ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN—POLONIA
VOL. XLVIII/XLIX,6 SECTIO AA 1993/1994

Department of Organic Chemistry and Technology
Faculty of Chemistry, Maria Curie-Skłodowska University

WANDA KOWALEWSKA, WAWRZYNIEC PODKOŚCIELNY

# *Synthesis, Structure and Properties of 5-Chloro- and 5-Bromo-N-(4-Acenaphtyl)-α-Mercaptoacetamides and Their Acetic Derivatives*

Synteza, struktura i właściwości 5-chloro- i 5-bromo-N-(4-acenaftylo)-α-merkaptoacetamidów i ich pochodnych kwasowych.

## 1. INTRODUCTION

N-(2-naphthyl)-α-mercaptoacetamide called also thionalide is a valuable reagent used in the analysis of metals due to its structure and its reactivity.

In the literature one can find a detailed way of the preparation of thionalide on a laboratory and industrial scale from 2-naphthyl-amine, ammonium rhodanate and chloroacetic acid [1].

The purpose of the present article (which is a continuation of the earlier investigation [2]) is a synthesis and the description of the basic physicochemical and biological properties of the so far undescribed 5-chloro-and 5-bromo-(4-acenaphthyl)-α-mercaptoacetamides and some of their derivatives.

The compounds which are of our interest contain the acenaphthyl (instead of a naphthyl core) as well as the halogen substitutes. They are analogous compounds to thionalide and they are also characterized by some valuable analytical properties as it was mentioned above.

The initial products to the synthesis of 5-chloro- and 5-bromo-N-(4-acenaphthyl)-α-mercaptoacetamides were 5-chloro- and 5-bromo-4-amino-acenaphthenes. The above mentioned amines, reacting with the natrium salt of the thiocyanoacetic acid were giving: 5-chloro- and 5-bromo-4-(4-acenaphthylo)-α-carbamylthioacetamides (I and II).

The carbamylthioacetamides in reaction with the hot, 12% ammonium solution were giving the needed 5-chloro- and 5-bromo-(4-acenaphthyl)-α-mercaptoacetamides (III and IV).

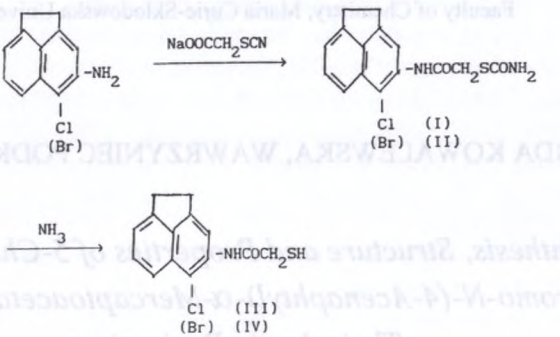



Fig. 1. Run of the above reactions

The commercially unavailable halogenoaminoacenaphthenes were received in our laboratory by the reduction of the halogenonitroacenaphthenes with 80% hydrazine hydrate in the presence of palladium on the active carbon coal in the solution of 96% ethyl alcohol.

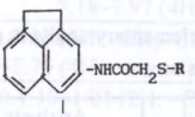
The output halogenonitroacenaphthenes were received according to our own method by the direct nitration of a corresponding halogenoacenaphthene with the concentrated nitric acid (d=1.42) in the glacial acetic acid in the temperature 0–5°C.

The structure of the halogenonitroacenaphthenes was confirmed with the help of the elementary analysis, IR, $^1$HNMR and basing on the agreement of the melting temperature with that of the compound received according to the literature data [3]. 5-chloro-4-nitroacenaphthene was so far prepared in an indirect way from the 5-nitroacenaphthene as the initial substance.

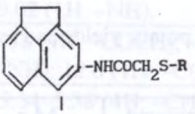
5-nitro-acenaphthene was reduced with 80% hydrazine hydrate in the solution of ethyl alcohol in the presence of Pd on the active carbon coal and the 5-aminoacenaphthene was received. The aminoacenaphthene was transformed into its acetyl derivative which was in consequence nitrated. The $NO_2$ group was introduced in position 4. The acetyl-compound was hydrolyzed and the received amino compound was changed (Sandmayer reaction) into the corresponding 5-chloro-4-nitroacenaphthene.

In the further investigation, by the reaction of 5-chloro- and 5-bromo-(4-acenaphthyl)-α-mercaptoacetamides with the salts of the acids: chloroacetic, α-

and β-bromo-propionic, α-bromo-iso-butyric, 4- and 2-bromobutyric, α-bromo-isovalerinic and 6- and 2-bromo-hexanic acid a whole series of some new compounds was received.




(III)




(IV)

| | R | | R |
|---|---|---|---|
| III-1 | $-CH_2COOH$ | IV-1 | $-CH_2COOH$ |
| III-2 | $-CH_2CH_2COOH$ | IV-2 | $-CH_2CH_2COOH$ |
| III-3 | $-CH(CH_3)-COOH$ | IV-3 | $-CH(CH_3)-COOH$ |
| III-4 | $-(CH_2)_3-COOH$ | IV-4 | $-(CH_2)_3-COOH$ |
| III-5 | $-CH(COOH)-CH_2CH_3$ | IV-5 | $-CH(COOH)-CH_2CH_3$ |
| III-6 | $-C(CH_3)_2-COOH$ | IV-6 | $-C(CH_3)_2-COOH$ |
| III-7 | $-(CH_2)_4-COOH$ | IV-7 | $-(CH_2)_4-COOH$ |
| III-8 | $-CH(COOH)-CH(CH_3)_2$ | IV-8 | $-CH(COOH)-CH(CH_3)_2$ |
| III-9 | $-(CH_2)_5-COOH$ | IV-9 | $-(CH_2)_5-COOH$ |
| III-10 | $-CH(COOH)-(CH_2)_3-CH_3$ | IV-10 | $-CH(COOH)-(CH_2)_3-CH_3$ |

Fig. 2. Structure of the newly obtained acids

The structure of all the newly received acids was presented in Figure 2, and their physicochemical properties as well as the results of the elementary analysis were given in Table 1.

The structure of the compounds was confirmed with the help of the spectral analysis IR and for most of the $^1$HNMR (Table 2).

The identification lines for the compounds I and II, occurring in the IR spectre at 3345–3173 $cm^{-1}$ correspond to the valence vibrations of the NH group, at 1621 $cm^{-1}$ to the deformation vibrations of the NH group, 1679–1657 $cm^{-1}$ correspond to the valence vibrations of the group C=O. The absorp-

tion line within 833–868 $cm^{-1}$ corresponds to the valence vibrations of the aromatic CH groups, while within 1431–1377 $cm^{-1}$ to the valence vibrations $C_{Ar}=C_{Ar}$.

Table 1. Melting points, yields and results of the elementary analyses of newly obtained compounds

| Compound Nr | M.p. [°C] | Yield [%] | Analysis, N [%] | |
|---|---|---|---|---|
| | | | calcd. | Found |
| I | 191-192 | 80 | 8.73 | 8.95 |
| II | 184-195 | 82 | 7.67 | 7.45 |
| III | 169-170 | 62 | 5.04 | 5.21 |
| IV | 175 | 62 | 4.34 | 4.65 |
| III-1 | 160-161 | 52 | 4.17 | 4.30 |
| III-2 | 124-125 | 48 | 3.99 | 3.72 |
| III-3 | 152-153 | 51 | 3.99 | 4.21 |
| III-4 | 144-145 | 62 | 3.85 | 3.71 |
| III-5 | 127-128 | 55 | 3.85 | 3.65 |
| III-6 | 162-163 | 60 | 3.85 | 3.61 |
| III-7 | 124-125 | 58 | 3.70 | 3.57 |
| III-8 | 144-145 | 54 | 3.70 | 3.48 |
| III-9 | 116-117 | 50 | 3.57 | 3.43 |
| III-10 | 135-136 | 49 | 3.57 | 3.38 |
| IV-1 | 163-164 | 55 | 3.68 | 3.80 |
| IV-2 | 142-143 | 52 | 3.55 | 3.39 |
| IV-3 | 152-153 | 56 | 3.55 | 3.40 |
| IV-4 | 121-122 | 51 | 3.43 | 3.28 |
| IV-5 | 134-135 | 58 | 3.43 | 3.31 |
| IV-6 | 145-146 | 48 | 3.43 | 3.55 |
| IV-7 | 133-134 | 50 | 3.31 | 3.08 |
| IV-8 | 125-126 | 50 | 3.31 | 3.50 |
| IV-9 | 113-114 | 49 | 3.21 | 3.40 |
| IV-10 | 126-127 | 51 | 3.21 | 3.05 |

Table 2. Proton chemical shift of 5-chloro- and 5-bromo-
-N-(4-acenaphthyl)-mercaptoacetamides and some of their acid derivatives

| Compound Nr | $^1$H–NMR (δ, ppm), 100 MHz |
|---|---|
| 1 | 2 |
| III | (DMSO) 3.00–3.17 (1H: –SH); 3.34 (4H: $-CH_2-CH_2-$); 3.41(2H: $-CO(CH_2)$; 7.22–7.81 (4H: –aromat); 9.93 (1H: –NH). |

Table 2. — continued

| 1 | 2 |
|---|---|
| IV | (DMSO) 2.01–2.20 (1H: –SH); 3.35-3.51 (6H: $–CH_2–CH_2–$, –COCH ); 7.18–7.97 (4H: –aromat); 9.02 (1H: –NH). |
| III-1 | (DMSO) 3.33 (4H: $–CH_2–CH_2–$); 3.49–3.58 (4H: $–COCH_2$, $–S–CH_2–$); 7.22–7.76 (4H: –aromat); 9.96 (1H: –NH); 12.6 (1H: –COOH). |
| III-2 | (DMSO) 1.10–1.24 (2H: $–CH_2COOH$); 3.34–3.38 (4H: $–CH_2–CH_2–$); 3.84–4.10 (4H: $–COCH_2$, $–S–CH_2–$); 7.22–7.80 (4H: –aromat). |
| III-3 | (DMSO) 1.36–1.43 (3H: $–CH_2$); 3.33 (4H: $–CH_2–CH_2–$); 3.56-3.77 (3H: $–COCH_2–$, –CH–); 7.22–7.80 (4H: -aromat); 9.78 (1H: –NH); 12.5 (1H: –COOH). |
| III-4 | ($CDCl_3$) 2.03 (2H: $–CH_2–CH_2–CH_2–$); 2.13 (2H: $–CH_2–COOH$); 2.22 (2H: $–S–CH_2–$); 3.35–3.53 (6H: $–CH_2–CH_2–$, $–COCH_2$); 7.18–7.96 (4H: –aromat); 9.1 (1H: –NH). |
| III-5 | ($CDCl_3$) 1.05 (3H: $–CH_2$); 1.8 (2H: $–CH_2–CH_2$); 3.20–3.38 (6H: $–CH_2–CH_2–$, $–COCH_2$); 3.49–3.57 (1H: –CH); 7.17–7.90 (4H: –aromat); 9.0 (1H: –NH); 9.55 (1H: –COOH). |
| III-7 | ($CDCl_3$) 1.68–1.78 (4H: $–CH_2–CH_2–CH_2–CH_2–$); 2.27–2.35 (2H: $–CH_2–COOH$); 2.68 (2H: $–S–CH_2$); 3.36 (4H: $–CH_2–CH_2–$); 3.48 (2H: $–COCH_2$); 7.20–8.04 (4H: –aromat); 9.25 (1H: –NH); 10.72 (1H: –COOH). |
| III-8 | ($CDCl_3$) 0.98–1.10 (6H: 2 $CH_3–$); 2.0–2.23 (1H: $CH–(CH_3)_2$); 3.21–3.28 (6H: $–CH_2–CH_2$, $–COCH_2$); 3.49–3.54 (1H: –CH–COOH); 7.24–7.9 (4H: –aromat); 8.98 (1H: –NH); 9.2 (1H: –COOH). |
| III-9 | ($CDCl_3$) 1.53–1.76 (6H: $–(CH_2)_3–$); 2.30 (2H: $–CH_2COOH$); 2.68 (2H: $–S–CH_2$); 3.37 (4H: $–CH_2–CH_2–$); 3.49 (2H: $–COCH_2$); 7.22–7.53 (4H: –aromat); 9.3 (1H: –NH); 9.89 (1H: –COOH). |
| III-10 | ($CDCl_3$) 0.85 (3H: $–CH_3$); 1.25–1.92 (6H: $–(CH_2)_3–$); 3.25–3.50 (6H: $–CH_2–CH_2–$, $–CO–CH_2$); 3.56 (1H: –CH–); 7.1–7.89 (4H: –aromat); 9.0 (1H: –NH); 10.72 (1H: –COOH). |
| IV-1 | (DMSO) 3.28 (4H: $–CH_2–CH_2–$); 3.51–3.60 (4H: $–COCH_2$, $S–CH_2–$); 7.22–7.81 (4H: –aromat); 9.98 (1H: –NH); 12.6 (1H: –COOH). |
| IV-3 | (DMSO) 1.36–1.44 (3H: $–CH_3$); 3.32 (4H: $–CH_2–CH_2–$); 3.56–3.7 (3H: $–CO–CH_2–$, –CH–COOH); 7.22–7.8 (4H: –aromat); 9.97 (1H:–NH); 12.60 (1H: –COOH). |
| IV-6 | (DMSO) 3.33 (6H: $–(CH_3)_2$); 3.40 (4H: $–CH_2–CH_2–$); 4.02 (2H: $–COCH_2$); 7.21–7.91 (4H: –aromat); 10.07 (1H: –NH). |
| IV-7 | (DMSO) 1.63–1.76 (6H: $–CH_2–CH_2–CH_2–$); 2.19–2.45 (1H: $–CH_2COOH$); 2.50–2.71 (2H: $–S–CH_2–$); 3.29 (4H: $–CH_2–CH_2–$); 3.47 (2H: $–COCH_2–$); 7.20–7.82 (4H: –aromat); 9.95 (1H: –NH). |
| IV-8 | (DMSO) 0.96–1.08 (6H: 2 $–CH_3$); 1.92–2.48 (1H: $–CH–(CH_3)_2$); 3.26 (1H: –S–CH–); 3.32 (4H: $–CH_2–CH_2–$); 3.60 (2H: $–COCH_2$); 7.22–7.83 (4H: –aromat); 10.02 (1H: –NH). |

Table 2. — continued

| 1 | 2 |
|---|---|
| IV-9 | (aceton) 1.49–1.68 (6H: $-CH_2-CH_2-CH_2-$); 2.20–2.26 (2H: $-CH_2COOH$); 2.68–2.82 (2H: $-S-CH_2-$); 3.35 (4H: $-CH_2-CH_2-$); 3.50 (2H: $-COCH_2$); 7.28–7.98 (4H: –aromat). |
| IV-10 | (DMSO) 0.8 (3H: $-CH_3$); 1.32–1.75 (6H: $-CH_2-CH_2-CH_2-$); 3.32 (4H: $-CH_2-CH_2-$); 3.62 (2H: $-COCH_2-$); 3.51 (1H: –CH–); 7.2–7.8 (4H: –aromat); 9.98 (1H: –NH). |

In compounds III and IV there are absorption lines within 2568–2548 $^{-1}$ and 1650 $cm^{-1}$ corresponding to the valence vibrations of the SH group at 3249 $cm^{-1}$ and 1650 $cm^{-1}$ to the vibrations of the NH group.

In the compounds of the kinds of the acidic derivatives of III and IV in the IR spectra there are the absorption lines at 3040–2832 $cm^{-1}$ corresponding to the valence vibrations of the OH group, at 1725–1651 $cm^{-1}$ to the valence vibrations of C=O and the deformations vibrations of the OH group at 1312–1211 $cm^{-1}$.

Newly received compounds were investigated at the Institute of Organic Industry in Warsaw in view of their biological activity. The physiological activity of the above mentioned compounds were studied against the insects, the *Tetranychus urticae* Koch, some plants and fungi. The study of the insecticide as well as *Tetranychus urticae* Koch activity were carried out in the laboratory, using some bioindicators like domestic fly, cockroach, plant louse, *Sitophilus granarius (L.)* and *Tetranychus urticae* Koch. In the investigation a sample of 1% or 0.1% acetone solution of the investigated compound was used. After 48 hours a test of the mortality of the indicators was carried out. The fungicidal activity was studied *in vitro*, using the fungi *Alternaria tenuis*, *Botrytis cinerea*, *Rhizoctoni solani*, *Fusarium culmorum* on the living plants covered with the spores of *Erysiphe graminis*. The phytocidal reaction of the compounds was studied before germination and after germination on 10 selected indicative plants, using the concentration corresponding to a dose of 5 kg/hectare.

The investigated compounds did not show any insecticide activity neither the *Tetranychus urticae* Koch nor phytocidal. One of them (I) turned out to have a good *Erysiphe graminis* reaction and the remaining ones were characterized by a middle one.

## 2. EXPERIMENTAL

### *1. 5-Chloroacetonaphthene*

5-Chloroacenaphthene was obtained according to the data found in literature [4] — by the addition of 21 $cm^{-1}$ of sulphuril chloride to 40 g of acenaphthene. The mixture was allowed to stand at room temperature during 48 hours and then it was distilled. The main fraction was gathered within 305–310°C. 20 g of product was received. It was crystallized in 150$cm^3$ of ethanol. The received substance was in the form of well shaped yellow blades which melted at 63°C.

### *2. 5-Bromoacetonaphthene*

154 g of acenaphthene and 380 $cm^3$ of 60% ethanol were heated at water bath to 45°C. Then 153 g of bromine was dropped into it during 30 minutes. The reacting mixture was warmed to 60°C and was kept at this temperature for 1 hour. Then it was cooled and the separated precipitate was filtered and dissolved in 200 $cm^3$ of benzene. After the diluent was removed by distillation, the remaining product was distilled under the decreased pressure and the main fraction was received at 205–210°C at 12 mmHg. The product (100 g) was crystallized in methanol (500 $cm^3$) and it represented yellow plates with m.p. at 54°C [5].

### *3. 5-Chloro-4-nitroacenaphthene.*

#### *Method a*

In the round bottom flask equipment with a mechanical stirrer, thermometer and a dropper, 17 g of 5-chloroacenaphthene and 56 $cm^3$ of the glacial acetic acid was placed. The mixture was cooled to 10°C and then 20 $cm^3$ of nitric acid (d=1.42) was dropped into it for about 20 minutes. The nitration was carried out so that the temperature never exceeded 15°C. After the whole amount of the nitric acid was dropped, the mixing was still kept on during 15 minutes. The separated precipitate was filtered, washed with water and dried. The received product (16 g) was crystallized three times in acetic acid (1 g in 10 $cm^3$) and 5-

chloro-4-nitroacenaphthene was received. Its melting point was of 141–142°C, according to literature data it is 142–143°C [3].

*Method b*

According to literature [3] in the second method 5-chloro-4-nitroacenaphthene was obtained by diazotization with the use of $NaNO_2$ in the acetic acid and sulphuric acid mixture at the temperature 5–20°C. To diazocompound $Cu_3Cl_2$ prepared in the reaction of $CuCl_2$, Cu, conc. HCl and water was introduced in the temperature range 80–90°C. The resulting mixture was then poured to water and extracted with benzene. After removal of the benzene the residue was recrystallized from ethanol to give yellow plates of 5-chloro-4-nitroacenaphthene; m.p. 141–142°C.

*4. 5-Chloro- and 5-bromo aminoacenaphthene*

In a round bottom flask fitted with a reflux condenser 0.15 mole of a corresponding nitrocompound was placed as well as 500 $cm^3$ of 96% ethanol, 1.5 g of 10% palladium on carbon and 40 $cm^3$ of 80% hydrazine hydrate. The whole mixture was warmed on the water bath during 2 hours, then the palladium was filtered. The solution was concentrated to 1/3 of volume, and 250 $cm^3$ of distilled water was added. The separated amino compound was filtered and dried.

5-chloro-4-aminoacenaphthene was in the form of colorless needles. The melting point 97–98°C. The yield 90%.

5-bromo-4-aminoacenaphthene was in the form of light yellow needles with the melting point 119–120°C. The yield 92%.

*5. 5-Chloro-N-(4-acenaphthyl)-α-carbamylothioacetamide (I)*
*5-Bromo-N-(4-acenaphthyl)-α-carbamylothioacetamide (II)*

A solution of 8.5 g (0.06 mole) of natrium salt of the thiocyanoacetic acid in 15 $cm^3$ of water was added into 0.05 mole of 5-chloro- or 5-bromo-4-aminoacenaphthene dissolved in 20$cm^3$ of glacial acetic acid. Then 10 $cm^3$ of water was still added and the reaction mixture was allowed to stand at the temperature of about 20°C during 12 hours. The separated precipitate was filtered, washed with water and with ethanol and then dried. 5-chloro- and 5-bromo-N-(4-acenaphthyl)-α-carbamylthioacetamide was purified by its crystallization with ethanol. Colorless needles of the compound I were received, with m.p. 191–192°C and the compound II appeared as shining plates of melting point 194–

195°C. The carbamylthioacetamides are easily soluble in acetone, dioxane, rather hard in methanol and ethanol, they are not soluble in water.

*6. 5-Chloro-N-(4-acenaphthyl)-α-mercaptoacetamide (III)*
*5-Bromo-N-(4-acenaphthyl)-α-mercaptoacetamide (IV)*

200 $cm^3$ of 12% ammonia was added into 0.02 mole of 5-chloro- or 5-bromo-N-(4-acenaphthyl)-α-carbamylothioacetamide and the whole of it was warmed on the boiling water bath during 20 minutes. Then the hot solution was filtered and immediately acidified with a diluted (1:1) HCl. After it was cooled, the separated precipitate was filtered, washed with a diluted hydrogen chloride, next with water, and then it as dried.

5-chloro- and 5-bromo-N-(4-acenaphthyl)-α-mercaptoacetamides, after they are crystallized in methanol, appear in the form of colourless needles of a melting point of 169–170°C (III) or shining plates of melting point 175°C (IV). The mercaptoacetamides are easily soluble in dioxane, acetone, with difficulty in methanol, ethanol and acetic acid, they are not soluble in water.

*7. The acid derivatives of 5-chloro- and 5-bromo-N-*
*-(4-acenaphthyl)-α-mercaptoacetamides*

0.01 mole of acenaphthylmercaptoacetamide was dissolved in 40 $cm^3$ of 20% water solution of NaOH and a solution of the natrium salt of a corresponding acid was added into the rapidly stirred liquid. (The natrium salt was obtained by neutralization of 0.015 mole of the acid dissolved in 20 $cm^3$ water with $NaHCO_3$.) The whole of it was heated on the boiling water bath for 20 minutes. Then it was cooled and separated precipitate of natrium salt was filtered. Crude compound was dissolved in 50–100 $cm^3$ of water and acidified with a diluted (1:1) HCl. The separated acid was filtered and dried. The compounds were crystallized:
the compounds III-1, IV-1 from 60% acetic acid,
III-2, IV-2 from the glacial acetic acid,
II-3, III-4, IV-3, IV-4 from 8% ethanol,
the remaining ones:
III-5, III-6, III-7, III-8, III-9, III-10, IV-5, IV-6, IV-7, IV-8, IV-9, IV-10 from ethanol.

The yield of the reactions and the melting points of the received compounds are given in Table 1.

## REFERENCES

[1] Jakovlev P.J., Malenina R.D., *Tionalid w analizie metali*, Moscow 1969.
[2] *Przem. Chem.*, 73/8 (1994).
[3] Saikachi Harno, Tsuge Otohiko, (Chiv. Kyushu) *Yakugaku Zasshi*, 80, 565–569 (1960); C.A., 52, 10062e.
[4] Crompton H., Walker U., *J. Chem. Soc.*, 101, 963 (1912).
[5] Daschevsskii, Karischin, *Org. Chem. Ind.* (USSR), 4, 108 (1937).

## STRESZCZENIE

Przedstawiono badania dotyczące syntezy, struktury i właściwości nowych 5-chloro- i 5-bromo-N-(4-acenaftylo)-α-merkaptoacetamidów. Związki te otrzymano w reakcji 5-chloro- lub 5-bromoamino-acenaftenów z solą sodową kwasu tiocyjanooctowego i alkalicznej hydrolizy utworzonych 5-chloro- i 5-bromo-N-(4-acenaftylo)-karbamylotioacetamidów. W wyniku działania na wymienione merkaptozwiązki solą sodową kwasu: chlorooctowego, α-i β-bromopropionowego, α-bromoizomasłowego, 4- i 2-bromobutanowego, α-bromoizowalerianowego oraz 6-i 2-bromoheksanowego otrzymano odpowiednie kwasy.

Dla wszystkich nowo otrzymanych związków określono podstawowe właściwości fizykochemiczne za pomocą analizy spektralnej IR i $^1$HNMR.

5-Chloro- i 5-bromo-N-(4-acenaftylo)-α-karbamylotioacetamidy (I i II) oraz 5-chloro- i 5-bromo-N-(4-acenaftylo)-α-merkaptoacetamidy (III i IV) zostały poddane badaniom biologicznym. Badano działanie tych substancji na owady, rośliny i grzyby. Dobrym działaniem mączniakobójczym wykazał się jedynie 5-chloro-N-(4-acenaftylo)-α-karbamylotioacetamid (I).