Bull. Chem. Soc. Ethiop. **2020**, 34(1), 157-161. ISSN 1011-3924
© 2020 Chemical Society of Ethiopia and The Authors Printed in Ethiopia
DOI: https://dx.doi.org/10.4314/bcse.v34i1.15

A NEW ROUTE TO [1,2,4]TRIAZOLO[4,3-*C*][1,3,5,2]TRIAZAPHOSPHININE-5-OXIDES: REACTIVITY OF *N*-ALKYL/ARYL-*N'*-(4*H*-1,2,4-TRIAZOL-3-YL) AMIDINES WITH *N,N*-DIMETHYLPHOSPHORAMICDICHLORIDE

Azhar Hajri* and Lamjed Marzouki

Laboratory of Functional Physiology and Valuation of Bio-resources (UR17ES27), Higher Institute of Biotechnology of Béja, Habib Bourguiba Street, Box 382, 9000 Béja, University of Jendouba, Tunisia

(Received June 10, 2019; Revised December 12, 2019; Accepted January 9, 2020)

ABSTRACT. A series of novel [1,2,4]triazolo[4,3-*c*][1,3,5,2]triazaphosphinine-5-oxidederivatives **2a-h** were synthesized by a reaction of *N*-alkyl/aryl-*N'*-(4*H*-1,2,4-triazol-3-yl) amidines with *N,N*-dimethylphosphoramic dichloride in the presence of triethylamine (TEA) in refluxing 1,4-dioxane. The structures of all the synthesized compounds have been established by NMR (^{1}H, ^{13}C, ^{31}P) and IR spectroscopy, as well as by elemental analysis and mass spectral analysis.

KEY WORDS: Amidines, Oxides, Triazaphosphinines, Triazole, Synthesis

INTRODUCTION

The rich chemistry and wide applications of organophosphorus compounds are receiving tremendous attraction by scientists [1-3]. Organophosphorus compounds, which are a wide class of chemical compounds containing organic moieties disciplines usually bonded directly to phosphorus or bonded through a heteroatom, such as sulfur, oxygen or nitrogen, are one of the most common chemicals in the human environment. Because of their unique properties and high biological activity, they have been demonstrated to possess anticancer [4], antimicrobial [5] and insecticidal activities [6].

On the other hand, it is known that [1,2,4]-triazole containingheterocyclic compounds are very interesting biologically active: antifungal [7], antibacterial [7], herbicidal [8], anticancer [9] and antileishmainal [10] effects. These observations encouraged us to synthesize of novel triazaphosphinine oxides containing[1,2,4]-triazole ring such as [1,2,4]triazolo[4,3-*c*][1,3,5,2]triazaphosphinine-5-oxidesderivatives.

RESULTS AND DISCUSION

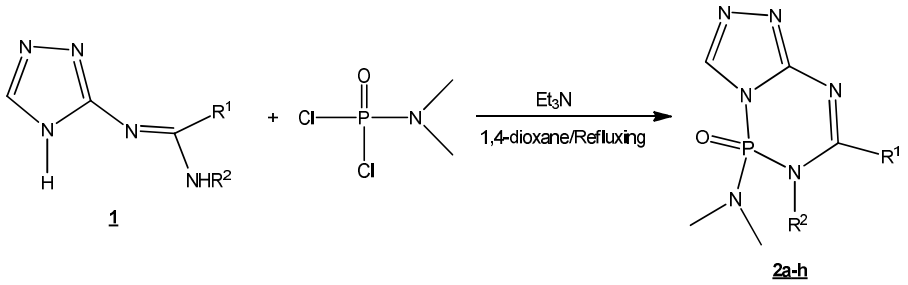
N-alkyl/aryl-*N'*-(4*H*-1,2,4-triazol-3-yl) amidines **1**, which are the starting material for this work, were obtained from the reaction of *N*-triazol-3-yl imidates with primary amines at room temperature in absolute ethanol [11]. The reaction between amidines **1** with *N,N'*-dimethylphosphoramicdichloride in the presence of triethylamine (TEA) under reflux of dioxane leads to [1,2,4]triazolo[4,3-*c*][1,3,5,2]triazaphosphinine-5-oxides derivatives **2a-h** (Scheme 1, Table 1).

The structures of compounds **2a-h** were deduced from their IR, ^{1}H NMR, ^{13}C NMR, MS spectra and elemental analysis. The IR spectra of compounds **2a-h** display absorption bands in the region of 1615-1612 cm^{-1} (C=N), 1300-1298 cm^{-1} (P=O) and strong bands in the region of 1190-1170 cm^{-1} indicating the presence of P-N moeity.

*Corresponding author. E-mail: lazharhajri.fsb@gmail.com

The ^{1}H NMR spectra data of products **2a-h** revealed the total absence of a signal specific to the NH amidinic and NH triazolic protons and they show the presence of separate signals for the two methyl groups in $N(CH_3)_2$ groups introduced by *N,N*-dimethylphosphoramicdichloride, which are splitted into doublets due to coupling with phosphorus.

^{13}C NMR spectra of compounds **2a-h** exhibited two signals attributable to the carbon atoms of P-NMe, indicating that the two methyl groups are not equivalent. The ^{31}P NMR spectrum of compound **2a-h** showed singlet signal to a phosphoryl group (P=O) at around δ 26 ppm.



1 2a-h

Scheme 1. Synthesis reaction of [1,2,4]triazolo[4,3-c][1,3,5,2]triazaphosphinine-5-oxides **2a-**h.

	R^1	R^2
2a	Methyl	Ethyl
2b	Ethyl	Ethyl
2c	Methyl	Propyl
2d	Ethyl	Propyl
2e	Methyl	Cyclopentyl
2f	Ethyl	Cyclopentyl
2g	Methyl	Phenyl-CH_2
2h	Ethyl	Phenyl-CH_2

Table 1. The results of synthesis of [1,2,4]triazolo[4,3-*c*][1,3,5,2]triazaphosphinine-5-oxides derivatives (**2a-h**).

Entry	Products	R^1	R^2	Yields (%)	M.p. (°C)
1	**2a**	Methyl	Ethyl	70	180-182
2	**2b**	Ethyl	Ethyl	68	194-196
3	**2c**	Methyl	Propyl	52	-
4	**2d**	Ethyl	Propyl	60	-
5	**2e**	Methyl	Cyclopentyl	65	212-214
6	**2f**	Ethyl	Cyclopentyl	72	220-222
7	**2g**	Methyl	Phenyl-CH_2	87	250-252
8	**2h**	Ethyl	Phenyl-CH_2	90	230-232

CONCLUSION

In summary, the synthesis of phosphorus containing fused and isolated heterocyclic systems such as [1,2,4]triazolo[4,3-*c*][1,3,5,2]triazaphosphinine-5-oxides have been achived via reaction of *N*-alkyl/aryl-*N*′-(4*H*-1,2,4-triazol-3-yl) amidines with *N,N*-dimethylphosphoramicdichloride under reflux.

EXPERIMENTAL

IR spectra were recorded with a Fourier transform infrared spectrometer (Nicolet IR 200 FT-IR, USA). ^{1}H and ^{13}C NMR spectra were recorded with $(CD_3)_2SO$ solvent containing tetramethylsilane (TMS) on a Bruker 300 spectrometer (USA) (^{1}H: 300 MHz, ^{13}C: 75.47 MHz, ^{31}P: 121.49 MHz). The chemical shifts were reported in δ values relative to TMS (internal reference) for ^{1}H and ^{13}C and relative to 85% H_3PO_4 (external reference) for ^{31}P. For the ^{1}H NMR, the multiplicities of signals are indicated by the following abbreviations: s: singlet, d: doublet, t: triplet, q: quartet, m: multiplet. Melting point (mp) was determined on an Electrothermal 9100 melting point apparatus (Weiss-Gallenkamp, Loughborough, UK). Elemental microanalysis was performed on a Perkin-Elmer analyzer apparatus (model 2400, series II-CHN, USA). The electron spray ionization (ESI) positive MS spectra were recorded on a Bruker Daltonics LC-MS spectrometer (USA). All chemicals, reagents and solvents were obtained from Sigma-Aldrich Company and were used without any purification. The completion of reaction was monitored by TLC.

Synthesis of [1,2,4]triazolo[4,3-c][1,3,5,2]triazaphosphinine-5-oxides derivatives ***2a-h***

N,N′-dimethylphosphoramic dichloride (2 mmol) was added dropwise to a mixture of *N*-alkyl/aryl-*N′*-(4*H*-1,2,4-triazol-3-yl) amidines **1** (2 mmol) and 6 mmol of TEA in anhydrous 1,4-dioxane (30 mL). The reaction mixture was heated under reflux for 24 h and then left to cool. The triethylammonium chloride obtained was filtered off. The solvent was removed under vacuum, and the resulting solid was collected and recrystallized from dichloromethane (**2a**, **2b**, **2e**, **2f**, **2g** and **2h)** or alternatively the oil obtained (**2c** and **2d**) was purified by column chromatography using silica gel (60–120 mesh) with ethyl acetate:hexane (3:7) as an eluent.

*5-(Dimethylamino)-6-ethyl-7-methyl-5,6-dihydro-[1,2,4]triazolo[4,3-c][1,3,5,2]triazaphosphinine-5-oxide (**2a**).* Brown powder; ^{1}H NMR (300 MHz, DMSO-d_6): δ 8.82 (s, 1H, N=C<u>H</u>-N-PO), 3.28 (q, 2H, ^{3}J = 7.8 Hz, CH_3-C<u>H_2</u>-N), 2.73 (d, 3H, O=P-N(C<u>H_3</u>)$_2$), 2.71 (d, 3H, O=P-N(C<u>H_3</u>)$_2$), 2.18 (s, 3H, C<u>H_3</u>-C(N)=N),1.42 (t, 3H, ^{3}J = 7.8 Hz, C<u>H_3</u>-CH_2-N); ^{13}C NMR (75.47 MHz, DMSO-d_6): δ 161.2 (N=<u>C</u>(CH_3)-N), 155.2 (N=<u>C</u>(N)-N), 151.4 (N=<u>C</u>H-N-PO), 37.2 (d, $^{2}J_{PC}$ = 3.5 Hz, N-<u>C</u>H_3), 37.1 (d, $^{2}J_{PC}$ = 3.5 Hz, N-<u>C</u>H_3), 32.3 (d, $^{2}J_{PC}$ = 3.2 Hz, CH_3-<u>C</u>H_2-N), 18.2 (<u>C</u>H_3-C(N)=N), 12.2 (<u>C</u>H_3-CH_2-N); ^{31}P NMR (121.49 MHz, DMSO-d_6): δ 26.1; IR, ν (cm^{-1}): 1190 (P-N), 1298 (P=O), 1612 (C=N); ESI-MS $[M+1]^+$: *m/z* = 243. Anal. calcd. for $C_8H_{15}N_6OP$ (%): C, 39.67; H, 6.24; N, 34.70. Found: C, 39.65; H, 6.22; N, 34.69.

*5-(Dimethylamino)-6,7-diethyl-5,6-dihydro-[1,2,4]triazolo[4,3-c][1,3,5,2]triazaphosphinine-5-oxide (**2b**).* Brown powder; ^{1}H NMR (300 MHz, DMSO-d_6): δ 8.80 (s, 1H, N=C<u>H</u>-N-PO), 3.26 (q, 2H, ^{3}J = 7.8 Hz, CH_3-C<u>H_2</u>-N), 2.74 (d, 3H, O=P-N(C<u>H_3</u>)$_2$), 2.73 (d, 3H, O=P-N(C<u>H_3</u>)$_2$), 2.28 (q, 2H, ^{3}J = 8.6 Hz, CH_3-C<u>H_2</u>-C(N)=N), 1.22 (t, 3H, ^{3}J = 8.6 Hz, C<u>H_3</u>-CH_2-C(N)=N); ^{13}C NMR (75.47 MHz, DMSO-d_6): δ 163.2 (N=<u>C</u>(CH_2-CH_3)-N), 155.8 (N=<u>C</u>(N)-N), 148.4 (N=<u>C</u>H-N-PO), 37.2 (d, $^{2}J_{PC}$ = 3.5 Hz, N-<u>C</u>H_3), 37.1 (d, $^{2}J_{PC}$ = 3.5 Hz, N-<u>C</u>H_3), 32.5 (d, $^{2}J_{PC}$ = 3.2 Hz, CH_3-<u>C</u>H_2-N), 23.2 (CH_3-<u>C</u>H_2-C(N)=N), 13.3 (<u>C</u>H_3-CH_2-N), 10.9 (<u>C</u>H_3-CH_2-C(N)=N). ^{31}P NMR (121.49 MHz, DMSO-d_6): δ 26.3; IR, ν (cm^{-1}): 1186 (P-N), 1298 (P=O), 1612 (C=N); ESI-MS $[M+1]^+$: *m/z* = 257. Anal. calcd. for $C_9H_{17}N_6OP$ (%): C, 42.18; H, 6.69; N, 32.80. Found: C, 42.17; H, 6.67; N, 32.78.

*5-(Dimethylamino)-7-methyl-6-propyl-5,6-dihydro-[1,2,4]triazolo[4,3-c][1,3,5,2]triazaphosphinine-5-oxide (**2c**).* Light brown viscous oil; ^{1}H NMR (300 MHz, DMSO-d_6): δ 8.86 (s, 1H, N=C<u>H</u>-N-PO), 3.24 (t, 2H, ^{3}J = 7.6 Hz, CH_3-CH_2-C<u>H_2</u>-N), 2.71 (d, 3H, O=P-N(C<u>H_3</u>)$_2$), 2.69 (d, 3H, O=P-N(C<u>H_3</u>)$_2$), 2.20 (s, 3H, C<u>H_3</u>-C(N)=N), 1.38 (m, 2H, CH_3-C<u>H_2</u>-CH_2-N), 0.99 (t, 3H, ^{3}J =

7.6 Hz, C<u>H</u>$_3$-CH$_2$-CH$_2$-N); ^{13}C-NMR (75.47 MHz, DMSO-d_6) δ (ppm): 160.8 (N=<u>C</u>(CH$_3$)-N), 154.8 (N=<u>C</u>(N)-N), 141.9 (N=<u>C</u>H-N-PO), 46.1 (d, $^2J_{PC}$ = 3.2 Hz, CH$_3$-CH$_2$-<u>C</u>H$_2$-N), 37.2 (d, $^2J_{PC}$ = 3.5 Hz, N-<u>C</u>H$_3$), 37.1 (d, $^2J_{PC}$ = 3.5 Hz, N-<u>C</u>H$_3$),21.1 (N=C(<u>C</u>H$_3$)-N), 20.8 (CH$_3$-<u>C</u>H$_2$-CH$_2$-N), 12.7 (<u>C</u>H$_3$-CH$_2$-CH$_2$-N). ^{31}P NMR (121.49 MHz, DMSO-d_6): δ 26.1; IR, ν (cm^{-1}): 1188 (P-N), 1298 (P=O), 1613 (C=N); ESI-MS [M+1]$^+$: *m/z* = 257. Anal. calcd. for $C_9H_{17}N_6OP$ (%): C, 42.18; H, 6.69; N, 32.80. Found: C, 42.16; H, 6.66; N, 32.78.

*5-(Dimethylamino)-7-ethyl-6-propyl-5,6-dihydro-[1,2,4]triazolo[4,3-c][1,3,5,2]triazaphosphinine-5-oxide(**2d**).* Brown viscous oil; ^{1}H-NMR (300 MHz, DMSO-d_6) δ (ppm): 8.86 (s, 1H, N=C<u>H</u>-N-PO), 3.23 (t, 2H, $^3J_{H\text{-}H}$ = 7.6 Hz, CH$_3$-CH$_2$-C<u>H</u>$_2$-N), 2.71 (d, 3H, O=P-N(C<u>H</u>$_3$)$_2$), 2.69 (d, 3H, O=P-N(C<u>H</u>$_3$)$_2$), 1.48 (m, 2H, CH$_3$-C<u>H</u>$_2$-CH$_2$-N), 1.39 (q, 2H, $^3J_{H\text{-}H}$ = 8.6 Hz, CH$_3$-C<u>H</u>$_2$-C(N)=N), 1.20 (t, 3H, $^3J_{H\text{-}H}$ = 8.6 Hz, C<u>H</u>$_3$-CH$_2$-C(N)=N), 1.01 (t, 3H, $^3J_{H\text{-}H}$ = 7.6 Hz, C<u>H</u>$_3$-CH$_2$-CH$_2$-N); ^{13}C-NMR (75.47MHz, DMSO-d_6) δ (ppm): 161.2 (N=<u>C</u>(CH$_2$-CH$_3$)-N), 155.6 (N=<u>C</u>(N)-N), 143.3 (N=<u>C</u>H-N-PO), 44.8 (d, $^2J_{PC}$ = 3.1 CH$_3$-CH$_2$-<u>C</u>H$_2$-N),37.2 (d, $^2J_{PC}$ = 3.5 Hz, N-<u>C</u>H$_3$), 37.1 (d, $^2J_{PC}$ = 3.5 Hz, N-<u>C</u>H$_3$), 21.4 (CH$_3$-<u>C</u>H$_2$-CH$_2$-N), 12.3 (<u>C</u>H$_3$-CH$_2$-CH$_2$-N), 11.8 (N=C(CH$_2$-<u>C</u>H$_3$)-N). ^{31}P NMR (121.49 MHz, DMSO-d_6): δ 26.4. IR, ν (cm^{-1}): 1170 (P-N), 1298 (P=O), 1612 (C=N); ESI-MS [M+1]$^+$: *m/z* = 271. Anal. calcd. for $C_{10}H_{19}N_6OP$ (%): C, 44.44; H, 7.09; N, 31.09. Found: C, 44.42; H, 7.07; N, 31.05.

*6-Cyclopentyl-5-(dimethylamino)-7-methyl-5,6-dihydro-[1,2,4]triazolo[4,3-c][1,3,5,2]triazaphosphinine 5-oxide (**2e**).* Dark brown powder; ^{1}H-NMR (300 MHz, DMSO-d_6): δ 8.84 (s, 1H, N=C<u>H</u>-N-PO), 3.78 (m, 1H, CH$_2$-CH$_2$-CH$_2$-CH$_2$-C<u>H</u>-N), 2.71 (d, 3H, O=P-N(C<u>H</u>$_3$)$_2$), 2.69 (d, 3H, O=P-N(C<u>H</u>$_3$)$_2$), 2.22 (s, 1H, C<u>H</u>$_3$-C(N)=N), 1.74 (m, 4H, C<u>H</u>$_2$-CH$_2$-CH$_2$-C<u>H</u>$_2$-CH-N), 1.41 (m, 4H, CH$_2$-C<u>H</u>$_2$-C<u>H</u>$_2$-CH$_2$-CH-N); ^{13}C-NMR (75.47 MHz, DMSO-d_6) δ (ppm): 160.6 (N=<u>C</u>(CH$_3$)-N), 155.7 (N=<u>C</u>(N)-N), 143.8 (N=<u>C</u>H-N-PO), 53.1 (d, $^2J_{PC}$ = 3.2 Hz, CH$_2$-CH$_2$-CH$_2$-CH$_2$-<u>C</u>H-N), 37.4 (d, $^2J_{PC}$ = 3.5 Hz, N-<u>C</u>H$_3$), 37.3 (d, $^2J_{PC}$ = 3.5 Hz, N-<u>C</u>H$_3$), 34.2 (<u>C</u>H$_2$-CH$_2$-CH$_2$-<u>C</u>H$_2$-CH-N), 22.5 (CH$_2$-<u>C</u>H$_2$-<u>C</u>H$_2$-CH$_2$-CH-N), 21.3 (N=C(<u>C</u>H$_3$)-N); ^{31}P NMR (121.49 MHz, DMSO-d_6): δ 26.6. IR, ν (cm^{-1}): 1175 (P-N), 1298 (P=O), 1612 (C=N); ESI-MS [M+1]$^+$: *m/z* = 283. Anal. calcd. for $C_{11}H_{19}N_6OP$ (%): C, 46.80; H, 6.78; N, 29.77; Found: C, 46.78; H, 6.79; N, 29.75.

*6-Cyclopentyl-5-(dimethylamino)-7-ethyl-5,6-dihydro-[1,2,4]triazolo[4,3-c][1,3,5,2]triazaphosphinine-5-oxide (**2f**).* Dark brown powder; ^{1}H-NMR (300 MHz, DMSO-d_6)) δ (ppm): 8.89 (s, 1H, N=C<u>H</u>-N-PO), 3.80 (m, 1H, CH$_2$-CH$_2$-CH$_2$-CH$_2$-C<u>H</u>-N), 2.28 (q, 2H, $^3J_{H\text{-}H}$ = 8.2 Hz, CH$_3$-C<u>H</u>$_2$-C(N)=N),), 2.71 (d, 3H, O=P-N(C<u>H</u>$_3$)$_2$), 2.69 (d, 3H, O=P-N(C<u>H</u>$_3$)$_2$), 1.71 (m, 4H, C<u>H</u>$_2$-CH$_2$-CH$_2$-C<u>H</u>$_2$-CH N), 1.46 (m, 4H, CH$_2$-C<u>H</u>$_2$-C<u>H</u>$_2$-CH$_2$-CH-N), 1.24 (t, 3H, $^3J_{H\text{-}H}$ = 8.2 Hz, C<u>H</u>$_3$-CH$_2$-C(N)=N); ^{13}C-NMR (75.47 MHz, DMSO-d_6) δ (ppm): 162.1 (N=<u>C</u>(CH$_2$-CH$_3$)-N), 154.8 (N=<u>C</u>(N)-N), 143.5 (N=<u>C</u>H-N-PO), 53.7 (d, $^2J_{PC}$ = 3.1 Hz, CH$_2$-CH$_2$-CH$_2$-CH$_2$-<u>C</u>H-N), 37.4 (d, $^2J_{PC}$ = 3.5 Hz, N-<u>C</u>H$_3$), 37.2 (d, $^2J_{PC}$ = 3.5 Hz, N-<u>C</u>H$_3$), 33.6 (<u>C</u>H$_2$-CH$_2$-CH$_2$-<u>C</u>H$_2$-CH-N), 25.1 (N=C(<u>C</u>H$_2$-CH$_3$)-N), 22.1 (CH$_2$-<u>C</u>H$_2$-<u>C</u>H$_2$-CH$_2$-CH-N), 11.8(N=C(CH$_2$-<u>C</u>H$_3$)-N). ^{31}P NMR (121.49 MHz, DMSO-d_6): δ 26.4. IR, ν (cm^{-1}): 1175 (P-N), 1298 (P=O), 1612 (C=N); ESI-MS [M+1]$^+$: *m/z* = 297. Anal. calcd. for $C_{12}H_{21}N_6OP$ (%): C, 48.64; H, 7.14; N, 28.36; Found: C, 48.62; H, 7.11; N, 28.34.

*6-Benzyl-5-(dimethylamino)-7-methyl-5,6-dihydro-[1,2,4]triazolo[4,3-c][1,3,5,2]triazaphosphinine-5-oxide (**2g**).* Colorless crystals; ^{1}H-NMR (300 MHz, DMSO-d_6) δ (ppm): 8.85 (s, 1H, N=C<u>H</u>-N-PO), 7.32-7.70 (m, 5<u>H</u>, Ar), 3.84 (s, 2H, C$_6$H$_5$-C<u>H</u>$_2$-N), 2.71 (d, 3H, O=P-N(C<u>H</u>$_3$)$_2$), 2.69 (d, 3H, O=P-N(C<u>H</u>$_3$)$_2$), 2.17 (s, 3H, C<u>H</u>$_3$-C(N)=N); ^{13}C-NMR (75.47 MHz, DMSO-d_6) δ (ppm): 162.3 (N=<u>C</u>(CH$_3$)-N), 154.6 (N=<u>C</u>(N)-N), 143.8 (N=<u>C</u>H-N-PO), 137.8 (1C$_{arom}$, <u>C</u>$_6$H$_5$-CH$_2$-N), 128.6 (2C$_{arom}$, <u>C</u>$_6$H$_5$-CH(N)-N), 127.1 (2C$_{arom}$, <u>C</u>$_6$H$_5$), 126.6 (1C$_{arom}$, <u>C</u>$_6$H$_5$), 37.4 (d, $^2J_{PC}$ = 3.5 Hz, N-<u>C</u>H$_3$), 37.2 (d, $^2J_{PC}$ = 3.5 Hz, N-<u>C</u>H$_3$), 44.6 (d, $^2J_{PC}$ = 3.1 Hz, C$_6$H$_5$-<u>C</u>H$_2$-N), 23.2

(N=C(CH_3)-N);).^{31}P NMR (121.49 MHz, DMSO-d_6): δ 26.2. IR, ν (cm^{-1}): 1186 (P-N), 1300 (P=O), 1615(C=N); ESI-MS $[M+1]^+$: *m/z* = 305. Anal. calcd. for $C_{13}H_{17}N_6OP$ (%): C, 51.31; H, 5.63; N, 27.62; Found: C, 51.27; H, 5.60; N, 27.59.

*6-Benzyl-5-(dimethylamino)-7-ethyl-5,6-dihydro-[1,2,4]triazolo[4,3-c][1,3,5,2]triazaphosphinine-5-oxide (**2h**).* Colorless crystals; ^{1}H-NMR (300 MHz, DMSO-d_6) δ (ppm): 8.86 (s, 1H, N=CH-N), 7.38-7.78 (m, 5H, Ar), 3.86 (s, 2H, C_6H_5-CH_2-N), 2.71 (d, 3H, O=P-N(CH_3)$_2$), 2.69 (d, 3H, O=P-N(CH_3)$_2$), 1.42 (q, 2H, $^3J_{H\text{-}H}$ = 8.6 Hz, 1H, CH_3-CH_2-C(N)=N), 1.24 (t, 3H, $^3J_{H\text{-}H}$ = 8.6 Hz, 1H, CH_3-CH_2-C(N)=N); ^{13}C-NMR (75.47 MHz, DMSO-d_6) δ (ppm): 162.5 (N=C(CH_2-CH_3)-N), 156.1 (N=C(N)-N), 143.7 (N=CH-N-PO), 136.8 (1C_{arom}, C_6H_5-CH_2-N), 129.1 (2C_{arom}, C_6H_5), 128.6 (2C_{arom}, C_6H_5), 126.2 (1C_{arom}, C_6H_5), 37.4 (d, $^2J_{PC}$ = 3.5 Hz, N-CH_3), 37.2 (d, $^2J_{PC}$ = 3.5 Hz, N-CH_3), 45.4 (d, $^2J_{PC}$ = 3.1 Hz, C_6H_5-CH_2-N), 23.5 (N=C(CH_2-CH_3)-N), 11.9 (N=C(CH_2-CH_3)-N); ^{31}P NMR (121.49 MHz, DMSO-d_6): δ 26.3. IR, ν (cm^{-1}): 1186 (P-N), 1300 (P=O), 1615(C=N); ESI-MS $[M+1]^+$: *m/z* = 319. Anal. calcd. for $C_{14}H_{19}N_6OP$ (%): C, 52.83; H, 6.02; N, 26.40; Found: C, 52.80; H, 5.99; N, 26.38.

REFERENCES

1. Shah, N.; Mundhra, S. Clinical profile of organophosphate poisoning at a tertiary-care center. *Int. J. Med. Sci. Public Health* **2016**, 5, 1621-1625.
2. Fukuto, T.R. Mechanism of action of organophosphorus and carbamate insecticides. *Environ. Health Perspect.* **1990**, 87, 245-254.
3. Demkowicz, S.; Rachon, J.; Daśko, M.; Kozak, W. Selected organophosphorus compounds with biological activity: Applications in medicine. *RSC Adv.* **2016**, 6, 7101-7112.
4. Wardle, N.J.; Bligh, S.W.A.; Hudson, H.R. Organophosphorus chemistry: Therapeutic intervention in mechanisms of viral and cellular replication. *Curr. Org. Chem.* **2005**, 9, 1803-1828.
5. Lokhandwala, S.R.; Desai, K.R. Novel organophosphorus compounds as potential antimicrobial agents. *Phosphorus Sulfur Silicon Relat. Elem.* **2008**, 183, 1264-1271.
6. Eddleston, M. Novel clinical toxicology and pharmacology of organophosphorus insecticide self-poisoning. *Annual Rev. Pharmacol. Toxicol.* **2019**, 59, 341-360.
7. Gupta, D.; Jain, D.K. Synthesis, antifungal and antibacterial activity of novel 1,2,4-triazole derivatives. *J. Adv. Pharm. Technol. Res.* **2015**, 6, 141-146.
8. Mu, J.X.; Zhai, Z.W.; Tan, C.X.; Weng, J.Q.; W.H.K.; Duke, S.O.; Zhang, Y.G.; Liu, X.H. Synthesis and herbicidal activity of 1,2,4-triazole derivatives containinga pyrazole moiety. *J. Heterocyclic Chem.* **2019**, 56, 968-1001.
9. El-Sayed, H.A.; El-Hashash, M.M.; Ahmed, A.E. Novel synthesis, ring transformation and anticancer activity of 1,3-thiazine, pyrimidine and triazolo[1,5-a] pyrimidinederivatives. *Bull. Chem. Soc. Ethiop.* **2018**, 32, 513-522.
10. El-Saghier, A.M.M.; Mohamed, M.A.A.; Abdalla, O.A.; Kadry, A.M. Utility of aminoacidcoupled 1,2,4-triazoles in organicsynthesis:synthesis of some new antileishmainal agents. *Bull. Chem. Soc. Ethiop.* **2018**, 32, 559-570.
11. Hajri, A.; Marzouki, M.L. Simple and efficient approach to synthesis of [1,2,4]triazolo[4,3-b][1,2,4,6]thiatriazine-1-oxidesfrom N-triazol-3-ylamidines. *Heterocycl. Commun.* **2017**, 23, 97-100.