Synthesis, Characterization and Thermal Degradation of Some New 3,5-dimethyl Pyrazole Derivatives

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The purpose of this research is to synthetize, characterize and thermal degradation of new heterolytic derivates with potential biological properties. The derivates synthesis was done by obtaining new molecules with pyralozone structure which combine two pharmacophore entities: the amidosulfonyl-R_1,R_2phenoxyacetil with the 3,5-dimethyl pyrazole which can have potential biological properties. The synthesis stages of the new products are presented as well as the elemental analysis data and IR, ^{1}H-NMR spectral measurements made for elucidating the chemical structures and thermostability study which makes evident the temperature range proper for their use and storage. The obtained results were indicative of a good correlation of the structure with the thermal stability as estimated by means of the initial degradation temperatures as well as with the degradation mechanism by means of the TG-FTIR analysis.

Keywords: hydrazides, 3,5-dimethyl pyrazole, spectral measurements, thermal analysis, degradation mechanism

The pyrozoles and its derivates belong to heterocyclic family which is mainly important due to antioxidant, antiviral, antitumor, antibacterial, hypoglycemic properties. Numerous researchers are using it in structural simulation in order to boost biological properties [1-13]. As most heterocyclic families they are a fascinating group of compounds with practical application: medicines with diverse pharmacological actions, dyes or substances used for analytical control, macromolecular substances.

In the last few years research have focused on obtaining biological active products with use in the agriculture as herbicides, growth biosimulators, acaricides, fungicides, etc. Among the diverse studied classes lately, ariloxialchil and carboxylic acids and derivates are considered taking to account their herbicide and auxinic actions [14-16].

Moreover, besides important analgesic and anti-inflammatory effects recent data shows that this compounds family presents antioxidant, antibacterial, antitumor, anticonvulsion, hypoglycemic, properties, etc. [17-23]. Discovery of new derivates in the nestroride anti-imflammatory class with both a pharmaceutical profile and therapeutic safety present a great interest among researches [24-27].

The purpose of this research is to develop new heterocyclic derivates with biologic properties. The most important arguments of this study is: their use as herbicides, as growth biosimulators, acaricides, fungicides part of an important of nonsteroidal anti-inflammatory agents prescribed in case of fever, arthritis, and muscular pains, this class of compounds undergoing a continuous development.

Experimental part

Materials

Hydrazine monohydrate 98%, acetylacetone, dimethyl-formamide were purchased from Sigma–Aldrich. All reagents and solvents had purity grade and were obtained from commercial suppliers.

Synthesis

The ^{1}H-NMR spectra were recorded in DMSO-d6 with a Bruker Avance 300 MHz instrument. The chemical shifts were expressed in ppm using tetramethylsilane (TMS) as internal standard. Spin multiplets are given as: s (singlet), d (doublet). FT-IR spectra were performed on a Biorad FT-IR- FTS 570^{o}C spectrometer. All melting points were determined on Bruker Vertex 70 Melting Point apparatus. Elemental analyses were carried out using a Perkin Elmer CHNS/O Analyzer Series II 2400 apparatus, and the results were within ± 0.4% of theoretical values.

General procedure of the synthesis

0.01 moles of hydrazide of amidosulfonyl-R_1,R_2-phenoxiacetic acid is dissolved in 20 mL dimethyl-formamide, then is added 0.011 moles of acetylacetone. The mix is heated for 30 minutes, by cooling and adding 20 mL of water precipitating N-hydrazide. The product is purifid by dissolving it in 20 mL of methanol, active coal treament and its dillution with 25 mL of water.

By cyclization of the intermediary in final product, it gets dissolved in 20 mL of ethilic alchool, adding 0.1 mL of aqeous solution of HCl 10%, the mix maininting for an hour to refluxing. A part of solvent gets distilled, in vaccum, and by reaction mass cooling gets precipitate 1-phenoxyacetil-3,5-dimethyl pyrazole wich puridies by solving it in acetone, at warm temperature, active coal treatment, cooling and crystallization [28, 29].

Preparation of 1-(2-methyl, 4-buthyl-amidosulfonyl)-phenoxyacetil-3,5-dimetyl pyrazole derivatives (**1**)

3.30 g (0.01 mmol) hydrazide of 2-methyl-4-buthyl-amidosulfonyl-phenoxyacetic acid is dissolved in 20 mL dimethylformamide, then is added 1.1 g (0.011 mmol) of acetylacetone. The mix is heated for 30 minutes, by cooling and adding 20 mL of water precipitating N-hydrazide. The product is purifid by dissolving it in 20 mL of methanol, active coal treament and its dillution with 25 mL of water. By cyclization of the intermediary in final product, it gets

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dissolved in 20 mL of ethilic alchool, adding 0.1 mL of aqeous solution of HCl 10 %, the mix maininting for an hour to refluxing. A part of solvent gets distilled, in vaccum, and by reaction mass cooling gets precipitate 1-(2-methyl-4-buthyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole wich puridies by solving it in acetone, at warm temperature, active coal treatment, cooling and crystallization.

Yield: 78.25 %; m.p. 127-129°C; white powder; Anal. Calcd. for $C_{18}H_{25}N_3O_4S$: C, 56.99, H, 6.59, N, 11.08, Found: C, 56.94, H, 6.64, N, 11.12; FT-IR (KBr, cm^{-1}): 1639 (-C=N-), 1610 (C=C), 1588 (-C-C-), 3070 (C-H), 1221 (C-S), 1134 ($-SO_2$-N-), 1731 (-C=O), 3249 (-NH-), 1200 (-C-N), 1512 (Ar-CH_3), 3598 (Ar-O-) cm^{-1}; ^{1}H-NMR d/ppm (400 MHz, DMSO): 0.99 (s,3H, -CH_3), 1.36 (s, 2H,-CH_2-), 1.58 (s, 2H, -CH_2-), 2.1 (s, 1H, -NH-), 2.39 (s, 3H, Ar-CH_3), 2.75 (d, 6H, -CH_3 of pyrazole ring), 3.20 (s, 2H, -CH_2-), 4.81 (s, 2H, -CH_2-), 5.12 (s, 2H, -CH_2-), 6.05 (s, H, -CH- of pyrazole ring), 7.03 (s, H, Ar-H), 7.67 (d, 2H, Ar-H).

Preparation of 1-(4-chloro, 2-diethyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole derivatives (**2**)

3.38 g (0.01 mmol) hydrazide of 4-chlor-2-diethyl-amidosulfonyl-phenoxyacetic acid is dissolved in 20 mL dimethylformamide, then is added 1.1 g (0.011 mmol) of acetylacetone. The mix is heated for 30 min, by cooling and adding 20 mL of water precipitating N-hydrazide. The product is purifid by dissolving it in 20 mL of methanol, active coal treament and its dillution with 25 mL of water. By cyclization of the intermediary in final product, it gets dissolved in 20 mL of ethilic alchool, adding 0.1 mL of aqeous solution of HCl 10%, the mix maininting for an hour to refluxing. A part of solvent gets distilled, in vaccum, and by reaction mass cooling gets precipitate 1-(4-chlor-2-diethyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole wich puridies by solving it in acetone, at warm temperature, active coal treatment, cooling and crystallization.

Yield: 79.35 %; m.p. 182-184°C; white powder; Anal. Calcd. for $C_{12}H_{22}N_3O_4SCl$: C, 51.06, H, 5.50, N, 10.51, Found: C, 51.00, H, 5.56, N, 10.57; FT-IR (KBr, cm^{-1}): 1648 (-C=N-), 1604 (C=C), 1579 (-C-C-), 3051 (C-H), 1232 (C-S), 1141 ($-SO_2$-N-), 1748 (-C=O), 3248 (-NH-), 1232 (-C-N), 1009 (Ar-Cl), 3586 (Ar-O-) cm^{-1}; ^{1}H-NMR d/ppm (400 MHz, DMSO): 1.05 (d, 6H, -CH_3), 2.98 (d, 6H, -CH_3 of pyrazole ring), 3.28 (d, 4H, -CH_2-), 5.14 (s, 2H, -CH_2-), 6.1 (s, H, -CH- of pyrazole ring), 6.86 (s, H, Ar-H), 7.34 (s, H, Ar-H), 7.97 (s, H, Ar-H).

Preparation of 1-(4-chloro, 2-dibutyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole derivatives (**3**)

3.7 g (0.01 mmol) hydrazide of 4-chlor-2-dibuthyl-amidosulfonyl-phenoxyacetic acid is dissolved in 20 mL dimethylformamide, then is added 1.1 g (0.011 mmol) of acetylacetone. The mix is heated for 30 min, by cooling and adding 20 mL of water precipitating N-hydrazide. The product is purifid by dissolving it in 20 mL of methanol, active coal treament and its dillution with 25 mL of water. By cyclization of the intermediary in final product, it gets dissolved in 20 mL of ethilic alchool, adding 0.1 mL of aqeous solution of HCl 10%, the mix maininting for an hour to refluxing. A part of solvent gets distilled, in vaccum, and by reaction mass cooling gets precipitate 1-(4-chlor-2-dibuthyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole wich puridies by solving it in acetone, at warm temperature, active coal treatment, cooling and crystallization.

Yield: 79.32 %; m.p. 173-175°C; white powder; Anal. Calcd. for $C_{21}H_{30}N_3O_4SCl$: C, 55.32, H, 6.58, N, 9.22, Found: C, 55.28; H, 6.64, N, 9.26; FT-IR (KBr, cm^{-1}): 1640 (-C=N-), 1605 (C=C), 1580 (C-C), 3052 (C-H), 1238 (C-S), 1150 ($-SO_2$-N-), 1734 (C=O), 3198 (-NH-), 1242 (C-N), 1110 (Ar-Cl), 3754 (Ar-O-) cm^{-1}; ^{1}H-NMR d/ppm (400 MHz, DMSO): 0.92 (d, 6H, -CH_3), 1.39 (d, 4H, -CH_2-), 1.52 (d, 4H, -CH_2-), 2.59 (d, 6H, -CH_3 of pyrazole ring), 3.18 (d, 4H, -CH_2-), 5.1 (s, 2H, -CH_2-), 5.89 (s, H, -CH- of pyrazole ring), 6.90 (s, H, Ar-H), 7.30 (s, H, Ar-H), 7.88 (s, H, Ar-H).

Preparation of 1-(2-chloro,4-ethyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole derivatives (**4**)

3.02 g (0.01 mmol) hydrazide of 2-chlor-4-ethyl-amidosulfonyl-phenoxyacetic acid is dissolved in 20 mL dimethylformamide, then is added 1.1 g (0.011 mmol) of acetylacetone. The mix is heated for 30 minutes, by cooling and adding 20 mL of water precipitating N-hydrazide. The product is purifid by dissolving it in 20 mL of methanol, active coal treament and its dillution with 25 mL of water. By cyclization of the intermediary in final product, it gets dissolved in 20 mL of ethilic alchool, adding 0.1 mL of aqeous solution of HCl 10 %, the mix maininting for an hour to refluxing. A part of solvent gets distilled, in vaccum, and by reaction mass cooling gets precipitate 1-(2-chlor-4-ethyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole wich puridies by solving it in acetone, at warm temperature, active coal treatment, cooling and crystallization.

Yield: 79.32 %; m.p. 173-175°C; white powder; Anal. Calcd. for $C_{21}H_{30}N_3O_4SCl$: C, 55.32, H, 6.58, N, 9.22, Found: C, 55.28; H, 6.64, N, 9.26; FT-IR (KBr, cm^{-1}): 1640 (-C=N-), 1605 (C=C), 1580 (-C-C-), 3052 (C-H), 1238 (C-S), 1150 ($-SO_2$-N-), 1734 (-C=O), 3198 (-NH-), 1242 (-C-N), 1110 (Ar-Cl), 3754 (Ar-O-) cm^{-1}; ^{1}H-NMR d/ppm (400 MHz, DMSO): 0.92 (d, 6H, -CH_3), 1.39 (d, 4H, -CH_2-), 1.52 (d, 4H, -CH_2-), 2.59 (d, 6H, -CH_3 of pyrazole ring),3.18 (d, 4H, -CH_2-), 5.1 (s, 2H, -CH_2-), 5.89 (s, H, -CH- of pyrazole ring), 6.90 (s, H, Ar-H), 7.30 (s, H, Ar-H), 7.88 (s, H, Ar-H).

Preparation of 1-(2-methyl,4-dibuthyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole derivatives (**5**)

3.86 g (0.01 mmol) hydrazide of 2-methyl-4-dibuthyl-amidosulfonyl-phenoxyacetic acid is dissolved in 20 mL dimethylformamide, then is added 1.1 g (0.011 mmol) of acetylacetone. The mix is heated for 30 minutes, by cooling and adding 20 mL of water precipitating N-hydrazide. The product is purifid by dissolving it in 20 mL of methanol, active coal treament and its dillution with 25 mL of water. By cyclization of the intermediary in final product, it gets dissolved in 20 mL of ethilic alchool, adding 0.1 mL of aqeous solution of HCl 10 %, the mix maininting for an hour to refluxing. A part of solvent gets distilled, in vaccum, and by reaction mass cooling gets precipitate 1-(2-methyl-4-dibuthyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole wich puridies by solving it in acetone, at warm temperature, active coal treatment, cooling and crystallization.

Yield: 76.65 %; m.p. 196-198°C; white powder; Anal. Calcd. for $C_{22}H_{35}N_3O_4S$: C, 60.41, H, 8.00, N, 9.61, Found: C, 60.35; H, 8.12, N, 9.68; FT-IR (KBr, cm^{-1}): 1642 (-C=N-), 1607 (C=C), 1583 (-C-C-), 3065 (C-H), 1227 (C-S), 1139 ($-SO_2$-N-), 1738 (-C=O), 3253 (-NH-), 1222 (-C-N), 1506 (Ar-CH_3), 3592 (Ar-O-) cm^{-1}; ^{1}H-NMR d/ppm (400 MHz, DMSO): 0.92 (d, 6H, -CH_3), 1.40 (d, 4H, -CH_2-), 1.54 (d, 4H, -CH_2-), 2.41 (s, 3H, Ar-CH_3), 2.55 (d, 6H, -CH_3 of pyrazole ring), 3.26 (d, 4H, -CH_2-), 5.21 (s, 2H, -CH_2-), 6.09 (s, H, -CH- of pyrazole ring), 6.86 (s, H, Ar-H), 7.61 (d, 2H, Ar-H).

Thermal analysis

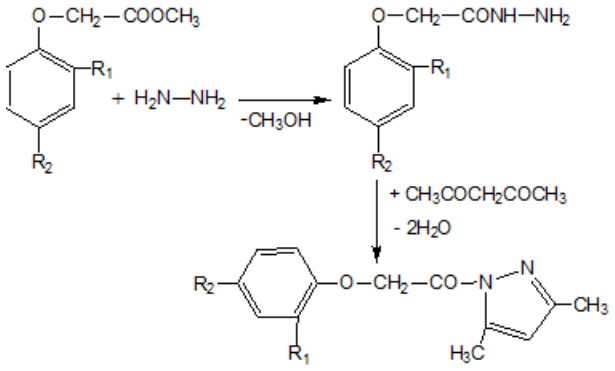
The thermogravimetric (TG) and differential scanning calorimeter (DSC) were performed by using a Perkin-Elmer Pyris Diamond TG/DSC thermobalance which records simultaneously the TG and DSC curves. The DTG

curves were obtained by numerical differentiation of the TG curves. The working conditions were the following: sample mass 10 mg, heating rate 10°C min^{-1}, temperature range 30 - 600°C in nitrogen stream (800 mL. min^{-1}).

Results and discussions

Synthesis

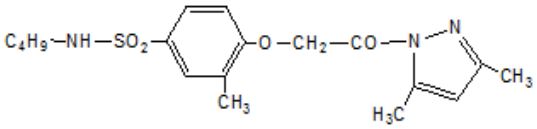
Synthesis of derivates was performed in order to obtain new molecules with amidosulfonyl R1,R2-phenoxyacetil-3,5-dimethyl-pyrazoles structures by attaching to nucleus



R_1= -CH_3 , -$SO_2N(C_2H_5)_2$, -$SO_2N(C_4H_9)_2$, Cl;
R_2= -$SO_2NHC_4H_9$,-$SO_2N(C_4H_9)_2$, Cl , -$SO_2NHC_2H_5$;

Fig. 1. The synthesis of 1- (amidosulfonyl R_1, R_2 phenoxyacetic acid) -3,5-dimethyl pyrazole derivatives

amidosulfonyl-R1 ,R2 phenoxyacetil to that of dimethyl-pyrazole ring (fig.1).



1-(2-methyl, 4-buthyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole (**1**)
Chemical formula: $C_{18}H_{23}N_3O_4S$
Molecular weight: 379
Melting point: 141-143 °C

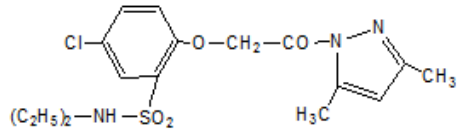
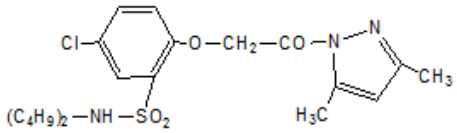
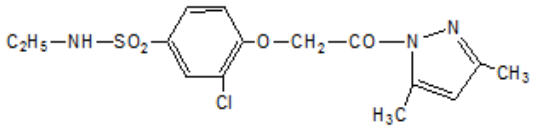


Fig. 2. Structures of new compounds

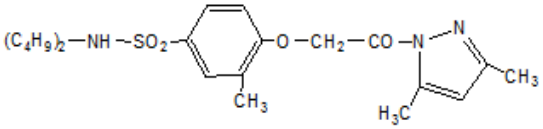
1- (4-chloro, 2-diethyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole (**2**)
Chemical formula: C_{1}-$H_{22}N_3O_4SCl$
Molecular weight: 399.5
Melting point: 216-218 °C



1- (4-chloro, 2-dibuthyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole (**3**)
Chemical formula: $C_{21}H_{30}N_3O_4SCl$
Molecular weight: 455.5
Melting point: 212-214 °C



1- (2-chloro, 4-ethyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole (**4**)
Chemical formula: $C_{15}H_{19}N_3O_7SCl$
Molecular weight: 371.5
Melting point: 186-188 °C



1-(2-methyl, 4-dibutyl-amidosulfonyl)-phenoxyacetil-3,5-dimethyl pyrazole (**5**)
Chemical formula: $C_{22}H_{33}N_3O_4S$
Molecular weight: 437
Melting point: 136-138 °C

The synthetized compunds which combine two pharmacore entities have the following structure (fig. 2).

The structures of the newly obtained derivatives were also confirmed by IR, ^{1}H-NMR spectral measurements and elemental analysis. The spectral analyses were in accordance with the assigned structures.

Structure elucidation by spectral measurement

Spectrum IR

Spectrum analysis of pyrazoles derivates, infrared, reveal vibration frequencies of main functional groups. It can be noticed a band movement due to valence vibrations of carbonyl groups C=O from 1650 - 1690 cm^{-1} to higher frequencies due to growth of rings of carbonyl groups. This shows that carbonyl group, from azolyde, (heterocycle of 5 terms containing two or more nitrogen atoms, of one of being connected to a acyl group) appear at relatively high frequencies of 1734 -1748 cm^{-1}. In the case of C=N string from pyrazolyc cycle the frequency is of 1639 - 1648 cm^{-1}. In case of derivates, where sulfonamidic group is entirely substituted it can be obserbed the band dissapearance due to valency vibration of N-H. The absorption band in the case of -NH group is between 3198 - 3253 cm^{-1}. The IR spectrum of compunds were identified the vibration frequencies according to the benzenic rings of 1576 - 1588 cm^{-1}, corresponding to vibrations νC-C and absobtions at 3045 - 3070 cm^{-1} generated by aromatic νC-H, plus intense bands of substitutes from aromatic nucleus at 1009-1115 cm^{-1} and those of 1506 - 1512 cm^{-1} of distorted vibration δCH_3, Ar-O band is between 3586 - 3754 cm^{-1} and in the case of S-N rings is between1672 - 1790 cm^{-1}. The band of valency vibration for C-N is at 1200 - 1242 cm^{-1} being a very intense one [30-33].

Spectrum RMN

The structure of these compounds was strongly confirmed by ^{1}H-NMR spectral data. In the pyrazole derivatives spectrum the heterocyclic -N- group of adequate ä values is to be found. In ^{1}H-NMR spectra the occurrence of pyrazole cycle is sustained by protons signales of CH group (6.74-5.50 ppm) and at the same time there were identified the corresponding protons of substitutes of pyrazole nucleus (radicals CH_3, δ = 2.55 - 2.98 ppm).

Within the domain of the aromatic protons the presence of the ethylene =C- proton can be noticed. The proton of the -N-C- group is the most unscreened one and it occurs after the aromatic protons. The values of the chemical shifts and the peak intensities in the ^{1}H-NMR spectra are in good agreement with the proton types and number in pyrazole derivatives.

Thermal analysis

The thermal methods (TG, DTG, DSC) were previously used by us in the study of thermal behavior of various materials [34–37]. This method allows the specification of the temperature range where the material is thermally stable and can be used. More recent the thermal methods (TG, DTG, DSC) were coupled with the FTIR analysis (TG-FTIR method) [38, 39], this method giving supplementary information crucial in the prediction of the thermal degradation mechanism. By analysing the gaseous species resulted on thermal degradation, this method gives useful information regarding the possible impact over the environment pollution, if in the material processing the initial degradation temperature is exceeded. The gaseous species were identified in the TG-FTIR analysis by means of their specific absorbances [38-40].

The TG, DTG, DSC and Gram-Schmidt curves of the new compounds resulting by working under N_2 (nitrogen)

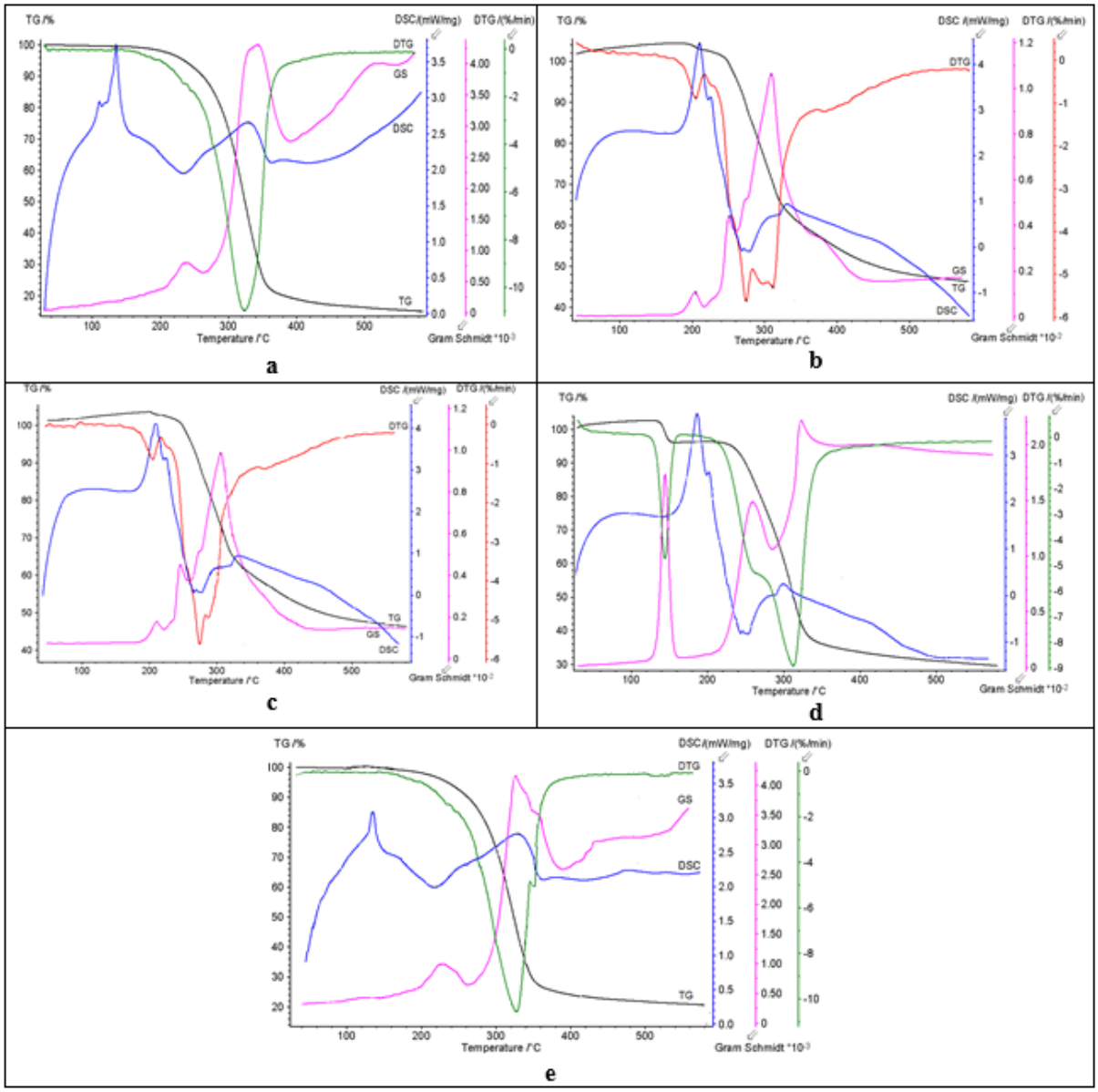


Fig.3. Thermograms of the new sample: the TG, DTG, DSC, and Gram-Schmidt curves, respectively;a-of the **1** sample, b**.** of the **2** sample; c.of the **3** samples; d. of the **4** samples; e. of the **5** samples

Sample	Degradation stage	T_{onset} °C	T_{peak} °C	T_{endset} °C	W%	T_{10} °C	T_{50} °C	T_{max} (GS) °C
1	I residue	163	323	384	86.00 14.00	267	328	242 352
2	I II III residue	186 243 288	207 282 315	221 289 362	1.98 20.08 37.48 40.46	219	289	203 258 308
3	I II III residue	178 252 284	210 276 293	225 284 365	2.18 14.20 35.34 48.28	231	307	206 252 316
4	I II III residue	136 250 285	150 256 320	164 272 375	4.22 13.80 53.08 28.90	183	297	155 263 327
5	I residue	165	336	386	77.55 22.45	263	312	229 330

Table 1
CHARACTERISTIC AMOUNTS FROM TG-DTG ANALYSIS

atmosphere within the 10-600°C temperature range are depicted in figures 3a-e.

The TG-DTG curve analysis shows that the degradation process is a complex and specific one. The samples are thermal degradated in major steps (step II, III) in temperature range of 150 - 386°C showing a similarity beytween sample 1 and 5 with present a thermal degradation process which occurs in a single stage while

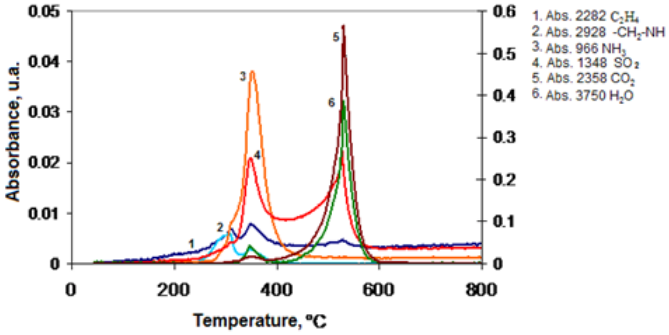
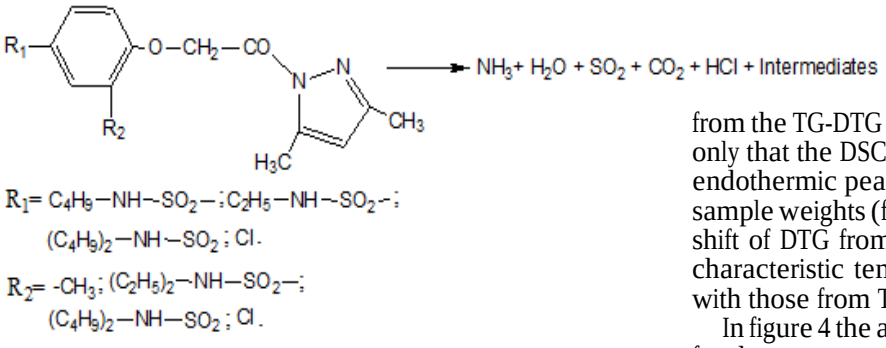


Fig. 4. IR absorbances versus temperature for the identification of the gaseous species eliminated from the sample 1 under study



$R_1 = C_4H_9-NH-SO_2-$; $C_2H_5-NH-SO_2-$; $(C_4H_9)_2-NH-SO_2$; Cl.

$R_2 = -CH_3$; $(C_2H_5)_2-NH-SO_2-$; $(C_4H_9)_2-NH-SO_2$; Cl.

Fig. 5. The mechanism of the thermal degradation

the other samples present a more complex degradation process, containing at least three degradation stages.

The parameters that characterize the thermal decomposition of the samples: T_{onset} - the temperature at which the thermal decomposition begins; T_{peak} - the temperature at which the degradation rate is maximum; T_{endset} - the temperature at end of the process; T_{10}, T_{50} - the temperature corresponding to 10 and 50 wt. % weight losses; T_{max} - temperature at which the maximum amount of gas released (from Gram-Schmidt curve); W - weight loss, are presented in table 1.

The total weight losses varies between 35.34 - 86%. Also, the thermal stability of the three compounds is differently. The 3 sample presents a better thermal stability as comparative with the other samples. The temperatures T_{10} (10% weight losses) vary between 183 - 267°C, while T_{50} (50% weight losses) varies between 289 - 328°C and depend on the structure of samples.

The initial degradation temperatures resulting from DTG are indicative of the following order of the thermal stabilities:

$$2 > 3 > 5 \geq 1 > 4$$

With every sample under study the DSC curves show a strongly endothermic peak within the 10 - 220°C range where the sample mass is clearly constant corresponding to the melting interval and the temperature at the peak maximum represents the melting point. The melting points of the samples are the same within the limits of the experimental errors.

The DSC curves for the thermal degradation of the samples are similar. The same behavior as that resulting from the TG-DTG analysis was noticed with the difference only that the DSC curves of all samples showed a slightly endothermic peak within the 300 - 510°C range while the sample weights (from TG) did not change although a slight shift of DTG from the basic line was noticed. The other characteristic temperatures from DSC are in agreement with those from TG-DTG.

In figure 4 the absorbance versus temperature is plotted for the gaseous species resulted by thermal degradation of the **1** sample under nitrogen atmosphere making evident both their nature and the elimination order as well as their content in the gaseous mixture.

As results from figure 4 the gas species eliminated by thermal degradation of new derivatives in nitrogen atmosfere over the endothermic domain (10 - 600 °C) are: CO, CO_2, H_2O, NH_3, HCl, SO_2, internmediates (HNCO, C_2H_4, CH_2-NH).

Based on the TG-FTIR analysis the most probable overall mechanism of the thermal degradation in nitrogen was presented in figure 5.

A good correlation was also noticed between the structure, thermal stability appreciated from the initial degradation temperatures from TG and DTG and the degradation mechanism. The thermal degradation mechanisms of the samples are complex and specific developing by successive simultaneous reactions depending on the structure and nature of the substitutes in the molecule.

The above conclusions are confirmed by the 3D spectra presented in figures 6a-e.

Conclusions

By combining the dimethyl-pyrazole ring with amidosulfonyl-R1,R2-phenoxyacetil moiety we designed new compounds with potential biological properties.

We have described a simple and accessible method to obtain these derivatives and confirmed their structures by IR and ^{1}H-NMR spectroscopic analysis and elemental analytical data.

The TG-DTG-DSC curves obtained with the pyrazol derivatives under study are indicative of complex and

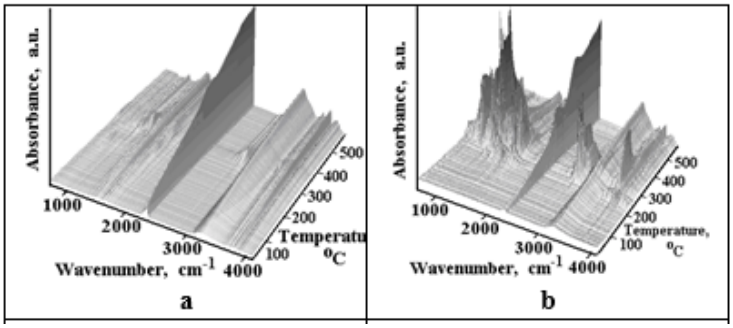


Fig.6. FT-IR 3D spectrum samples
a. 3D FTIR spectra obtainea for the thermal degradation of the sample **1**; b. 3D FTIR spectra obtainea for the thermal degradation of the sample **2**

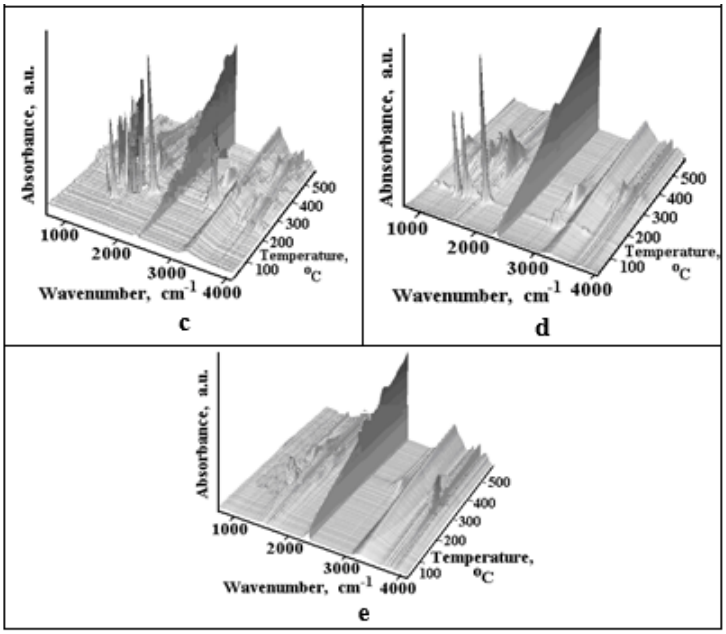


Fig.6. FT-IR 3D spectrum samples
c. 3D FTIR spectra obtainea for the thermal degradation of the sample **3;** d. 3D FTIR spectra obtainea for the thermal degradation of the sample **4;** e. 3D FTIR spectra obtainea for the thermal degradation of the sample **5**

specific degradation mechanisms and consequently of the structure influence**.**

The TG-FTIR analysis affords the conclusion that the gaseous species evolved by degradation are in accordance to those resulting from TG, DTG, DSC analysis.

The thermal stability depends on the chemical structure of new pyrazole derivatives making

possible to ascertain the temperature range proper for using and storing these.

References

1. MACAEV, F., RUSU, G., POGREBNOI, S., GUDIMA, A., STINGACI, E., VLAD, L., SHVETS, N., DIMOGLO, A., KANDEMIRLI, F., REYNOLDS, R., Bioorg. Med. Chem., **13**, 2005, p. 4842.
2. ASHISH, K.T., ANIL, M., VERMA, H.N., MISHRA, A., Ind. J. Chem., **45**B, 2006, p. 489.
3. SHAMSUZZAMAN, S., SIDDIQUI, T., ALAM, M.G., DAR, A.M., J. of Saudi Chem. Soc., **19**, 2015, p. 387.
4. RAHMAN, M.A, SIDDIQUI, A.A., Int. J. Pharm. Sci. Drug Res., **2**, no. 3, 2010, p. 165.
5. SERBEZEANU, D, VLAD-BUBULAC, T., HAMCIUC, C., Mat. Plast., **48**, no. 1, 2011, p.7
6. LIU, F., LUO, X.Q., SONG, B.A., BHADURY, P.S., YANG, S., JIN, L.H., XUE, W., HU, D.Y., Bioorg. Med. Chem., **16**, 2008, p. 3632.
7. SMADI, S., POPOVICI, I., COJOCARU, I., BRAHA, S., OCHIUZ, L., DORNEANU, O., Mat. Plast., **46**, no. 1, 2009, p 83.
8. SHIVARAMA HOLLAA, B., GONSALVES, R., SHENOY, S., Eur. J. Med. Chem., **35**, 2000. p. 267.
9. KUMAR, A., D'SOUZA, S.S., GAONKAR, S.L., RAI, K.M.L., SALIMATH, B.P., Invest. New Drugs, **26**, 2008, p. 425.
10. APOTROSOAEI, M., VASINCU, I., DRAGAN, O., BURON, F., ROUTIER, S., PROFIRE, L., Molecules, **19,** no. 9, 2014, p. 13824.
11. NITULESCU, G.M., MATEI, L., ALDEA, I. M., DRAGHICI, C., OLARU, O.T., BLEOTU, C., Arabian J. of Chem., 2015, http://dx.doi.org/10.1016/j.arabjc.2015.12.006.
12. ALAM, S.M., CHOI, J.H., LEE, D.U., Bioorg. Med. Chem., **20**, 2012, p. 4103.
13. ZARGHI, A., TABATABAI, S.A., FAIZI, M., AHADIAN, A., NAVABI, P., ZANGANEH, V., SHAFIEE, A., Bioorg. Med. Chem. Lett., **15**, 2005, p. 1863.
14. CHAVAN, V.P., SONAWANE, S.A., SHINGARE, M.S., KARALE, B.K., Chem. Heterocycl. Comp., **42**, 2006, p. 625.
15. CONTRERAS, J., RIVAL, Y., CHAYER, S., BOURGUIGNON, J., WERMUTH, C., J. Med. Chem., **42**, 1999, p. 730.
16. ZHENG, X., LI, Z., WANG, Y., CHEN, W., HUANG, Q., LIU, C., SONG, G., J. Fluorine Chem., **123**, 2003, p. 163.
17. BARBUCEANU, S.F., ALMAJAN, G.L., DRAGHICI, C., SARAMET, G., ENACHE, C., BANCESCU, G., Rev. Chim. (Bucharest), **62**, no. 3, 2011, p. 308.
18. HARIRFOROOSH, S., ASGHAR, W., JAMALI, F., J. of Pharmacy and Pharm. Sci., **16**, no. 5, 2013, p. 821.
19. MARIAPPAN, G., SAHA, B.P., SUTHARSON, L., PANDEY1, L., KUMAR, D., J. Pharm. Res., **3**, no. 12, 2010, p. 2856.
20. LEDETI, I.V., BERCEAN, V.N., TANASE I.M., CREANGA A.A., BADEA, V., CSUNDERLIKREV, C., Rev. Chim. (Bucharest), **61**, no. 10, 2010, p. 937.
21. SHIVARAMA HOLLAA, B., GONSALVES, R., SHENOY, S., Eur. J. Med. Chem., **35**, 2000, p. 267.
22. FARGHALY, A.R., EL-KASHEF, H., Arkivoc., **11**, 2006, p. 76.
23. EL-ESSAWY, F.A., KHATTAB, A.F., ABDEL-RAHMAN, A.A.H., Monatsh Chem., **138**, 2007, p. 777.
24. RAO, P.P.N., KABIR, S.N., MOHAMED, T., Pharmaceuticals, **3**, 2010, p. 1530.
25. TANAS, S., ODABASOGLU, F., HALICI, Z., CAKIR, A., AYGUN, H., ASLAN, A., SULEYMAN, H., J. Nat. Med., **64**, no. 1, 2010, p. 42.
26. TARANALLI, A., THIMMAIAH, N., SRINIVAS, S., SARAVANAN, E., Asian J. Pharm. Clinic Res, **2**, no. 4, 2009, p. 79.
27. STEINMEYER, J., Arthritis Res., **2,** no. 5, 2000, p. 379.
28. OCHIAI, M., KAMIKADO, T., Chem. Pharm. Bull., **14**, no.6, 1966, p.628.
29. DUMITRASCU, A., Studies on obtaining new derivatives of sulfamoyl-R-phenoxyacetic acids with potential biological action , PhD Thesis, Gheorghe Asachi Technical University of Iasi
30. PAVEL, S., HOPF, H, JONES, P.G., LUPU, V.V., BIRSA, L.M., Rev. Chim. (Bucharest) **67**, no. 4, 2016, p. 683.
31. CHIRITA, P., ASAFTEI, I.V., SANDU, I., SARBU, L.G., LUPU, V., Rev. Chim. (Bucharest), **68**, no. 1, 2017, p. 147.
32. POPESCU, V., SANDU, I.C.A., POPESCU, G., Rev. Chim. (Bucharest), **67**, no. 10, 2016, p. 1994.
33. TOADER, E., BAHRIN, L.G., SANDU, I., BIRSA, M.L., REZUS, C., Rev. Chim. (Bucharest), **67**, no. 7, 2016, p. 1394.
34. MOCANU, A.M., ODOCHIAN, L., MOLDOVEANU, C., CARJA, G., Therm. Acta, **509**, no. 1-2, 2010, p.33.
35. ODOCHIAN, L., MOCANU, A.M., MOLDOVEANU, C., CARJA, G., ONISCU, C., J. Therm. Anal. and Cal., **94**, no. 2, 2008, p. 329
36. MOCANU, A.M., LUCA, C., Rev. Chim. (Bucharest), **65**, no.2, 2014, p. 185.
37. MOCANU, A.M., ODOCHIAN, L., MOLDOVEANU, C., CARJA, G., ONISCU, C., Rev. Chim. (Bucharest), **60**, no. 9, 2009, p. 928.
38. MOCANU, A.M., ODOCHIAN, L., MOLDOVEANU, C., CARJA, G., Therm. Acta, **509**, no. 1-2, 2010, p.33.
39. MOCANU, A.M., ODOCHIAN, L., APOSTOLESCU, N., MOLDOVEANU, C., J. Therm. Anal. Calorim., **103**, 2011, p. 283.
40. *** NIST-Chemistry Webbook Standard Reference, Database, 69, 2005, release http://webbook.nist.gov/chemistry.

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