SYNTHESIS OF 16-(4-IODOPHENYL)HEXADECANOIC ACID

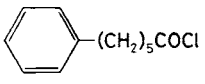
Jiří PROTIVA, Jaroslav PECKA, Eva KLINOTOVÁ and Miloš PROCHÁZKA

Department of Organic Chemistry,
Charles University, 128 40 Prague 2

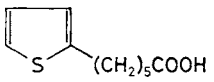
Received March 15th, 1985

16-(4-Iodophenyl) hexadecanoic acid was prepared in six steps by two methods: from 6-(2-thienyl)-hexanoic acid and 6-phenylhexanoyl chloride or by alkylation, or acylation, of 2-thienylthiophene. Mass and ^{1}H NMR spectra of some prepared compounds are discussed. The synthesis is suitable for preparation of radioactively labelled acids used as myocardial imaging agents.

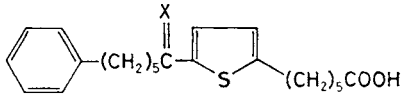
Saturated fatty acids, containing in the ω-position radioactive iodine (^{123}I or ^{125}I) or a substituent bearing this isotope, are recently used as myocardial imaging agents for diagnosis of infarct and cardiomyopathy[1,2]. Since acids, substituted only with iodine, are very rapidly washed out from the myocardium, undergo a fast *in vivo* deiodination, and leave longer radioactive background, there is an increasing interest in iodinated ω-phenyl or ω-thienyl fatty acids. So far, ^{123}I or ^{125}I-labelled 15-(4-iodophenyl)pentadecanoic acid[2,3], 17-(5-iodothienyl)heptadecanoic acid[4] or their α- or β-methyl analogues[5] have been studied and employed for this purpose. The metabolism of ω-iodo or ω-(4-iodophenyl) substituted fatty acids with an odd number of carbon atoms is sufficiently known[1]. On the contrary, saturated fatty acids with an even number of carbons have not been hitherto diagnostically applied and also the biological degradation of the ω-(4-iodophenyl) derivatives has not been studied as yet. It was therefore of interest to prepare 16-(4-iodophenyl)hexadecanoic acid (*XIII*) for the above-mentioned diagnostic purposes. The parent unsubstituted 16-phehylhexadecanoic acid is already known, its syntheses being based on reduction of the corresponding oxo compounds[6–8].



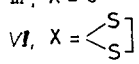
I



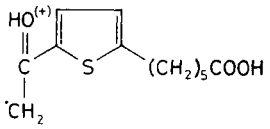
II



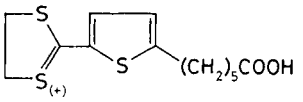
III, X = O

VI, X = 

The present communication concerns the preparation of the acid *XIII* by two methods, using thiophene for elongation of the carbon chain[9,10]. Friedel–Crafts acylation of 6-(2-thienyl)hexanoic acid (*II*) with 6-phenylhexanoyl chloride (*I*) in the presence of tin tetrachloride as catalyst afforded 6-(5-(ω-phenylhexanoyl)--2-thienyl)hexanoic acid (*III*). Its mass spectrum exhibits a relatively marked molecular ion which gives rise to characteristic fragments. The most abundant ion *a*, *m/z* 240, arises by the McLafferty rearrangement controlled by the keto group. Instead of the usually employed Huang–Minlon reaction, we reduced the carbonyl group in the ketone *III via* the corresponding dithioketal *IV* prepared by treatment with ethanedithiol in the presence of boron trifluoride etherate. The advantage of this method lies not only in the mild reaction conditions and high yields but also in the possibility of simultaneous removal of all the sulfur atoms in the molecule in one step. The dominant ion *b*, *m/z* 301, in the mass spectrum of dithioketal *IV* is typical for fragmentation of dithioketals. Desulfuration of *IV* with Raney nickel afforded 16-phenylhexadecanoic acid (*XI*) in high yield.



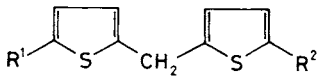
a, *m/z* 240



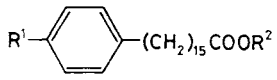
b, *m/z* 301

Since the preparation of the described starting compounds *I* and *II* is very laborious, our second synthesis started from 2-thenylthiophene (*V*) which was functionalized by introducing either the phenyl-containing moiety or the carbon chain with the carboxyl group. Reaction of 2-thenylthiophene (*V*) with butyl lithium gave the organolithium compound which on treatment with benzyl chloride afforded 2-benzyl--5-thenylthiophene (*VI*) in a 35% yield. This not very satisfactory yield is caused, *inter alia*, by simultaneous formation of considerable amounts of 1-phenyl-2,2'-dithienylethane (characterized in the ^{1}H NMR spectrum by a doublet at δ 3·31 (J = = 7·5 Hz) and a triplet at δ 4·65 (J = 7·5 Hz)) which can be separated from the desired derivative *VI* by crystallization. Acylation of 2-thenylthiophene (*V*) with ethoxycarbonylpentanoyl chloride in carbon disulfide in the presence of tin tetrachloride as catalyst, and subsequent alkaline hydrolysis, afforded the keto acid *IX* in good yield. Its mass spectrum exhibits a dominant peak at *m/z* 222 ($C_{11}H_{10}OS_2$) due to the ion formed by McLafferty rearrangement, controlled by the keto group. Analogous acylation of compound *VI*, followed by alkaline hydrolysis, gave keto acid *VII* which was reduced by the Huang–Minlon procedure to acid *VIII*. Similarly, the keto acid *IX* was reduced to the oily acid *X* which could be crystallized at −70°C from large amount of light petroleum and dried *in vacuo* at a temperature lower than 0°C. The preparation of the acid *VIII* and its derivatives from the acid *X* is

difficult. We did not succeed in the attempted alkylation of *X* with *p*-nitrobenzyl bromide or *p*-nitrobenzyl alcohol which, after reduction of the nitro group and desulfurization, should have led to 16-(4-aminophenyl)hexadecanoic acid. Under all the conditions used, destruction of the starting material in the acidic medium was faster than formation of the product. We tried zinc chloride, alone or with hydrogen chloride or bromide, sulfuric acid, and phosphorus pentoxide as catalysts in the attempted reaction with *p*-nitrobenzyl alcohol; tin tetrachloride was used in the experiment with *p*-nitrobenzyl bromide. Desulfuration of the acid *VIII* with Raney



V, $R^1 = R^2 = H$
VI, R^1 = benzyl, $R^2 = H$
VII, R^1 = benzyl, $R^2 = -CO(CH_2)_4COOH$
VIII, R^1 = benzyl, $R^2 = -(CH_2)_5COOH$
IX, $R^1 = H$, $R^2 = -CO(CH_2)_4COOH$
X, $R^1 = H$, $R^2 = -(CH_2)_5COOH$



XI, $R^1 = R^2 = H$
XII, $R^1 = H$, $R^2 = CH_3$
XIII, $R^1 = I$, $R^2 = H$

nickel afforded the acid *XI* in a good yield. We introduced iodine into *para*-position of the phenyl group using decomposition of the arylthallium derivative prepared by reaction of the methyl ester *XII* (obtained by esterification of *XI* with diazomethane) with thallium(III) trifluoroacetate in trifluoroacetic acid[3,11,12]. The crude thallium derivative on reaction with potassium iodide afforded the iodo ester which, without isolation, was subjected to alkaline hydrolysis to give the acid *XIII*. Its ^{1}H NMR spectrum exhibited a characteristic AA'BB' system due to the *ortho* and *meta*-protons of the phenyl ring at δ 6·83 and δ 7·5, a doublet of doublets (J = 8·2 Hz), but also minor signals at 6·8 and 7·3 ppm probably due to traces of the *ortho*-derivative.

EXPERIMENTAL

Melting points were determined on a Kofler block and are uncorrected. Measurements of ^{1}H NMR spectra were done on a Tesla 80 instrument in deuteriochloroform with hexamethyldisiloxane as internal standard; chemical shifts are given in the δ-scale. Mass spectra were taken on a Varian MAT 311 spectrometer, electron energy 70 eV, ionizing current 1 mA, direct inlet at 50–200°C. All the given compositions of the ions were confirmed by the high resolution technique; error less than 5 ppm. Thin-layer chromatography was carried out on Silufol UV 254 plates in benzene–ether (8 : 2 or 9 : 1) (detection with UV light) or on plates, coated with silica gel Merck 60G, in the above-mentioned solvent systems (detection by spraying with 10% sulfuric acid followed by heating to 200°C). The starting compounds *I* and *II* were prepared as follows. Hexanedioic acid monoethyl ester and 5-ethoxycarbonylpentanoyl chloride were prepared by modified known[13,14] procedures. Reaction of 5-ethoxycarbonylpentanoyl chloride with benzene and thiophene[15] afforded 5-benzylpentanoic acid and 5-thenoylpentanoic acid, respectively. Huang-Minlon

reduction of these respective acids gave 6-phenylhexanoic acid and 6-(2-thienyl)hexanoic acid (*II*, m.p. 39–40°C; reported[16] m.p. 41–43°C). 6-Phenylhexanoic acid was treated with thionyl chloride to give 6-phenylhexanoyl chloride (*I*), b.p. 151–152°C/1·5 kPa (reported[17] b.p. 151 to 152°C/1·5 kPa). 2-Thenylthiophene (*V*) was prepared by zinc chloride-catalyzed reaction of thiophene with formaldehyde[18] and purified by distillation through a column (b.p. 131°C/1·3 kPa) and crystallization from light petroleum; m.p. 47°C. Working up the extract means washing with water to neutrality and drying over anhydrous sodium sulfate.

6-(5-(6-Phenylhexanoyl)-2-thienyl)hexanoic Acid (*III*)

Freshly distilled tin tetrachloride (5·5 ml) was added dropwise at 5–10°C to a stirred solution of chloride *I* (7 g) and acid *II* (6·5 g) in benzene (50 ml). The solution was stirred for 1 h with cooling, for 1 h at room temperature, and then refluxed for 30 min on a water bath. After cooling, the mixture was decomposed with ice and 10% hydrochloric acid, extracted with ether (3 × 100 ml), and the combined ethereal extracts were worked up. Evaporation of the solvent gave 10 g of the crude product which was extracted several times with hot light petroleum. The extracts were combined and concentrated to crystallization, affording the acid *III* (9·2 g; 74%), m.p. 70–71°C. Mass spectrum, *m/z* (%): 372 (M^+, $C_{22}H_{28}O_3S$, 32), 285 (8); 263 (9), 257 (10), 253 (14), 240 (100), 235 (26), 225 (45), 139 (60), 97 (38), 91 (94). ^{1}H NMR spectrum 1·59 m (12 H); 2·8 m (8 H); 6·89 d (1 H, J = 4 Hz); 7·28 s (5 H); 7·58 d (1 H, J = 4 Hz); 11·13 bs (1 H).

Dithioketal *IV*

1,2-Ethanedithiol (3·8 ml) and boron trifluoride etherate (4 ml) were added dropwise to a solution of keto acid *III* (14 g) in acetic acid (50 ml). The solution was set aside at room temperature for 24 h, heated to 70°C for 1 h, cooled, diluted with water (150 ml) and extracted with ether. After the usual work-up procedure, the solvent was evaporated, leaving the oily dithioketal *IV* (15·1 g; 89%). Mass spectrum, *m/z* (%): 448 (M^+, $C_{24}H_{32}O_2S_3$, 6), 387 (6), 372 (5), 355 (21), 301 ($C_{13}H_{17}O_2S_3$, 100), 123 (18), 91 (76).

2-Benzyl-5-thenylthiophene (*VI*)

A solution of butyllithium in ether (prepared from 55 ml of butyl bromide and 9 g of lithium) was added dropwise during 30 min to a stirred and cooled (0°C) solution of 2-thenylthiophene (*V*; 100 g) in ether (500 ml) under nitrogen. After stirring at 0°C for 30 min, a solution of benzyl chloride (38 ml) in ether (100 ml) was added during 30 min. The mixture was allowed to stand for 15 h at room temperature, refluxed for 9 h, concentrated to about half of the original volume, decomposed with water (200 ml) under cooling and the aqueous layer was extracted twice with ether (200 ml). The combined organic layers were washed with water, dried over calcium chloride and the solvent was evaporated. Fractionation *in vacuo* afforded, after the unreacted starting *V* (33 g, m.p. 45°C, from light petroleum), a fraction, boiling at 160–210°C/0·3 kPa, which consisted of the title compound *VI* (35 g; 35%, based on the reacted *V*); m.p. 40–41°C (ether–methanol). Mass spectrum, *m/z* (%): 270 (M^+, $C_{16}H_{14}S_2$, 63), 193 (7·5), 179 (100), 173 (25), 97 (12), 91 (13). ^{1}H NMR spectrum: 3·92 s (2 H); 4·1 s (2 H); 6·53 d (1 H, J = 3·5 Hz); 6·46 d (1 H, J = 3·5 Hz); 6·72 m (2 H); 6·98 dd (1 H, J_1 = 5 Hz, J_2 = 2 Hz); 7·12 s (5 H). Mother liquors from the crystallization of *VI* contained considerable amount of 1-phenyl-2,2′-dithienylethane.

5-(5-(5-Benzyl-2-thenyl)-2-thienoyl)pentanoic Acid (*VII*)

Freshly distilled tin tetrachloride (13·5 ml) was added during 30 min to a cooled (0°C) and stirred

solution of *VI* (22 g) and 5-ethoxycarbonylpentanoyl chloride (17 g) in benzene (100 ml). The mixture was stirred for 1 h at 0°C, for 2 h at 20°C, and decomposed with ice and hydrochloric acid (10%). The product was taken up in chloroform (3 × 150 ml), the extract worked up, the solvent evaporated and the residue refluxed with 10% ethanolic potassium hydroxide (60 ml) for 3 h. After cooling and acidification with 10% hydrochloric acid, the liberated acid was extracted with chloroform (3 × 100 ml), the extract was worked up, filtered through a column of silica gel (40 g) and taken down. Crystallization of the residue from benzene–light petroleum afforded the product (15·8 g), melting at 114—118°C. Recrystallization from larger volumes of heptane, from acetic acid and finally from chloroform–ether gave pure acid *VII* (9·4 g; 27%), m.p. 121°C. Mass spectrum, *m/z* (%): 398 (M^+, $C_{22}H_{22}O_3S_2$, 16), 380 (42), 312 (15), 297 (46), 269 (65), 221 (38), 186 (72), 179 (43), 173 (51), 135 (31), 92 (100). ^{1}H NMR spectrum: 1·66 bs (4 H); 2·31 t (2 H, J = 6·5 Hz); 2·76 t (2 H, J = 6·5 Hz); 3·97 s (2 H); 4·15 s (2 H); 6·52 d (1 H, J = 3·3 Hz); 6·61 d (1 H, J = 3·3 Hz); 6·75 d (1 H, J = 3·5 Hz); 7·13 s (5 H); 7·42 d (1 H, J = 3·5 Hz).

6-(5-(5-Benzyl-2-thenyl)-2-thienyl)hexanoic Acid (*VIII*)

Keto acid *VII* (8·4 g) was dissolved in warm diethylene glycol (30 ml) and hydrazine hydrate (85%; 5 ml) and the solution was heated to 120°C for 1/2 h. Potassium hydroxide (7·5 g) in diethylene glycol (20 ml) was added and the temperature was gradually raised (with distillation of water and unreacted hydrazine hydrate) to 195°C. The mixture was kept at 195°C for 2 h, cooled, diluted with water (150 ml) and washed with ether (2 × 100 ml). The aqueous layer was acidified with 10% hydrochloric acid and extracted with ether (3 × 100 ml). After the usual work-up procedure, the ethereal solution was taken down and the residue crystallized from ether–light petroleum and then from methanol, yielding acid *VIII* (6·9 g; 85%), m.p. 67—68°C. Mass spectrum, *m/z* (%): 384 (M^+, $C_{22}H_{24}O_2S_2$, 45), 338 (11), 293 (60), 269 (100), 192 (45), 186 (34), 173 (38), 91 (100). ^{1}H NMR spectrum: 1·3—1·75 bm (4 H); 2·26 t (2 H, J = 6·5 Hz); 2·66 t (2 H, J = 7 Hz); 3·97 s (2 H); 2·83 s (2 H); 6·45 m (4 H); 7·13 s (5 H).

5-(5-Thenyl-2-thenoyl)pentanoic Acid (*IX*)

Tin tetrachloride (50 ml) in carbon disulfide (50 ml) was added dropwise during 15 min to a stirred and cooled (—20°C) solution of 2-thenylthiophene (*V*; 114 g) and 5-ethoxycarbonylpentanoyl chloride (61 g) in carbon disulfide (500 ml). After stirring for another 15 min without cooling, the mixture was shaken with an ice-water mixture and chloroform (500 ml). The organic layer was washed with water and worked up. The concentrated residue was heated with a 10% solution of potassium hydroxide (300 ml) in 90% ethanol for 2 h to 50°C and concentrated *in vacuo*. The residue was mixed with water (200 ml) and the aqueous solution was extracted with chloroform (2 × 150 ml). The combined chloroform portions were worked up and taken down and the residue was fractionated on a column. The fraction, boiling at 128—135°C/1·3 kPa, was recrystallized from light petroleum, affording unreacted *V* (83 g), m.p. 46°C. The aqueous solution (after extraction with chloroform) was acidified with hydrochloric acid and again extracted with chloroform. The chloroform portions were dried over anhydrous sodium sulfate, concentrated and diluted with ether. The strongly polar side-product (9·8 g) was filtered off and the filtrate taken down. The residue was dissolved in benzene, and the solution filtered through a column of silica gel (200 g). Crystallization from benzene–light petroleum and from acetic acid afforded 42 g of *IX* (61%, based on the reacted 2-thenylthiophene), m.p. 71—76°C. Further crystallization from light petroleum raised the m.p. to 76—77°C. Mass spectrum, *m/z* (%): 308 (M^+, $C_{15}H_{16}O_3S_2$, 8), 290 (9), 222 (100), 207 (95), 179 (75), 147 (26), 135 (47), 97 (54), 91 (23). ^{1}H NMR spectrum: 1·67 m (4 H); 2·27 t (2 H, J = 6·5 Hz); 2·75 t (2 H, J = 6·5 Hz); 4·25 s (2 H); 6·82 bs (2 H); 7·1 m (2 H); 7·45 d (1 H, J = 5 Hz); 10·42 bs (1 H).

6-(5-Thenyl-2-thienyl)hexanoic Acid (*X*)

A solution of acid *IX* (35 g) in diethylene glycol (150 ml) and hydrazine hydrate (85%, 25 ml) was heated to 120°C for 30 min. Potassium hydroxide (40 g) in diethylene glycol (100 ml) was added and the mixture was refluxed for 30 min. The temperature was then increased to 200°C with simultaneous removal of water and unreacted hydrazine hydrate by distillation. The mixture was kept at 200°C for 2 h, cooled and diluted with water. The solution was washed with ether (2 × 200 ml), the aqueous layer acidified with 10% hydrochloric acid, the product extracted with ether (4 × 200 ml), the extract worked up and the solvent evaporated. The residue was dissolved in benzene and passed through a column of silica gel (50 g). Evaporation of the solvent afforded acid *X* (32·2 g; 96%) as an oil which solidified on standing (m.p. about 30°C). Mass spectrum, *m/z* (%): 294 (M^+, $C_{15}H_{18}O_2S_2$, 52), 248 (5), 205 (8), 193 (100), 179 (84), 160 (25), 97 (33). ^{1}H NMR spectrum: 1·51 m (6 H); 2·27 t (2 H, J = 6·5 Hz); 2·68 t (2 H, J = 6·5 Hz); 4·18 s (2 H); 6·48 d (1 H, J = 3·5 Hz); 6·58 d (1 H, J = 3·5 Hz); 6·82 m (2 H); 7·06 dd (1 H, J_1 = 5 Hz, J_2 = 2 Hz).

16-Phenylhexadecanoic Acid (*XI*)

a) Raney nickel (60 ml of the sedimented material) was added during 2·5 h to a stirred boiling solution of acid *VIII* (3·4 g) in ethanol (50 ml). After stirring and heating for another 2 h, the nickel was filtered and extracted successively with boiling ethanol (2 × 150 ml) and an ethanol–acetic acid mixture (20 : 1; 3 × 150 ml). The combined extracts were taken down and the residue was stirred with a mixture of 5% hydrochloric acid (100 ml) and benzene (100 ml) for 30 min. The organic layer was separated, washed with water, dried, concentrated and mixed with light petroleum. The precipitated material was filtered and crystallized from methanol to give acid *XI* (1·6 g; 54%), m.p. 75°C (reported[7] m.p. 76–77°C, light petroleum). Mass spectrum, *m/z* (%): 332 (M^+, $C_{22}H_{36}O_2$, 22), 314 (35), 223 (12), 205 (11), 191 (21), 134 (33), 133 (38), 117 (27), 104 (97), 92 (100), 91 (100). ^{1}H NMR spectrum: 1·19 bs (26 H); 1·52 shoulder (2 H, J = 8 Hz); 2·53 t (2 H, J = 7·5 Hz); 7·10 s (5 H).

b) Dithioketal *IV* (6 g) was desulfurized with Raney nickel in ethanol analogously to the acid *VIII*. The crude product (4·4 g; 80%) on crystallization from methanol afforded acid *XI*, m.p. 74–75°C.

Methyl 16-Phenylhexadecanoate (*XII*)

16-Phenylhexadecanoic acid (*XI*; 2·6 g) was dissolved at 0°C in ether (100 ml), containing diazomethane (10 mmol). After stirring for 3 h, the solvent was evaporated *in vacuo* and the obtained ester (2·73 g) solidified at room temperature. ^{1}H NMR spectrum: 1·24 bs + 1·55 m (26 H), 2·22 t (2 H, J = 7 Hz), 2·53 t (2 H, J = 7 Hz), 3·59 s (3 H), 7·12 s (5 H).

16-(4-Iodophenyl)hexadecanoic Acid (*XIII*)

A solution of methyl ester *XII* (1 g) and thallium trifluoroacetate (2·5 g) in trifluoroacetic acid (8 ml) was stirred for 170 h under exclusion of moisture and light. A solution of potassium iodide (2·5 g) in water (15 ml) was added with stirring, followed after 15 minutes' stirring by sodium thiosulfate pentahydrate (2 g) in water (5 ml). The mixture was stirred for another 15 min, poured into water (80 ml) and extracted with ether (4 × 60 ml). The combined ethereal extracts were worked up and the solvent was evaporated. The residue was chromatographed on a silica gel column (50 g) in benzene and the obtained crude ester (1·15 g) hydrolysed with sodium hydroxide in aqueous ethanol. After the usual work-up procedure, the crude product (1 g) was twice crystall-

ized from methanol to give acid *XIII* (0·8 g; 60%), m.p. 85–90°C. For $C_{22}H_{35}IO_2$ (458·1) calculated: 57·64% C, 7·70% H, 27·69% I; found: 57·69% C, 7·69% H, 28·02% I. Mass spectrum, *m/z* (%): 458 (M^+, 5), 410 (11), 339 (4), 332 (6), 313 (30), 217 (44), 131 (34), 117 (34), 92 (53), 91 (100). ^{1}H NMR spectrum: 1·17 bs + 1·5 shoulder (28 H); 2·26 t (2 H, J = 7–7·5 Hz); 2·45 t (2 H, J = 7–7·5 Hz); 6·83 + 7·50 dd (4 H, J = 8·0 Hz); 10·7 bs (1 H).

REFERENCES

1. Machulla H. J., Knust E. J.: Nucl. Med. *23*, 111 (1984).
2. Goodman M. M., Knapp F. F., jr, Richards P., Mausner F.: J. Radioanal. Chem. *89*, 63 (1985).
3. Goodman M. M., Kirsch G., Knapp F. F., jr: J. Med. Chem. *27*, 390 (1984).
4. Goodman M. M., Kirsch G., Knapp F. F., jr: J. Heterocycl. Chem. *21*, 1579 (1984).
5. Knapp F. F., jr, Goodman M. M., Kabalka G. W., Sastry K. A. R.: J. Med. Chem. *27*, 94 (1984).
6. Hase J., Oura H.: Pharm. Bull. *2*, 368 (1954).
7. Huisgen R., Ugi I.: Chem. Ber. *93*, 2693 (1960).
8. Ischizawa A., Yamamura M., Ichii M., Sakashita Y., Goto R.: Nippon Kagaku Zasshi *89*, 516 (1968); Chem. Abstr. *69*, 76716 (1968).
9. Badger G. M., Rodda M. J., Sasse W. H. F.: J. Chem. Soc. *1954*, 4162.
10. McGhie J. F., Ross W. A., Evans D., Tomlin J. F.: J. Chem. Soc. *1962*, 350.
11. Taylor E. C., Kienzle F., Robey R. L., McKillop A., Hunt J. D.: J. Amer. Chem. Soc. *93*, 4845 (1971).
12. McKillop A., Fowler J. S., Zelesko M. J., Hunt J. D.: Tetrahedron Lett. *1969*, 2427.
13. Swann S., Oehler R., Buswell R. J.: Org. Syntheses, Coll. Vol. II, p. 276.
14. Archer S., Pratt M. G.: J. Amer. Chem. Soc. *66*, 1656 (1944).
15. Papa D., Schwenk E., Hankin M.: J. Amer. Chem. Soc. *69*, 3018 (1947).
16. Fieser L. F., Berliner E., Bondhus F. J., Chang F. C., Dauben W. G., Ettlinger M. G., Fawaz G., Fields M., Heidelberger Ch., Heymann H., Vaughan W. R., Wilson A. G., Wilson E., Wu M., Leffler M. T., Hamlin K. E., Matson E. J., Moore E. E., Moore M. B., Zaugg H. E.: J. Amer. Chem. Soc. *70*, 3174 (1948).
17. Staudinger H., Müller F.: Chem. Ber. *56*, 711 (1923).
18. Goldfarb J. L., Danyushevskii J. L.: Izv. Akad. Nauk SSSR (Khim.) *1956*, 1361.

Translated by M. Tichý.