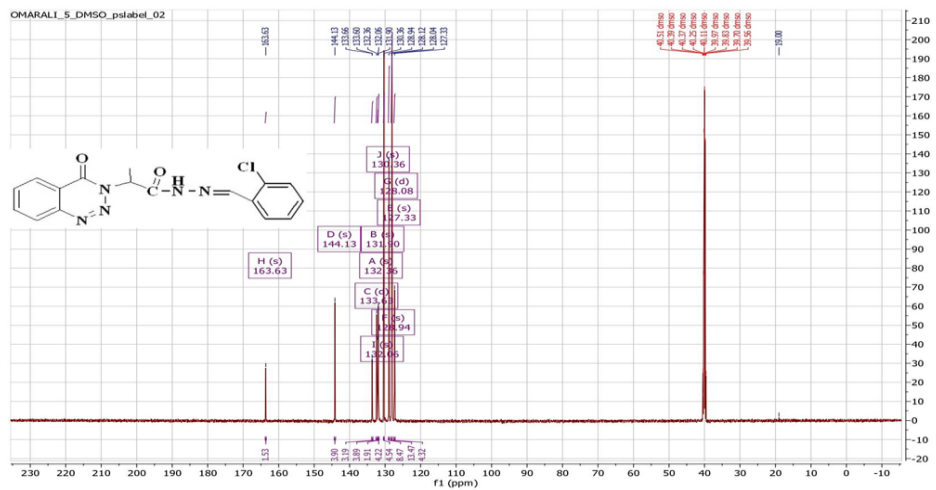
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Instrument type and / or accessory

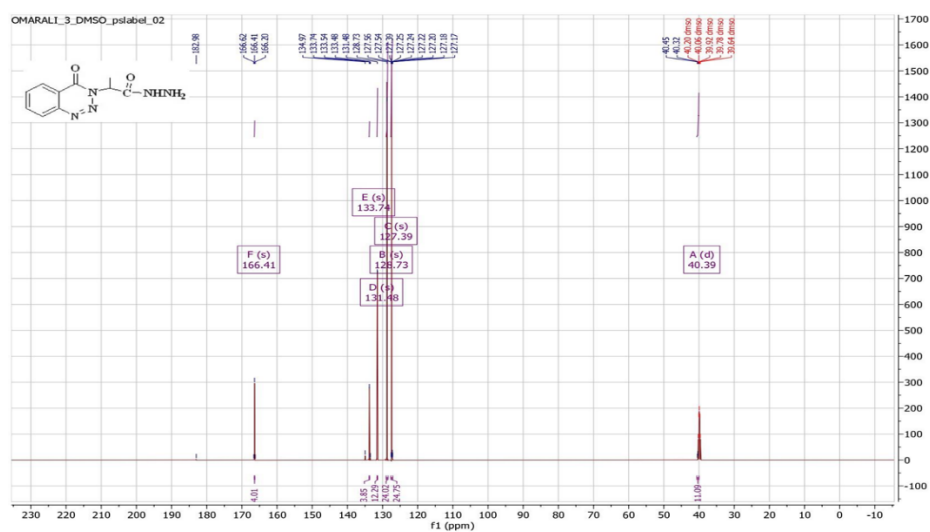
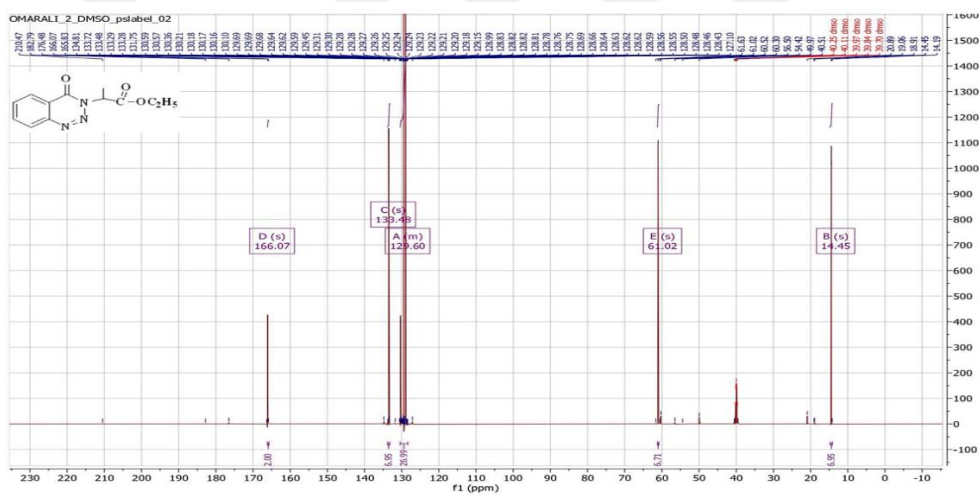
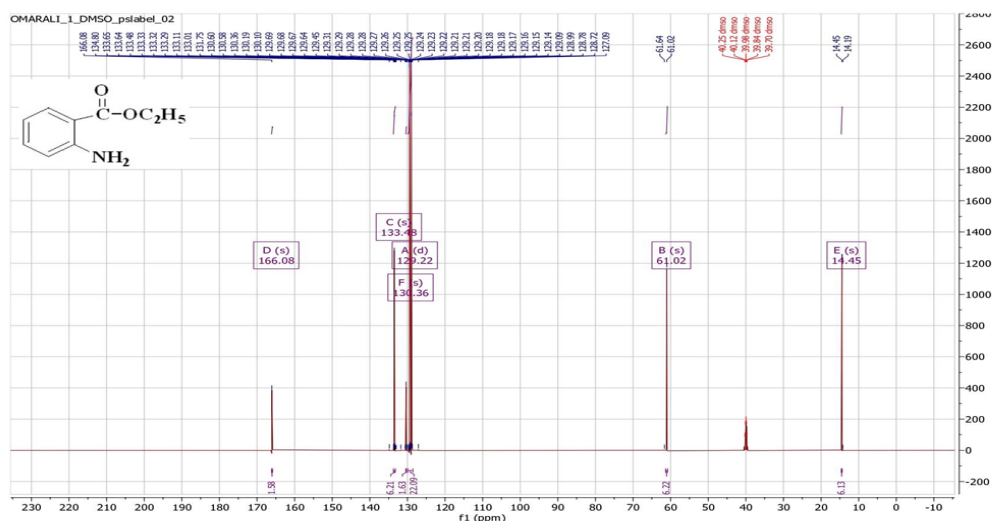
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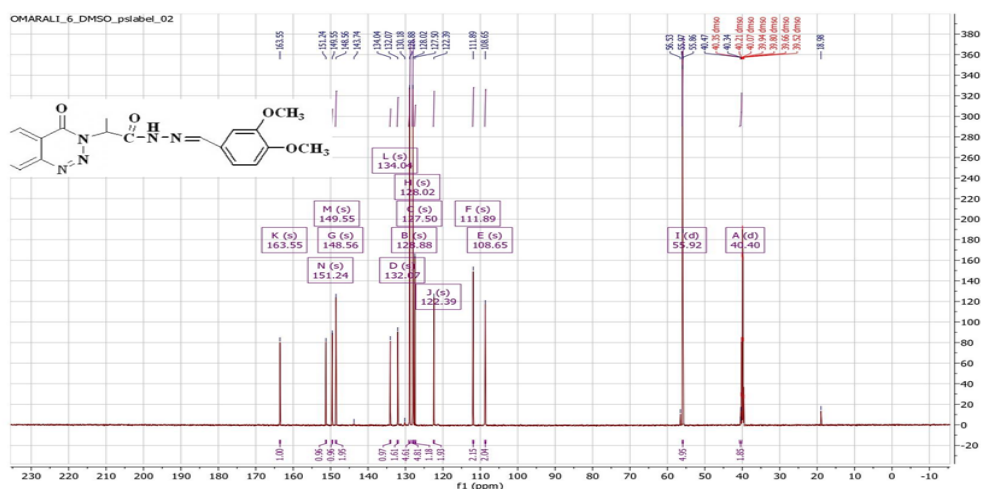
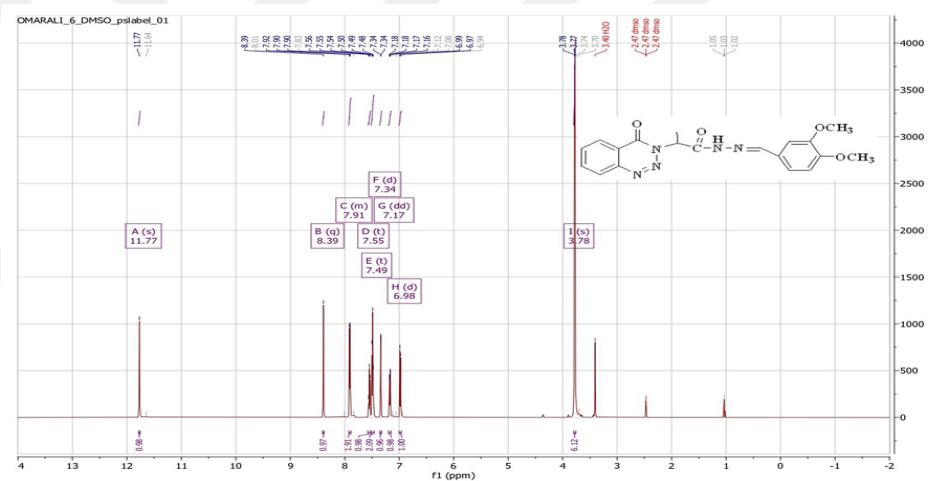
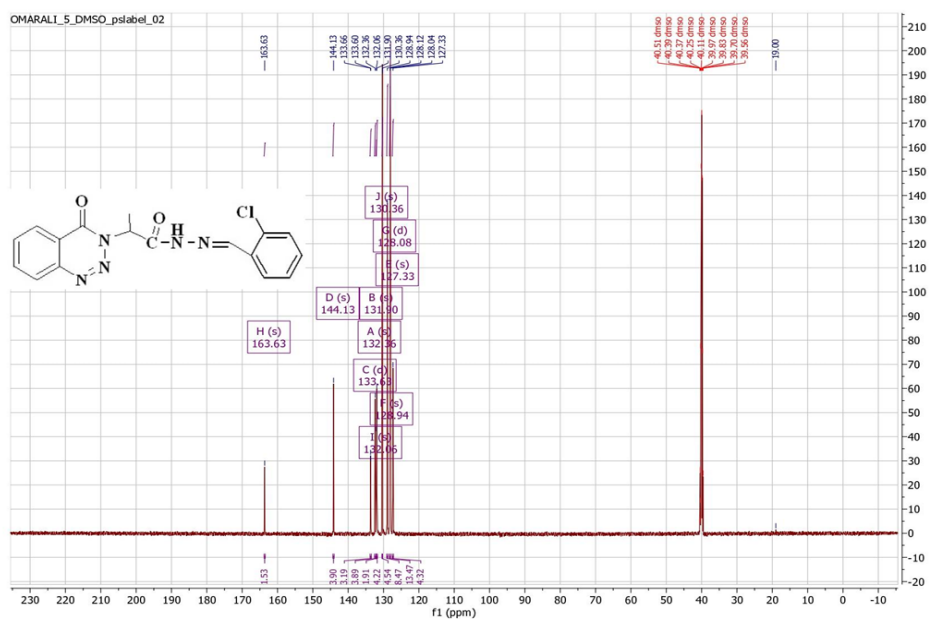
APPENDIX 17. (NMR spectrum of APT-APT-'H)





APPENDIX 18. (NMR spectrum of APT-APT-13C)





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Graduate School of Natural and Applied Sciences 2023-Present
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Faculty of Engineering 2011-2012
Department of Chemistry

Work Experience

Year	Institution	Position
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