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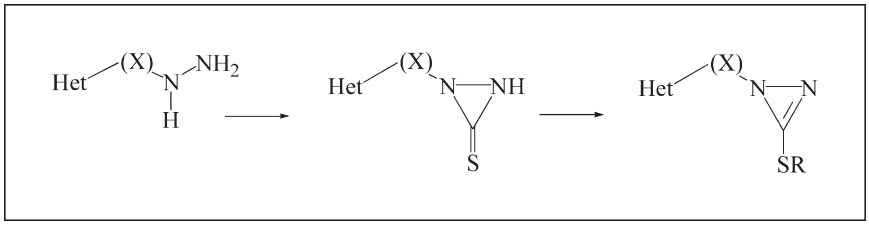

A convenient method for synthesis of novel 1-[pyrimidinyl], 1-[1,3,5-triazin-2-carbonyl], and 1-[thiazol-5-carbonyl] derivatives of 3-thioxo-diaziridine **1**, **3**, **5**, and **7** from corresponding hydrazides, CS2, and KOH is elaborated. The highest reaction yield was observed when these initial reagents were taken in molar ratio of 1:1.7:2.0, respectively. By alkylation of compounds **1**, **3**, **5**, and **7** that proceeds exclusively at sulfur atom, the 3-sulfanyl derivatives of 1-[pyrimidinyl]-, 1-[1,3,5-triazin-2-carbonyl]-, and 1-[thiazol-5-carbonyl]-diazirines **2**, **4**, **6**, and **8** were formed. The structures of synthesized compounds were confirmed by proton and carbon nuclear magnetic resonance (NMR), mass spectra (MS), and elemental analysis. The fungicidal activities of S-substituted derivatives were studied. Data of preliminary biological tests testify that these compounds can be of interest in search for new fungicides.

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INTRODUCTION

Diazirines and diaziridines, highly strained, three-membered heterocyclic rings with two nitrogen atoms, were first discovered independently by Abendroth and Henrich [1], Paulsen [2], and Schmitz and Ohme [3]. In the following years, the series of diazirine and diaziridine derivatives were synthesized and determined by fluorescence [4,5], infrared and electronic absorption spectroscopy [6–10], and microwave and electron diffraction methods [11–13]. Chiroptical properties of several derivatives have been also investigated [14–16].

The most common method of diaziridine synthesis is a combination of a carbonyl compound, an amine, and an electrophilic aminating agent such as chloroamine, *N*-chloro-alkylamine or hydroxylamine-*O*-sulfonic acid [17–19]. As an initial compound, aliphatic Schiff bases [20,21] or *O*-sulfonated oximes [22] also can be used. Schmitz [23] and Gupta [24] obtained several diaziridine derivatives from aminal.

Diazirines were obtained mainly by oxidative dehydrogenation of diaziridines by different oxidants [25]. Some diazirine derivatives were synthesized by the reaction of oxime tosylates with *O*-alkoxyamine [26], difluoramine with azomethines [27], or amidines with NaOCl (NaOBr) [28].

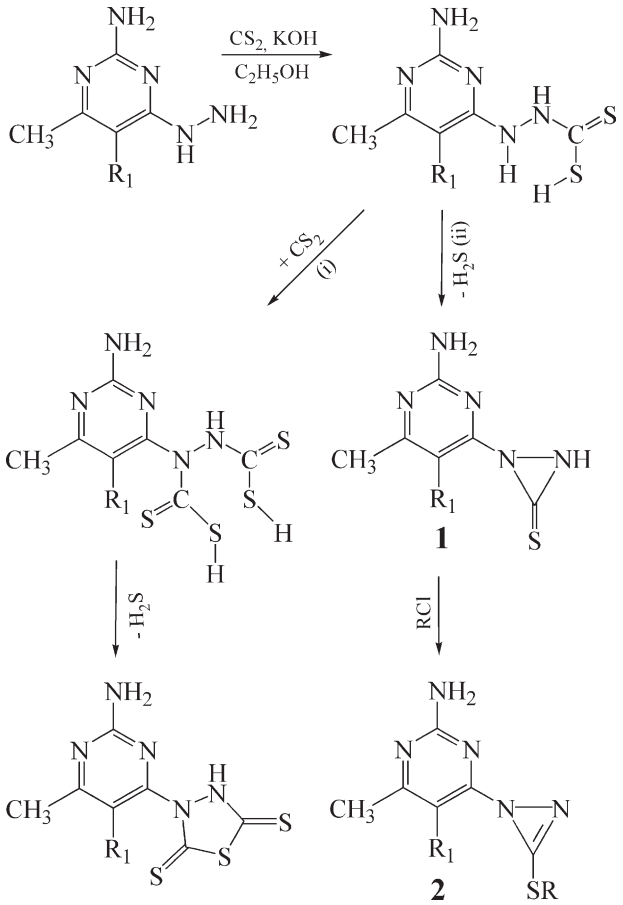
From the 60s, various substituted diaziridines and diazirines were synthesized [29–43]. Halogen derivatives are ideal precursors for spectroscopic studies of carbens [44–46]; several derivatives were suggested as alkylating agents [47] and potential reagents for photolabeling of biological receptor sites [48–57], some of the substituted diaziridines and diazirines were investigated as anticancer drugs [58,59], potential monoamine oxidase inhibitors [60,61] and anesthetics [62,63]. At the same time, to our astonishment, diazirine and diaziridine derivatives practically are not investigated as chemical means of plant protection [64].

The purposes of the present research were the synthesis of novel 1,3-disubstituted diazirines and further study their fungicidal activity.

RESULTS AND DISCUSSION

In our early investigations, it has been established that, under the action of CS_2 and triethylamine on 2-amino-4-hydrazino-6-methyl-pyrimidine, expected potassium salt of 2-(2-amino-6-methyl-pyrimidin-4-yl)-hydrazinecarbodithioic acid was formed [65]. At the same time, our new research has revealed that in more severe conditions, when the mixture of CS_2 and KOH was

Scheme 1. Alternative courses of cyclization.



added in excess to hydrazide spirit boiling solution, the hydrogen sulphide evolved. The physical constants of the obtained compound differed from those of the above mentioned substance.

As a result of hydrogen sulphide elimination, the 1,3,4-thiadiazolidine (i) or three-membered diaziridine cycle (ii) may be formed (Scheme 1). In experiments, the amounts of CS_2 and KOH were varied; however, in all cases, the same substance was formed. The amount of CS_2 affects only the yield of a final product. The maximal reaction yield was observed when hydrazide, CS_2, and KOH were taken in molar ratio of 1:1.7:2.0. These data indicate that a diaziridine cycle is formed, as for thiadiazolidine cycle formation, more than double excess of CS_2 is required. Along the experiment, at first, the potassium salt is formed, which is converted into diaziridine derivative under the action of a hydrochloric acid.

The data of spectral methods also verify mainly a diaziridine cycle formation. In ^{13}C NMR spectra of compounds **1a,b**, besides the absorptions of alkyl groups and pyrimidine cycle, only one signal of thion group C=S (δ = 164.6 ppm) is observed. In ^{1}H NMR spectra, the signal of a mobile proton is observed in the range of 14.0 ppm that corresponds to the proton of NH group. The values of molecular ion peaks (M^+) in mass spectra of these compounds are also in agreement with the fact of diaziridine cycle formation.

Compound **1** can exist in thion or thiol tautomeric forms. However, it has been established that under the action of alkyl halides at room temperature in water or at short-term heating in acetone, only 3-S-substitution took place. In ^{13}C NMR spectra of compound **2**, the signal of C=S group is disappeared, and in ^{1}H NMR spectra the chemical shifts of attached alkyl groups are also in agreement with S-substitution.

By the described method, the 1-(4-methoxy-6-methyl-pyrimidin-2-yl)-diaziridine-3-thion (**3**) and corresponding S-substituted derivatives (**4**) also were obtained from (4-methoxy-6-methyl-pyrimidin-2-yl)-hydrazine (Scheme 2).

With the purpose of investigation, the influence of carbonyl group on reaction course, the similar interactions were carried out with 4,6-bis-dimethylamino-[1,3,5]triazine-2-carboxylic acid hydrazide and 3,4-dimethyl-2-thioxo-2,3-dihydro-thiazole-5-carboxylic acid hydrazide, obtaining (4,6-bis-dimethylamino-[1,3,5]triazine-2-yl)-(3-thioxo-diaziridin-1-yl)-methanone (**5**), (3,4-dimethyl-2-thioxo-2,3-dihydro-thiazole-5-yl)-(3-thioxo-diaziridin-1-yl)-methanone (**7**), and corresponding S-substituted derivatives (**6** and **8**) (Scheme 2). The structures of compounds **4**, **6**, and **8** were also confirmed by ^{1}H and ^{13}C NMR, MS, and elemental analysis.

Biological activity. For preliminary screening tests, the compounds **2d,l,i,j,o** and **8a,d** were selected, and a

Scheme 2. Synthesis of S-substituted diazirines.

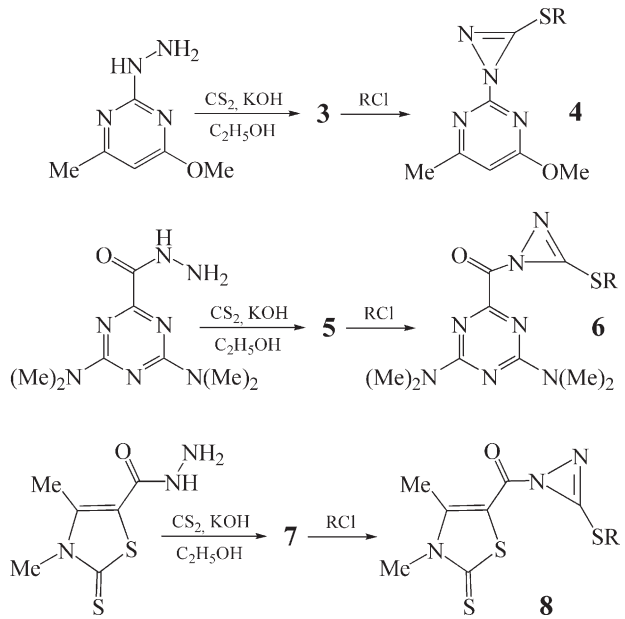


Table 1

The fungicidal activity of compounds **2** and **8**.

Preparation	Water solution concentration (%)	Pathogen growth (%)
Control	Pure water	100
Dividend	0.1	0
	0.01	0
	0.001	0
2d	0.1	0
	0.01	50
	0.001	100
2l	0.1	0
	0.01	20
	0.001	100
2i	0.1	0
	0.01	0
	0.001	0
2j	0.1	0
	0.01	40
	0.001	100
2o	0.1	0
	0.01	0
	0.001	70
8a	0.1	0
	0.01	0
	0.001	40
8d	0.1	0
	0.01	60
	0.001	100

fungicidal activity of their water solutions in concentrations of 0.1, 0.01, and 0.001% against the fungal disease of grain-crops *Tilletia tritici* was investigated. The activity of compounds was compared with that of the dividend—a systemic seed treatment fungicide that is widely used in agriculture. All investigated substances in a various degree suppressed the growth of fungal pathogen (Table 1), testifying the necessity of deeper research of the fungicidal activity among the diazirine derivatives. One substance (**2i**) with highest activity was selected for field trials.

EXPERIMENTAL

The ^{1}H NMR and ^{13}C NMR spectra were determined by Varian Mercury-300 MHz spectrometer, in the mixture of solvents DMSO-d_6 and CCl_4 (1:3), mass spectra were recorded on MX-1321A MS system. The reaction course control and individuality of the obtained substances were checked by using the TLC method on ''Silufol UV-254'' plates and acetone:hexane mixture (2:1) as eluent. Melting points are uncorrected. Initial hydrazides were prepared as described in [66,67].

Synthesis of compounds 1, 3, 5, and 7.

General Procedure. To a mixture of 0.02 mol azinyl-, azinylcarbonyl, or 1-[thiazol-5-carbonyl] hydrazide, 10 mL ethanol and 0.034 mol CS_2, a solution of 0.04 mol KOH in 10 mL ethanol at boiling was added dropwise with continuous stirring, and then the mixture was boiled for 7 to 8 h. After evaporation of ethanol, the residue was dissolved in water and acidified with 36% HCl up to pH 6. In an hour, the sediment of compounds **1**, **3**, **5**, and **7** was filtered off and dried in the air. The compounds **1**, **3**, **5**, and **7** were obtained as white, yellowish, or yellow crystals.

*1-(2-Amino-6-methyl-pyrimidin-4-yl)-diaziridine-3-thione (**1a**).* The compound was obtained in 75% yield; mp 333–335°C; recrystallized from ethanol:water (1:1); ^{1}H NMR: δ 2.13 (d, J = 1.0, 3H, 6-CH_3); 6.20 (q, J = 1.0, 1H, 5-H); 9.55 (b.s, 2H, 2-NH_2); ~14.0 (v.b.s, 1H, NH). MS (*m/z*): 181 (M^+). Anal. Calcd. for $C_6H_7N_5S$: C, 39.77; H, 3.89; N, 38.65; S, 17.69; Found: C, 39.60; H, 3.77; N, 38.43; S, 17.34.

*1-(2-Amino-5-butyl-6-methyl-pyrimidin-4-yl)-diaziridine-3-thione (**1b**).* The compound was obtained in 85% yield; mp 240–242°C; recrystallized from ethanol:water (1:1); ^{1}H NMR: δ 0.99 (m, 3H, CH_3-Bu); 1.30–1.38 (m, 4H, CH_2CH_2); 2.09 (s, 3H, 6-CH_3); 2.55 (b.t, 2H, Pyr-CH_2); 6.61 (b.s, 2H, 2-NH_2); ~14.0 (v.w.s, 1H, NH); ^{13}C NMR: δ 13.62; 18.60; 22.08; 24.10; 30.63; 112.18; 152.85; 153.81; 164.43. MS (*m/z*): 237 (M^+). Anal. Calcd. for $C_{10}H_{15}N_5S$: C, 50.61; H, 6.37; N, 29.51; S, 13.51; Found: C, 50.48; H, 6.24; N, 29.24; S, 13.85.

*1-(4-methoxy-6-methyl-pyrimidin-2-yl)-diaziridine-3-thione (**3**).* The compound was obtained in 70% yield; mp 337–339°C; recrystallized from ethanol:water (1:1); ^{1}H NMR: δ 3.10 (d, J = 1.0, 3H, 6-CH_3); 3.97 (s, 3H, OCH_3); 6.08 (q, J = 1.0, 1H, 5-H); 13.88 (b.s, 1H, NH). MS (*m/z*): 196 (M^+). Anal. Calcd. for $C_7H_8N_4OS$: C, 42.85; H, 4.11; N, 28.55; S, 16.34; Found: C, 42.68; H, 3.91; N, 28.38; S, 15.97.

*(4,6-Bis-dimethylamino-[1,3,5]triazin-2-yl)-(3-thioxo-diaziridin-1-yl)-methanone (**5**).* The compound was obtained in 74% yield; mp 227–229°C; recrystallized from ethanol:water (1:1); ^{1}H NMR: δ 3.18 and 3.24 [s,s, 6H,6H, N(CH_3)$_4$]; 14.28 (b.s, 1H, NH). MS (*m/z*): 267 (M^+). Anal. Calcd. for $C_9H_{13}N_7OS$: C, 40.44; H, 4,.90; N, 36.68; S, 11.99; Found: C, 40.21; H, 4,.72; N, 36.48; S, 11.63.

*(3,4-Dimethyl-2-thioxo-2,3-dihydro-thiazol-5-yl)-(3-thioxo-diaziridin-1-yl)-methanone (**7**).* The compound was obtained in 76% yield; mp 223–224°C; recrystallized from methanol; ^{1}H NMR: δ 2.67 (s, 3H, 4-CH_3); 3.69 (s, 3H, 3-CH_3); 14.40 (v.b.s, 1H, NH); ^{13}C NMR: δ 14.47; 34.20; 101.96; 143.84; 153.58; 176.35; 186.36. MS (*m/z*): 245 (M^+). Anal. Calcd. for $C_7H_7N_3OS_3$: C, 34.27; H, 2.88; N, 17.13; S, 39.21; Found: C, 33.97; H, 2.68; N, 16.85; S, 38.54.

Synthesis of compounds 2, 4, 6, and 8.

General procedure. To a solution of 0.05 mol KOH and 0.05 mol of compound **1**, **3**, **5**, or **7** in 10 mL of water, 0.05 mol of alkyl halide was added with continuous stirring at 20°C, and the mixture was allowed to stand overnight. The residue was filtered off, washed with water and dried in the air. Aryloxyethyl derivatives were obtained at heating in acetone at 50 to 55°C for 3 to 4 h. The compounds **2**, **4**, **6**, and **8** were obtained as white, yellowish or yellow crystals.

*1-(2-Amino-6-methyl-pyrimidin-4-yl)-3-methylsulfanyl-1H-diazirine (**2a**).* The compound was obtained in 70% yield; mp 186–187°C; recrystallized from dioxane:water (1:2); ^{1}H NMR: δ 2.28 (d, J = 1.0, 3H, 6-CH_3); 2.65 (s, 3H, SCH_3); 6.62 (q, J = 1.0, 1H, 5-H); 7.62 (b.s, 2H, 2-NH_2). MS (*m/z*): 195 (M^+). Anal. Calcd. for $C_7H_9N_5S$: C, 43.06; H, 4.65; N, 35.87; S, 16.42; Found: C, 42.94; H, 4.47; N, 35.67; S, 16.16.

*1-(2-Amino-5-butyl-6-methyl-pyrimidin-4-yl)-3-ethylsulfanyl-1H-diazirine (**2b**).* The compound was obtained in 59% yield; mp 103–105°C; recrystallized from dioxane:water (1:2);

^{1}H NMR δ (ppm): 0.98 (t, J = 7.4, 3H, CH_3-Pr); 1.30 (t, J = 7.4, 3H, CH_3CH_2S); 1.42 and 1.58 (m, 4H, CH_2CH_2); 2.24 (s, 3H, 6-CH_3); 2.75 (t, J = 7.4, 2H, 5-CH_2-Pr); 3.08 (q, J = 7.4, 2H, CH_3CH_2S); 7.42 (b.s, 2H, NH_2); ^{13}C NMR: δ 13.55; 14.19; 19.24; 22.08; 25.17; 30.82; 31.43; 109.09; 136.07; 142.83; 147.67; 153.41. MS (*m/z*): 265 (M^+). Anal. Calcd. for $C_{12}H_{19}N_5S$: C, 54.31; H, 7.22; N, 26.39; S, 12.08; Found: C, 54.48; H, 7.37; N, 26.05; S, 11.84.

*1-(2-Amino-5-ethyl-6-methyl-pyrimidin-4-yl)-3-methylsulfanyl-1H-diazirine (**2c**)*. The compound was obtained in 80% yield; mp 203–205°C; recrystallized from dioxane:water (1:2); ^{1}H NMR: δ 1.20 (t, J = 7.4, 3H, CH_3CH_2); 2.25 (s, 3H, 6-CH_3); 2.67 (s, 3H, SCH_3); 2.78 (q, J = 7.4, 2H, CH_2CH_3); 7.30 (b.s, 2H, 2-NH_2). MS (*m/z*): 223 (M^+). Anal. Calcd. for $C_9H_{13}N_5S$: C, 48.41; H, 5.87; N, 31.36; S, 14.36; Found: C, 48.27; H, 5.69; N, 31.08; S, 14.61.

*1-(2-Amino-5-ethyl-6-methyl-pyrimidin-4-yl)-3-ethylsulfanyl-1H-diazirine (**2d**)*. The compound was obtained in 80% yield; mp 155–157°C; recrystallized from dioxane:water (1:2); ^{1}H NMR: δ 1.19 (t, J = 7.4, 3H, CH_3CH_2); 1.24 (t, J = 7.4, 3H, CH_3CH_2S); 2.32 (s, 3H, 6-CH_3); 2.75 (q, J = 7.4, 2H, CH_3CH_2); 3.21 (q, J = 7.4, 2H, CH_3CH_2S); 6.93 (2H, b.s, 2-NH_2). MS (*m/z*): 237 (M^+). Anal. Calcd. for $C_{10}H_{15}N_5S$: C, 50.61; H, 6.37; N, 29.51; S, 13.51; Found: C, 50.49; H, 6.18; N, 29.20; S, 13.80.

*[1-(2-Amino-5-ethyl-6-methyl-pyrimidin-4-yl)-1H-diazirin-3-ylsulfanyl]-acetic acid methyl ester (**2e**)*. The compound was obtained in 67% yield; mp 177–179°C; recrystallized from hexane; ^{1}H NMR: δ 1.20 (t, J = 7.5, 3H, CH_3CH_2); 2.27 (s, 3H, 6-CH_3); 2.80 (q, J = 7.5, 2H, CH_3CH_2); 3.63 (s, 3H, OCH_3); 3.90 (s, 2H, SCH_2); 7.38 (b.s, 2H, 2-NH_2). MS (*m/z*): 281 (M^+). Anal. Calcd. for $C_{11}H_{15}N_5O_2S$: C, 46.96; H, 5.37; N, 24.89; S, 11.40; Found: C, 46.75; H, 5.22; N, 24.60; S, 11.64.

*[1-(2-Amino-5-ethyl-6-methyl-pyrimidin-4-yl)-1H-diazirin-3-ylsulfanyl]-acetic acid ethyl ester (**2f**)*. The compound was obtained in 71% yield; mp 201–203°C; recrystallized from hexane; ^{1}H NMR: δ 1.18 (t, J = 7.5, 3H, CH_3CH_2); 1.22 (t, J = 7.3, 3H, CH_3CH_2O); 2.28 (s, 3H, 6-CH_3); 2.82 (q, J = 7.5, 2H, CH_3CH_2); 3.85 (s, 2H, SCH_2); 4.08 (q, J = 7.3, 2H, CH_3CH_2O); 7.38 (b.s, 2H, 2-NH_2). MS (*m/z*): 295 (M^+). Anal. Calcd. for $C_{12}H_{17}N_5O_2S$: C, 48.80; H, 5.80; N, 23.71; S, 10.83; Found: C, 48.69; H, 5.58; N, 23.46; S, 10.51.

*1-(2-Amino-5-ethyl-6-methyl-pyrimidin-4-yl)-3-benzylsulfanyl-1H-diazirine (**2g**)*. The compound was obtained in 80% yield; mp 168–170°C; recrystallized from dioxane:water (1:2); ^{1}H NMR δ (ppm): 1.20 (3H, t, J = 7.4, CH_3CH_2); 2.24 (3H, s, 6-CH_3); 2.80 (q, J = 7.4, 2H, CH_3CH_2); 4.29 (s, 2H, SCH_2); 7.18–7.22 (5H, m, C_6H_5); 7.23 (2H, b.s, 2-NH_2); ^{13}C NMR: δ 13.28; 18.67; 19.01; 41.98; 110.29; 127.12; 127.97; 128.47; 128.50; 135.46; 136.00; 142.65; 147.46; 153.06. MS (*m/z*): 299 (M^+). Anal. Calcd. for $C_{15}H_{17}N_5S$: C, 60.18; H, 5.72; N, 23.39; S, 10.71; Found: C, 60.02; H, 5.58; N, 23.12; S, 10.52.

*1-(2-Amino-5-ethyl-6-methyl-pyrimidin-4-yl)-3-phenoxy-ethylsulfanyl-1H-diazirine (**2h**)*. The compound was obtained in 69% yield; mp 138–140°C; recrystallized from toluene; ^{1}H NMR: δ 1.21 (t, J = 7.5, 3H, CH_3CH_2); 2.25 (s, 3H, 6-CH_3); 2.80 (q, J = 7.5, 2H, CH_3CH_2); 3.42 (t, J = 7.1, 2H, SCH_2); 4.25 (t, J = 7.1, 2H, OCH_2); 6.70–7.23 (m, 5H, C_6H_5); 7.40 (b.s, 2H, 2-NH_2). MS (*m/z*): 329 (M^+). Anal. Calcd. for $C_{16}H_{19}N_5OS$: C, 58.34; H, 5.81; N, 21.26; S, 9.73; Found: C, 58.14; H, 5.65; N, 20.92; S, 9.85.

*1-(2-Amino-5-butyl-6-methyl-pyrimidin-4-yl)-3-phenoxy-ethylsulfanyl-1H-diazirine (**2i**)*. The compound was obtained in 75% yield; mp 110–112°C; recrystallized from toluene; ^{1}H NMR: δ 0.97 (t, J = 7.4, 3H, CH_3-Bu); 1.43 and 1.58 (m, 4H, CH_2CH_2); 2.23 (3H, s, 6-CH_3); 2.77 (t, J = 7.4, 2H, Pyr-CH_2); 3.42 (t, J = 7.1, 2H, SCH_2); 4.23 (t, J = 7.1, 2H, OCH_2); 6.72–7.23 (m, 5H, C_6H_5); 7.40 (b.s, 2H, 2-NH_2). MS (*m/z*): 357 (M^+). Anal. Calcd. for $C_{18}H_{23}N_5OS$: C, 60.48; H, 6.49; N, 19.59; S, 8.97; Found: C, 60.28; H, 6.25; N, 19.21; S, 8.65.

*1-(2-Amino-5-ethyl-6-methyl-pyrimidin-4-yl)-3-(2-p-tolyloxy-ethylsulfanyl)-1H-diazirine (**2j**)*. The compound was obtained in 82% yield; mp 132–134°C; recrystallized from toluene; ^{1}H NMR: δ 1.20 (t, J = 7.4, 3H, CH_3CH_2); 2.23 (s, 3H, 6-CH_3); 2.25 (s, 3H, CH_3-tolyl); 2.80 (q, J = 7.4, 2H, CH_3CH_2); 3.42 (t, J = 7.1, 2H, SCH_2); 4.22 (t, J = 7.0, 2H, OCH_2); 6.62 and 6.96 (m,m, 2H,2H, C_6H_4); 7.38 (b.s, 2H, 2-NH_2). MS (*m/z*): 343 (M^+). Anal. Calcd. for $C_{17}H_{21}N_5OS$: C, 59.45; H, 6.16; N, 20.39; S, 9.34; Found: C, 59.23; H, 6.01; N, 20.12; S, 8.97.

*1-(2-Amino-5-ethyl-6-methyl-pyrimidin-4-yl)-3-(2-o-tolyloxy-ethylsulfanyl)-1H-diazirine (**2k**)*. The compound was obtained in 73% yield; mp 163–165°C; recrystallized from toluene; ^{1}H NMR: δ 1.20 (t, J = 7.4, 3H, CH_3CH_2); 2.23 (s, 3H, 6-CH_3); 2.25 (s, 3H, CH_3-tolyl); 2.80 (q, J = 7.4, 2H, CH_3CH_2); 3.42 (t, J = 7.1, 2H, SCH_2); 4.22 (t, J = 7.0, 2H, OCH_2); 6.62 and 6.96 (m,m, 2H,2H, C_6H_4); 7.38 (b.s, 2H, 2-NH_2). MS (*m/z*): 343 (M^+). Anal. Calcd. for $C_{17}H_{21}N_5OS$: C, 59.45; H, 6.16; N, 20.39; S, 9.34; Found: C, 59.21; H, 6.13; N, 20.25; S, 9.03.

*[1-(2-Amino-5-ethyl-6-methyl-pyrimidin-4-yl)-1H-diazirin-3-ylsulfanyl]-acetonitrile (**2l**)*. The compound was obtained in 85% yield; mp 178–180°C; recrystallized from acetone:water (1:2); ^{1}H NMR: δ 1.23 (t, J = 7.4, 3H, CH_3CH_2); 2.27 (s, 3H, 6-CH_3); 2.80 (q, J = 7.4, 2H, CH_3CH_2); 4.10 (s, 2H, SCH_2); 7.33 (b.s, 2H, 2-NH_2). MS (*m/z*): 248 (M^+). Anal. Calcd. for $C_{10}H_{12}N_6S$: C, 48.37; H, 4.87; N, 33.85; S, 12.91; Found: C, 48.19; H, 4.67; N, 33.59; S, 12.65.

*2-[1-(2-Amino-5-ethyl-6-methyl-pyrimidin-4-yl)-1H-diazirin-3-ylsulfanyl]-acetamide (**2m**)*. The compound was obtained in 87% yield; mp 177–179°C; recrystallized from ethanol:water (1:1); ^{1}H NMR: δ 1.20 (t, J = 7.5, 3H, CH_3CH_2); 2.27 (s, 3H, 6-CH_3); 2.80 (q, J = 7.5, 2H, CH_3CH_2); 3.75 (s, 2H, SCH_2); 6.97 and 7.51 (b.s, 1H,1H, NH_2-amid); 7.46 (b.s, 2H, 2-NH_2); ^{13}C NMR: δ 13.46; 18.72; 19.25; 40.85; 109.98; 136.96; 143.40; 148.00; 153.30; 168.51. MS (*m/z*): 266 (M^+). Anal. Calcd. for $C_{10}H_{14}N_6OS$: C, 45.10; H, 5.30; N, 31.56; S, 12.04; Found: C, 45.21; H, 5.13; N, 31.30; S, 11.84.

*2-[1-(2-Amino-5-butyl-6-methyl-pyrimidin-4-yl)-1H-diazirin-3-ylsulfanyl]-acetamide (**2n**)*. The compound was obtained in 88% yield; mp 203–205°C; recrystallized from ethanol:water (1:1); ^{1}H NMR: δ 0.97 (t, J = 7.4, 3H, CH_3-Bu); 1.45 and 1.60 (m, 4H, CH_2CH_2); 2.24 (s, 3H, 6-CH_3); 2.75 (q, J = 7.4, 2H, Pyr-CH_2); 3.75 (s, 2H, SCH_2); 7.10 and 7.53 (b.s, 1H,1H, NH_2-amid); 7.54 (b.s, 2H, 2-NH_2). MS (*m/z*): 294 (M^+). Anal. Calcd. for $C_{12}H_{18}N_6OS$: C, 48.96; H, 6.16; N, 28.55; S, 10.89; Found: C, 48.75; H, 6.02; N, 28.19; S, 10.76.

*3-[1-(2-Amino-5-ethyl-6-methyl-pyrimidin-4-yl)-1H-diazirin-3-ylsulfanyl]-pentane-2,4-dione (**2o**)*. The compound was obtained in 77% yield; mp 175–177°C; recrystallized from acetone:water (1:2); ^{1}H NMR: δ 1.20 (t, J = 7.5, 3H, CH_3CH_2); 2.25 (s, 3H, 6-CH_3); 2.50 [s, 6H, $(CH_3)_2$ of ketone and enol]; 2.77 (q, J = 7.5, 2H, CH_3CH_2); 5.98 (s, CH-

ketone-15%); 7.10 (b.s, 2H, 2-NH_2); 17.2 (v.b.s, OH-enol-85%); ^{13}C NMR: δ 13.21; 18.75; 18.84; 24.44; 101.13; 110.42; 138.91; 142.49; 146.69; 152.93; 196.92. MS (*m/z*): 307 (M^+). Anal. Calcd. for $C_{13}H_{17}N_5O_2S$: C, 50.80; H, 5.57; N, 22.78; S, 10.43; Found: C, 50.69; H, 5.39; N, 22.51; S, 10.78.

*1-(4-methoxy-6-methyl-pyrimidin-2-yl)-3-ethylsulfanyl-1H-diazirine (**4a**).* The compound was obtained in 67% yield; mp 147–149°C; recrystallized from dioxane:water (1:2); ^{1}H NMR: δ 1.45 (t, J = 7.2, 3H, CH_3CH_2); 2.90 (d, J = 1.0, 3H, 6-CH_3); 3.27 (q, J = 7.2, 2H, SCH_2); 4.00 (s, 3H, OCH_3); 6.30 (q, J = 1.0, 1H, 5-H). MS (*m/z*): 224 (M^+). Anal. Calcd. for $C_9H_{12}N_4OS$: C, 48.20; H, 5.39; N, 24.98; S, 14.30; Found: C, 48.02; H, 5.22; N, 24.67; S, 13.91.

*[1-(4-methoxy-6-methyl-pyrimidin-2-yl)-1H-diazirine-3-ylsulfanyl]-acetonitrile (**4b**).* The compound was obtained in 75% yield; mp 210–212°C; recrystallized from acetone:water (1:2); ^{1}H NMR: δ 2.89 (d, J = 1.0, 3H, 6-CH_3); 4.04 (s, 3H, OCH_3); 4.25 (s, 2H, SCH_2); 6.40 (q, J = 1.0, 1H, 5-H); ^{13}C NMR δ: 18.70; 19.92; 53.89; 102.58; 116.47; 137.05; 146.44; 155.09; 164.48. MS (*m/z*): 235 (M^+). Anal. Calcd. for $C_9H_9N_5OS$: C, 45.95; H, 3.86; N, 29.77; S, 13.63; Found: C, 45.82; H, 3.67; N, 29.51; S, 13.81.

*(4,6-Bis-dimethylamino-[1,3,5]triazin-2-yl)-(3-methylsulfanyl-diazirin-1-yl)-methanone (**6a**).* The compound was obtained in 80% yield; mp 158–160°C; recrystallized from hexane:benzene (1:1); ^{1}H NMR: δ 2.80 (s, 3H, S—CH_3); 3.15 and 3.23 [s,s, 6H,6H, $N(CH_3)_4$]. MS (*m/z*): 281 (M^+). Anal. Calcd. for $C_{10}H_{15}N_7OS$: C, 42.69; H, 5.37; N, 34.85; S, 11.40; Found: C, 42.42; H, 5.26; N, 34.59; S, 11.12.

*(4,6-Bis-dimethylamino-[1,3,5]triazin-2-yl)-(3-benzylsulfanyl-diazirin-1-yl)-methanone (**6b**).* The compound was obtained in 55% yield; mp 125–127°C; recrystallized from hexane:benzene (1:1); ^{1}H NMR: δ 3.16 and 3.23 [s,s, 6H,6H, $N(CH_3)_4$]; 4.56 (s, 2H, S—CH_2); 7.22–7.50 (m, 5H, C_6H_5). MS (*m/z*): 357 (M^+). Anal. Calcd. for $C_{16}H_{19}N_7OS$: C, 53.76; H, 5.36; N, 27.43; S, 8.97; Found: C, 53.62; H, 5.17; N, 27.13; S, 8.68.

*(3,4-Dimethyl-2-thioxo-2,3-dihydro-thiazol-5-yl)-(3-methylsulfanyl-diazirin-1-yl)-methanone (**8a**).* The compound was obtained in 76% yield; mp 154–156°C; recrystallized from toluene; ^{1}H NMR: δ 2.70 (s, 3H, 4-CH_3); 2.78 (s, 3H, SCH_3); 3.71 (s, 3H, 3-CH_3); ^{13}C NMR: δ 14.08; 14.46; 34.21; 102.29; 143.28; 158.18; 163.36; 186.33. MS (*m/z*): 259 (M^+). Anal. Calcd. for $C_8H_9N_3OS_3$: C, 37.05; H, 3.50; N, 16.20; S, 37.09; Found: C, 36.85; H, 3.28; N, 15.89; S, 36.78.

*(3,4-Dimethyl-2-thioxo-2,3-dihydro-thiazol-5-yl)-(3-propylsulfanyl-diazirin-1-yl)- methanone (**8b**).* The compound was obtained in 87% yield; mp 124–126°C; recrystallized from hexane:benzene (1:1); ^{1}H NMR: δ 1.09 (t, J = 7.3, 3H, CH_3-Pr); 1.87 (m, 2H, $CH_3CH_2CH_2$); 2.71 (s, 3H, 4-CH_3); 3.26 (t, J = 7.2, 2H, SCH_2); 3.70 (s, 3H, 3-CH_3); ^{13}C NMR: δ 12.58; 14.43; 22.09; 33.83; 34.18; 102.33; 143.16; 158.05; 162.71; 186.30. MS (*m/z*): 287 (M^+). Anal. Calcd. for $C_{10}H_{13}N_3OS_3$: C, 41.79; H, 4.56; N, 14.62; S, 33.47; Found: C, 41.62; H, 4.34; N, 14.21; S, 33.62.

*[1-(3,4-Dimethyl-2-thioxo-2,3-dihydro-thiazol-5-carbonyl)-1H-diazirin-3-ylsulfanyl]-acetic acid methyl ester (**8c**).* The compound was obtained in 65% yield; mp 103–104°C; recrystallized from benzene; ^{1}H NMR: δ 2.70 (s, 3H, 4-CH_3); 3.71 (s, 3H, 3-CH_3); 3.77 (s, 3H, OCH_3); 4.16 (s, 2H, SCH_2). MS (*m/z*): 317 (M^+). Anal. Calcd. for $C_{10}H_{11}N_3O_3S_3$: C, 37.84; H, 3.49; N, 13.24; S, 30.31; Found: C, 37.70; H, 3.25; N, 13.00; S, 29.95.

*2-[1-(3,4-Dimethyl-2-thioxo-2,3-dihydro-thiazol-5-carbonyl)-1H-diazirin-3-ylsulfanyl]-acetamid (**8d**).* The compound was obtained in 81% yield; mp 192–194°C; purified at boiling from ethanol; ^{1}H NMR: δ 2.70 (s, 3H, 4-CH_3); 3.70 (s, 3H, 3-CH_3); 4.00 (s, 2H, SCH_2); 7.12 and 7.58 (b.s, 2H, NH_2); ^{13}C NMR: δ 14.51; 34.34; 35.90; 102.30; 143.78; 158.16; 162.79; 167.14; 186.30. MS (*m/z*): 302 (M^+). Anal. Calcd. for $C_9H_{10}N_4O_2S_3$: C, 35.75; H, 3.33; N, 18.53; S, 31.81; Found: C, 35.53; H, 3.14; N, 18.33; S, 31.94.

*3-[1-(3,4-Dimethyl-2-thioxo-2,3-dihydro-thiazol-5-carbonyl)-1H-diazirin-3-ylsulfanyl]-pentane-2,4-dione (**8e**).* The compound was obtained in 90% yield; mp 174–176°C; recrystallized from hexane:benzene (1:1); ^{1}H NMR: δ 2.45 [s, 6H, $(CH_3)_2$ ketone and enol]; 2.69 (s, 3H, 4-CH_3); 3.70 (s, 3H, 3-CH_3); 5.76 (s, CH-ketone 20%); 17.35 (b.s, OH-enol 80%); ^{13}C NMR: δ 14.43; 23.93; 34.20; 38.66; 102.17; 143.68; 158.77; 161.36; 186.39; 197.08. MS (*m/z*): 343 (M^+). Anal. Calcd. for $C_{12}H_{13}N_3O_3S_3$: C, 41.97; H, 3.82; N, 12.23; S, 28.01; Found: C, 41.72; H, 3.79; N, 11.92; S, 27.74.

*(3,4-Dimethyl-2-thioxo-2,3-dihydro-thiazol-5-yl)-(3-benzylsulfanyl-diazirin-1-yl)-methanone (**8f**).* The compound was obtained in 94% yield; mp 132–134°C; recrystallized from hexane:benzene (1:1); ^{1}H NMR: δ 2.68 (s, 3H, 4-CH_3); 3.69 (s, 3H, 3-CH_3); 4.50 (s, 2H, SCH_2); 7.23–7.46 (m, 5H, C_6H_5); ^{13}C NMR: δ 14.44; 34.17; 36.01; 102.20; 127.32; 128.05; 128.58; 135.36; 143.36; 158.27; 162.19; 186.35. MS (*m/z*): 335 (M^+). *Anal* Calcd. for $C_{14}H_{13}N_3OS_3$: C, 50.12; H, 3.91; N, 12.53; S, 28.67; Found: C, 50.23; H, 3.79; N, 12.23; S 28.36.

*(3,4-Dimethyl-2-thioxo-2,3-dihydro-thiazol-5-yl)-[3-(4-chloro-benzylsulfanyl)-diazirin-1-yl]-methanone (**8g**).* The compound was obtained in 88% yield; mp 168–169°C; recrystallized from hexane:benzene (1:1); ^{1}H NMR: δ 2.68 (s, 3H, 4-CH_3); 3.69 (s, 3H, 3-CH_3); 4.49 (s, 2H, SCH_2); 7.30 and 7.46 (m,m, 2H,2H, C_6H_4); ^{13}C NMR: δ 14.45; 34.19; 35.17; 102.19; 128.10; 130.28; 132.84; 134.46; 143.43; 158.35; 162.03; 186.36. MS (*m/z*): 369 and 371 (M^+). Anal. Calcd. for $C_{14}H_{12}ClN_3OS_3$: C, 45.46; H, 3.27; N, 11.36; S, 26.00; Cl, 9.58; Found: C, 45.27; H, 3.09; N, 11.12; S, 25.78, Cl, 9.28.

*(3,4-Dimethyl-2-thioxo-2,3-dihydro-thiazol-5-yl)-{3-[2-(4-bromo-phenoxy)-ethylsulfanyl]-diazirin-1-yl}-methanone (**8h**).* The compound was obtained in 90% yield; mp 158–160°C; recrystallized from hexane:benzene (1:1); ^{1}H NMR: δ 2.69 (s, 3H, 4-CH_3); 3.65 (t, J = 6.1, 2H, SCH_2); 3.70 (s, 3H, 3-CH_3); 4.36 (t, J = 6.1, 2H, OCH_2); 6.86 and 7.35 (m,m, 2H,2H, C_6H_4); ^{13}C NMR: δ 14.44; 31.12; 34.19; 65.63; 102.20; 112.44; 116.12; 131.63; 143.40; 156.76; 158.33; 162.38; 186.37. MS (*m/z*): 443 and 445 (M^+). Anal. Calcd. for $C_{15}H_{14}BrN_3O_2S_3$: C, 40.54; H, 3.18; N, 9.46; S, 21.65. Found: C, 40.30; H, 2.95; N, 9.68; S, 21.56.

REFERENCES AND NOTES

[1] Abendroth, H. J.; Henrich, G. Angew Chem 1959, 71, 283.
[2] Paulsen, S. R. Angew Chem 1960, 72, 781.
[3] Schmitz, E.; Ohme, R. Tetrahedron Lett 1961, 2, 612.
[4] Modarelli, D. A.; Platz, M. S. J Am Chem Soc 1993, 115, 470.
[5] Ford, F.; Yyzawa, T.; Platz, M. S.; Matzinger, S.; Fulscher, M. J Am Chem Soc 1998, 120, 4430.

[6] Ettinger, R. J Chem Phys 1964, 40, 1693.
[7] Simmons, J. D.; Bartky, I. R.; Bass, A. M. J Mol Spectrosc 1965, 17, 48.
[8] Robin, J. M. B.; Basch, H.; Kuebler, N. A.; Wiberg, K. B.; Ellison, G. B. J Chem Phys 1969, 57, 45.
[9] Robertson, L. C.; Merritt, J. A. J Chem Phys 1972, 57, 941.
[10] Hepburn, P. H.; Hollas, J. M. J Mol Spectrosc 1974, 50, 126.
[11] Pierce, L.; Dobyns, V. J Am Chem Soc 1962, 84, 2651.
[12] Hencher, J. L.; Bauer, S. H. J Am Chem Soc 1967, 89, 5527.
[13] Scharpen, L. H.; Wollrab, J. E.; Ames, D. P.; Merritt, J. A. J Chem Phys 1969, 50, 2063.
[14] Rauk, A. J Am. Chem Soc 1981, 103, 1023.
[15] Shustov, G. V.; Kadorkina, G. K.; Kostyanovskii, R. G.; Rauk, A. J Am Chem Soc 1988, 110, 1719.
[16] Shustov, G. V.; Varlamov, S. V.; Rauk, A.; Kostyanovskii, R. G. J Am Chem Soc 1990, 112, 3403.
[17] Church, R. F. R.; Kende, A. S.; Weiss, M. J. J Am Chem Soc 1965, 87, 2665.
[18] Makhova, N. N.; Kamalova, N. G.; Strelenko, Y. A. Mendeleev Commun 2001, 11, 227.
[19] Blair, J. A.; Gardner, R. J. J Chem Soc Perkin Trans 1 1972, 1, 485.
[20] Schmitz, E.; Schinkowiski, K. Ber Dtsch Chem Ges 1964, 97, 49.
[21] Nabeya, A.; Tamura, Y.; Kodama, T.; Iwakura, Y. J Org Chem 1973, 38, 3758.
[22] Kostyanovsky, R. G.; Shustov, G. V.; Markov, V. I. Izv Akad Nauk SSSR, Ser Khim 1974, 2823.
[23] Schmitz, E. Angew Chem Int Ed Engl 1964, 3, 333.
[24] Gupta, R. R.; Kumar, M.; Gupta, V. J Heterocycl Chem 1998, 335.
[25] Schmitz, E.; Ohme, R. Org Synth 1965, 45, 83.
[26] Shustov, G. V.; Tavakalyan, R. G.; Kostyanovsky, R. G. Angew Chem Int Ed Engl 1981, 20, 200.
[27] Graham, W. H. J Am Chem Soc 1962, 84, 1063.
[28] Graham, W. H. J Am Chem Soc 1965, 87, 4396.
[29] Heine, H. W.; Lehman, L. S.; Glaze, A. P.; Douglas A. W. J Org Chem 1980, 45, 1317.
[30] Firth, W. C., Jr. J Org Chem 1968, 33, 3489.
[31] Alper, H.; Delledonne, D.; Kameyama, M.; Robert, D. Organometallics 1990, 9, 762.
[32] Heine, H. W.; Baclawski, L. M.; Bonser, S. M.; Wachob, G. D. J Org Chem 1976, 41, 3229.
[33] Nabeya, A.; Saito, J.; Koyama, H. J Org Chem 1979, 44, 3935.
[34] Church, R. F. R.; Weiss, M. J. J Org Chem 1970, 35, 2465.
[35] Jung, M.; Schurig, V. J Am Chem Soc 1992, 114, 529.
[36] Nielsen, I. M. B. J Phys Chem A 1998;102, 3193.
[37] Nielsen, A. T.; Moore, D. W.; Atkins, R. L.; Mallory, D.; DiPol, J.; LaBerge, J. M. J Org Chem 1976, 41, 3221.
[38] Komatsu, M.; Nishikaze, N.; Sakamoto, M.; Ohshiro, Y.; Agawa, T. J Org Chem 1974, 39, 3198.
[39] Shustov, G. V.; Tavakalyan, R. G.; Pleshkova, A. P.; Kostyanovsky, R. G. Chem Heterocycl Comp 1981, 17, 662.
[40] Maxey, C. T.; Sleiman, H. F.; Massey, S. T.; McElwee-White, L. J Am Chem Soc 1992, 114, 5153.
[41] Ishihara, H.; Hori, K.; Sugihara, H.; Ito, Y. N.; Katsuki, T. Helv Chim Acta 2002, 85, 4272.
[42] Mangholz, S. E.; Briner, K.; Bernet, B.; Vasella, A. Helv Chim Acta 2003, 86, 2490.
[43] Kuznetsov, V. V.; Syroeshkina, J. S., Moskvin, D. I.; Struchkova, M. I.; Makhova, N. N.; Zharov, A. A. J Heterocycl Chem 2008, 45, 497.
[44] Moss, R. A. Acc Chem Res 2005, 39, 267.
[45] Griffin, G. W. Angew Chem Int Ed Engl 1971, 10, 537.
[46] Schmitz, E.; Habisch, D.; Stark, A. Angew Chem Int Ed Engl 1963, 2, 548.
[47] Szantay, Cs.; Chmielewicz, Z. F.; Bardos, T. J. J Med Chem 1967, 10, 101.
[48] Brunner, J.; Senn, H.; Richards, F. M. J Biol Chem 1980, 255, 3313.
[49] Ziegler, K.; Frimmer, M. Biochim Biophys Acta 1986, 855, 136.
[50] Hatanaka, Y.; Hashimoto, M.; Kurihara, H.; Nakayama, H.; Kanaoka, Y. J Org Chem 1994, 59, 383.
[51] Sato, S.; Yamada, M., Wakahara, T.; Tsuchiya, T.; Ishitsuka, M. O.; Akasaka, T.; Liu, M. T. H. Tetrahedron Lett 2007, 48, 6290.
[52] Volke, D.; Daghish, M.; Hennig, L.; Findeisen, M.; Giesa, S.; Oehme, R.; Welzel, P. Helv Chim Acta 2003, 86, 4214.
[53] Shigdel, U. K.; Zhang, J.; Chuan, H. Angew Chem Int Ed Engl 2007, 47, 90.
[54] Winnacker, M.; Breeger, S.; Strasser, R.; Carell, Th. Chembiochem 2009, 10, 109.
[55] Hashimoto, M.; Hatanaka, Y. Eur J Org Chem 2008, 2513.
[56] Bender, T.; Huss, M.; Wieczorek, H.; Grond, S.; von Zezschwitz, P. Eur J Org Chem 2007, 3870.
[57] Walter, M.; Wiegand, M.; Lindhorst, Th. K. Eur J Org Chem 2006, 719.
[58] Gutierrez, P. L.; Fox, B. M.; Mossoba, M. M.; Bachur, N. R. Mol. Pharm 1984, 26, 582.
[59] Sosnovsky, G.; Lukszo, J. J Cancer Res Clin Oncol 1984, 107, 217.
[60] Paget, Ch. J.; Davis, Ch. S. J Med Chem 1964, 7, 626.
[61] Wells, J. N.; Shirodkar, A. V.; Knevel, A. M. J Med Chem 1966, 9, 195.
[62] Husain, S. S.; Forman, S. A.; Kloczewiak, M. A.; Addona, G. H.; Olsen, R. W.; Pratt, M. B. Cohen, J. B.; Miller, K. W. J Med Chem 1999, 42, 3300.
[63] Xi, J.; Liu, R.; Rossi, M. J.; Yang, J.; Loll, P. J.; Dailey, W. P.; Eckenhoff, R. G. Chem Biol 2006, 1, 377.
[64] Dahlman, D. L.; Kadaba, P. K. Pestic Sci 1988, 22, 71.
[65] Dovlatyan, V. V.; Khachatryan, N. Kh. Armenian Chem J 1971, 24, 167.
[66] Dovlatyan, V. V.; Hambardzumyan, E. N.; Gomktsyan, T. A.; Vorskanyan, A. S.; Khachatryan, N. Kh.; Yengoyan, A. P. Chem J Armenia 2000, 53, 87.
[67] Dovlatyan, V. V.; Eliazyan, K. A.; Pivazyan, V. A.; Yengoyan, A. P. Chem Heterocycl Comp 2003, 39, 1238.