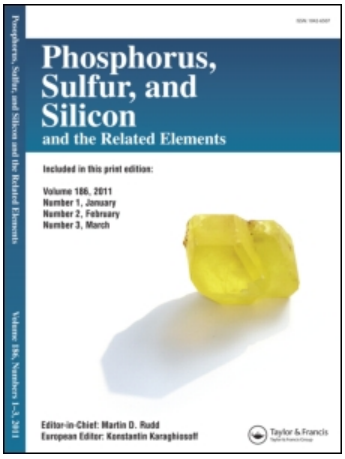


Phosphorus, Sulfur, and Silicon and the Related Elements

Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713618290

Rapid Synthesis and Biological Activities of Some New Benzothiazol-2-Ylhexahydro-S- Triazine Derivatives

Pawan Kumar Pareek[a]; Mithlesh[a]; Prashant Kriplani[b]; Ravikant[c]; Kishan Gopal Ojha[a]
[a] Department of Pure and Applied Chemistry, M.D.S. University, Ajmer, India [b] Government Women Engineering College, Ajmer, India [c] Hygia Institute of Pharmaceutical Education and Research, Lucknow, India

Online publication date: 03 July 2010

To cite this Article Pareek, Pawan Kumar , Mithlesh, Kriplani, Prashant , Ravikant and Ojha, Kishan Gopal(2010) 'Rapid Synthesis and Biological Activities of Some New Benzothiazol-2-Ylhexahydro-S- Triazine Derivatives', Phosphorus, Sulfur, and Silicon and the Related Elements, 185: 7, 1338 — 1345
To link to this Article: DOI: 10.1080/10426500903040933
URL: http://dx.doi.org/10.1080/10426500903040933

Phosphorus, Sulfur, and Silicon, 185:1338–1345, 2010

ISSN: 1042-6507 print / 1563-5325 online
DOI: 10.1080/10426500903040933

Taylor & Francis
Taylor & Francis Group

RAPID SYNTHESIS AND BIOLOGICAL ACTIVITIES OF SOME NEW BENZOTHIAZOL-2-YLHEXAHYDRO-S-TRIAZINE DERIVATIVES

Pawan Kumar Pareek,[1] Mithlesh,[1] Prashant Kriplani,[2] Ravikant,[3] and Kishan Gopal Ojha[1]

[1]*Department of Pure and Applied Chemistry, M.D.S. University, Ajmer, India*
[2]*Government Women Engineering College, Ajmer, India*
[3]*Hygia Institute of Pharmaceutical Education and Research, Lucknow, India*

2,4,6-Substituted 1,3,5-tris(benzothiazolyl)hexahydro-1,3,5-triazine derivatives were synthesized by the condensation of substituted benzothiazoles with aldehydes by conventional as well as by microwave irradiation (solvent free and solid supported) methods. All compounds were tested for antibacterial and antifungal activities, and the results have been compared with standard drugs. Acaricidal and anti-feedant activities were also tested.

Supplemental materials are available for this article. Go to the publisher's online edition of* Phosphorus, Sulfur, and Silicon and the Related Elements *to view the free supplemental file.

Keywords Acaricidal activity; antifeedant activity; antimicrobial activity; benzothiazole; solid support MW synthesis; 1,3,5-triazine

INTRODUCTION

Nitrogen- and sulfur-containing heterocycles play an important role, not only for life science but also in many other industrial fields related to special and fine chemistry. Among them, benzothiazoles comprise a class of therapeutic compounds that exert a wide range of biological activities such as antibacterial,[1–5] antifungal,[6–9] antihelminthic,[10, 11] antiviral,[12,13] etc. 2-(4-Aminophenyl)benzothiazole derivatives have been extensively studied for their anticancer action.[14, 15] s-Triazine derivatives have revealed new biological activities with interesting potential in therapeutic applications besides their traditional employment as herbicidal[15–17] and antiviral[18–22] agents. They have also been reported to possess anti-HIV,[24] anticancer,[24–29] antithyroid,[31] and diuretic[32] activities.

Received 10 November 2008; accepted 13 May 2009.

We are thankful to CDRI, Lucknow, India, for the spectroscopic studies. We are also thankful to Dr. Ashish Bhatnagar, Head, Dept. of Microbiology, MDS University, Ajmer, India, for providing the antimicrobial screening facility.

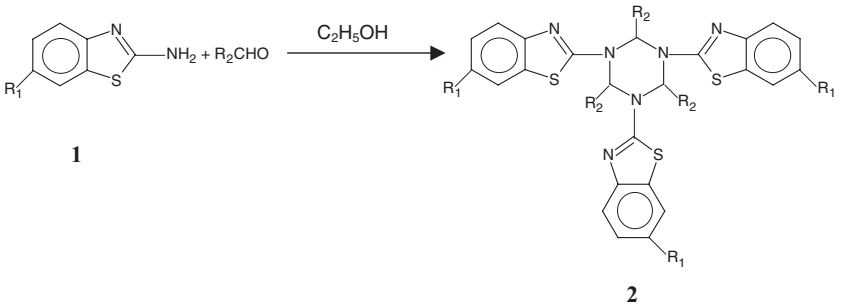
Address correspondence to Kishan Gopal Ojha, Department of Pure and Applied Chemistry, M.D.S. University, K-21, Gandhi Nagar, Naka Madar, Ajmer-305007, India. E-mail: kgojha@rediffmail.com

The application of microwave irradiation using solid support is used for carrying out chemical transformations that are pollution-free, ecofriendly, and associated with high reaction yields, rendering the microwave method superior to conventional methods.

Hence with a view to further assess the pharmacological profile of benzothiazoles and s-triazine derivatives and the benefits associated with microwave synthesis, it was thought worthwhile to synthesize some new derivatives by incorporating the 2-aminobenzothiazole and s-triazine moieties in a single molecular framework. The present article deals with the synthesis of 2,4,6-trisubstituted 1,3,5-tris(benzothiazol-2-yl)hexahydro-1,3,5-triazines followed by antimicrobial susceptibility tests (AST) against *Lactobacillus sp.*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Micrococcus leutius*, *Kocuria rosea*, *Aspergillus niger*, and *Aspergillus candidus* using standard methods and comparison with standard drugs. All the synthesized derivatives were also screened for their acaricidal and antifeedant activities.

RESULTS AND DISCUSSION

6-Substituted 2-aminobenzothiazoles (**1**) were synthesized by earlier reported methods.[33,34] 2,4,6-Trisubstituted 1,3,5-tris(benzothiazol-2-yl)hexahydro-1,3,5-triazines (**2**) were synthesized by condensation of the aminobenzothiazoles (**1**) (1.0 mol) with the aldehydes (1.0 mol) in ethanol with continuous stirring and refluxing for 13 h (Scheme 1).



1 **2**

Scheme 1

In view of the long reaction times, moderate yields (Table I), tedious workup of the reaction mixture, and requirement of large amounts of solvents associated with the conventional method, a relatively more versatile yet simplified procedure was perceived in which the substituted benzothiazoles and aldehydes could be made to react without using any solvent (without as well as with solid support). Microwave-assisted synthesis has received attention as a new strategy for organic synthesis due to the fact that many reactions seem to proceed much more readily under such conditions as opposed to the corresponding thermal-assisted reactions.[35] The strategy worked well, affording the desired product with improved yields in significantly lower reaction time (Tables I and II). The synthesized compounds are characterized by their analytical and IR, ^{1}H NMR, and mass spectroscopic data.

Table I Preparation of 2,4,6-trisubstituted 1,3,5-tris(benzothiazol-2-yl)hexahydro-1,3,5-triazines

				Conventional heating		Microwave neat reaction	
Compound	R^1	R^2	Mp (°C)	Time (h)	Yield (%)	Time(min)	Yield (%)
2a	OCH_3	H	100	13	50	3.5	60
2b	OCH_3	CH_3	110	13	52	3.0	60
2c	OCH_3	$CH_3CH{=}CH-$	135	13	50	3.5	60
2d	OC_2H_5	H	125	13	58	3.0	60
2e	OC_2H_5	CH_3	130	13	50	3.0	65
2f	OC_2H_5	$CH_3CH{=}CH-$	132	13	58	3.0	66
2g	CH_3	H	128	13	50	3.0	63
2h	CH_3	CH_3	95	13	55	3.0	65
2i	CH_3	$CH_3CH{=}CH-$	129	13	50	3.0	63
2j	NO_2	H	112	13	51	3.5	65
2k	NO_2	CH_3	140	13	55	3.0	60
2l	NO_2	$CH_3CH{=}CH-$	127	13	52	3.0	65
2m	CI	H	120	13	48	3.5	62
2n	Cl	CH_3	98	13	52	3.5	65
2o	Cl	$CH_3CH{=}CH-$	135	13	50	3.5	62
2p	Br	H	102	13	56	3.0	65
2q	Br	CH_3	117	13	53	3.5	55
2r	Br	$CH_3CH{=}CH-$	170	13	55	3.5	65

Table II Preparation of 2,4,6-trisubstituted 1,3,5-tris(benzothiazol-2-yl)-hexahydro-1,3,5-triazines

	Solid Supported Microwave Irradiation							
	Silica basic		Alumina neutral		Alumina acidic		Alumina	
Compound	Time (min)	Yield (%)	Time (min)	Yield (%)	Time (min)	Yield (%)	Time (min)	Yield (%)
2a	4.0	50	3.5	55	2.0	65	1.5	75
2b	4.0	50	3.5	65	2.0	75	1.5	80
2c	2.5	50	2.5	55	1.5	65	1.0	80
2d	4.0	58	3.5	60	2.0	68	1.5	75
2e	4.0	50	3.5	60	2.0	65	1.5	78
2f	2.5	58	2.0	60	1.5	68	1.0	80
2g	4.0	55	3.5	60	2.0	66	1.5	75
2h	4.0	52	3.5	65	2.0	78	1.0	84
2i	2.5	55	2.0	66	1.5	82	1.0	92
2j	4.5	55	3.5	60	2.0	68	1.5	78
2k	3.5	50	3.0	58	2.5	65	2.0	75
2l	2.5	55	2.0	58	1.5	68	1.0	80
2m	4.0	55	3.5	60	2.0	65	1.5	76
2n	4.0	57	3.5	59	2.0	68	1.5	72
2o	2.5	55	2.0	58	1.0	65	0.5	85
2p	2.5	58	2.0	68	1.5	80	1.0	87
2q	4.0	58	3.5	60	2.0	67	1.5	78
2r	2.5	58	2.0	61	1.5	65	1.0	92

CONCLUSION

Antibacterial Activity

The substituted benzothiazoles show very low activity against all the bacteria under study. But 2,4,6-substituted 1,3,5-tris(benzothiazol-2-yl)hexahydro-1,3,5-triazine derivatives exhibit enhanced activity comparable to standard drugs. Compounds **2j**, **2m**, and **2q** exhibit considerable antibacterial activity against *Lactobacillus sp.* Compounds **2l**, **2o**, and **2r** show good activity against *Pseudomonas aeruginosa*. Compounds **2f**, **2i**, and **2l** exhibit significant activities against *Staphylococcus aureus*. Compounds **2f**, **2i**, and **2r** show good effects against *Kocuria rosea.*

Antifungal Activity

2,4,6-Substituted 1,3,5-tris(benzothiazol-2-yl)hexahydro-1,3,5-triazines exhibit higher antifungal activities as compared with the corresponding benzothiazoles but only moderate activity as compared with standard drugs.

Acaricidal Activity

It is evident from the LD_{50} values in Table S2 (available online in ths Supplemental Materials) that compound **2e** exhibits the lowest LD_{50} value, thus possessing the highest contact toxicity against insects. The decreasing order of contact toxicity of the compounds is as follows: **2e** > **2i** = **2k** = **2m** = **2p** = **2q** = **2r** > **2f** = **2n** > **2b** > **2a** = **2g** = **2j** > **2d** > **2c** = **2o** > **2l** > **2h**.

Antifeedant Activity

It is evident from the LD_{50} values in Table S3 (Supplemental Materials) that compound **2k** exhibits the lowest LD_{50} value, thus possessing the highest contact toxicity against insects. The decreasing order of contact toxicity of the compounds is as follows: **2k** > **2i** > **2e** > **2r** > **2n** > **2h** > **2p** > **2f** = **2g** > **2c** > **2o** > **2j** > **2d** = **2m** > 2l > **2b** > **2a** = **2q**.

EXPERIMENTAL

Reagent grade chemicals were used without further purification. The substrates and solvents were used as received. All melting points were taken in open capillaries and are uncorrected. The purity of the synthesized compounds was checked by thin layer chromatography (TLC). IR spectra (ν in cm^{-1}) were measured on a Perkin Elmer FTIR spectrophotometer (Spectrum RX1) using KBr pellets. ^1H NMR spectra were recorded in $CDCl_3$ or DMSO with tetramethylsilane (TMS) as the internal standard at 300 MHz on a Bruker DRTX-300 spectrometer. The chemical shifts δ are given in ppm. Fast atom bombardment mass spectra (FAB-MS) were recorded at room temperature on a Jeol SX-102/DA-6000 mass spectrophotometer/data system using argon/xenon (6 kV, 10mA) as the FAB gas. The accelerating potential was 10 kV. Microwave synthesis was carried out in a Q-pro-M Modified Microwave system. The elemental analyses were performed by use of a Carlo Erba-1108 elemental analyzer.

2,4,6-Trisubstituted 1,3,5-Tris(benzothiazol-2-yl) hexahydro-1,3,5-triazines (2)

Conventional method. The 6-substituted 2-aminobenzothiazoles (0.1 mol) and aldehydes (0.1 mol) were dissolved in 10 mL of absolute ethanol and stirred for 30 min. Heating with stirring was continued for 13 h. The triazines were obtained by evaporation of the ethanol under vacuum. Impurities were dissolved in diethyl ether, and the products were purified by washing with petroleum ether (40–60°C).

Microwave method. The 6-substituted 2-aminobenzothiazoles (0.01 mol) and aldehydes (0.01 mol) were taken in a round bottomed flask and subjected to microwave irradiation. Upon completion of the reaction as monitored by TLC (at intervals of 30 sec), the reaction mixture was cooled, and the sticky mass obtained was triturated with a few drops of petroleum ether (40–60°C). The products were dried and recrystallized from ethanol.

Solid-supported microwave synthesis. The 6-substituted 2-aminobenzothiazole (0.01 mol), the aldehyde (0.01 mol), and solid alumina (acidic/basic/neutral) or silica gel were mixed thoroughly in a mortar. This mixture was transferred to a round-bottomed flask and irradiated in the microwave oven at 30 sec intervals of specified times. Upon completion of the reaction as monitored by TLC, the reaction mixture was cooled, and the sticky mass obtained was triturated with a few drops of petroleum ether (40–60°C). The products were dried and recrystallized from ethanol.

1,3,5-Tris(6-methoxybenzothiazol-2-yl)hexahydro-1,3,5-triazine (2a). ^{1}H NMR: δ 1.76 (s, 6H, NCH_2), 3.91 (s, 9H, OCH_3), 7.32–7.91 (m, 9H, ArH). MS: 576 (M^+). IR: 1057, 1140, 1170, 1350, 1460, 1465, 1545, 1586, 2960. Anal. Calcd. for $C_{27}H_{24}N_6O_3S_3$: C, 56.23; H, 4.19; N, 14.57; O, 8.32; S, 16.68; Found: C, 56.20; H, 4.15; N, 14.54; O, 8.30; S, 16.63.

1,3,5-Tris(6-methoxybenzothiazol-2-yl)-2,4,6-trimethylhexahydro-1,3,5-triazine (2b). ^{1}H NMR: δ 1.25–1.27 (d, $J = 6.3$ Hz, 9H, CH_3), 3.84 (q, $J = 6.9$ Hz, 3H, NCH), 3.92 (s, 9H, OCH_3), 7.33–7.90 (m, 9H, ArH). MS: 618 (M^+). IR: 1000, 1050, 1150, 1180, 1210, 1540, 1585. Anal. Calcd. for $C_{30}H_{30}N_6O_3S_3$: C, 58.23; H, 4.89; N, 13.58; O, 7.76; S, 15.54; Found: C, 58.21; H, 4.85; N, 13.51; O, 7.72; S, 15.52.

1,3,5-Tris(6-methoxybenzothiazol-2-yl)-2,4,6-tri(1-propenyl)hexahydro-1,3,5-triazine (2c). ^{1}H NMR: δ 2.95 (d, $J = 5.9$ Hz, 9H, CH_3), 3.91 (s, 9H, OCH_3), 3.95 (d, $J = 5.1$ Hz, 3H, NCH), 6.20 (dd, $J_1 = 6.3$ Hz, $J_2 = 6.2$ Hz, 3H, CH), 6.92 (dq, $J_1 = 3.1$ Hz, $J_2 = 2.9$ Hz, 3H, = CH), 7.33–7.91 (m, 9H, ArH). MS: 696 (M^+). IR: 1058, 1140, 1170, 1460, 1550, 1590, 1625, 2960, 3059. Anal. Calcd. for $C_{36}H_{36}N_6O_3S_3$: C, 62.05; H, 5.21; N, 12.06; O, 6.89; S, 13.80; Found: C, 62.00; H, 5.15; N, 12.02; O, 6.81; S, 13.79.

1,3,5-Tris(6-ethoxybenzothiazol-2-yl)hexahydro-1,3,5-triazine (2d). ^{1}H NMR: δ 2.17 (s, 6H, NCH_2), 2.32 (t, $J = 6.6$ Hz, 9H, OCH_2CH_3), 4.21 (q, $J = 6.0$ Hz, 6H, OCH_2), 7.32–7.91 (m, 9H, ArH). MS: 618 (M^+). IR: 1054, 1224, 1350, 1355, 1460, 1468, 1540, 1595, 2973. Anal. Calcd. for $C_{30}H_{30}N_6O_3S_3$: C, 58.23; H, 4.89; N, 13.58; O, 7.76; S, 15.54; Found: C, 58.20; H, 4.87; N, 13.88; O, 7.73; S, 15.56.

1,3,5-Tris(6-ethoxybenzothiazol-2-yl)-2,4,6-trimethylhexahydro-1,3,5-triazine (2e). ^{1}H NMR: δ 1.54–1.57 (d, $J = 6.1$ Hz, 9H, CH_3), 2.62 (t, $J = 6.1$ Hz, 9H, OCH_2CH_3), 3.41 (q, $J = 7.1$ Hz, 6H, OCH_2), 3.91 (q, $J = 6.7$ Hz, 3H, NCH), 7.44–7.89 (m, 9H, ArH). MS: 660 (M^+). IR: 920, 1040, 1150, 1200, 1460, 1530, 1595. Anal. Calcd. for $C_{33}H_{36}N_6O_3S_3$: C, 59.98; H, 5.49; N, 12.72; O, 7.26; S, 14.55; Found: C, 59.95; H, 5.47; N, 12.68; O, 7.22; S, 14.52.

1,3,5-Tris(6-ethoxybenzothiazol-2-yl)-2,4,6-tri(1-propenyl)hexahydro-1, 3,5-triazine (2f). ^{1}H NMR: δ 2.62 (t, $J = 6.2$ Hz, 9H, OCH_2CH_3), 2.90 (d, $J = 5.8$ Hz, 9H, $CH = CHCH_3$), 3.40 (q, $J = 7.1$ Hz, 6H, OCH_2), 3.90 (d, $J = 6.6$ Hz, 3H, NCH), 6.20 (dd, $J = 6.3$ Hz, $J = 6.2$ Hz, 3H, CH), 6.91 (dq, $J = 3.1$ Hz, $J = 3.0$ Hz, 3H, = CH), 7.45–7.88 (m, 9H, ArH). MS: 738 (M^+). IR: 1050, 1150, 1158, 1186, 1455, 1530, 1620, 2900, 3075. Anal. Calcd. for $C_{39}H_{42}N_6O_3S_3$: C, 63.39; H, 5.73; N, 11.37; O, 6.50; S, 13.02; Found: C, 63.36; H, 5.70; N, 11.32; O, 6.48; S, 13.00.

1,3,5-Tris(6-methylbenzothiazol-2-yl)hexahydro-1,3,5-triazine (2g). ^{1}H NMR: δ 2.17–2.18 (s, 6H, NCH_2), 2.25 (s, 9H, CH_3), 7.72–8.29 (m, 9H, ArH). MS: 528 (M^+). IR: 1150, 1360, 1460, 1468, 1540, 1585, 2878, 2900. Anal. Calcd. for $C_{27}H_{24}N_6S_3$: C, 61.34; H, 4.58; N, 15.90; S, 18.19; Found: C, 61.31; H, 4.55; N, 15.89; S, 18.16.

1,3,5-Tris(6-methylbenzothiazol-2-yl)-2,4,6-trimethylhexahydro-1,3,5-triazine (2h). ^{1}H NMR: δ 1.96 (d, $J = 6.1$ Hz, 9H, CH_3), 2.24 (s, 9H, CH_3), 3.98 (q, $J =$ 6.8 Hz, 3H, N-C-H), 7.71–8.22 (m, 9H, ArH). MS: 570 (M^+). IR: 980, 1150, 1210, 1540, 1586, 2860, 2900. Anal. Calcd. for $C_{30}H_{30}N_6S_3$: C, 63.13; H, 5.30; N, 14.72; S, 16.85; Found: C, 63.12; H, 5.28; N, 14.71; S, 16.81.

1,3,5-Tris(6-methylbenzothiazol-2-yl)-2,4,6-tri(1-propenyl)hexahydro-1, 3,5-triazine (2i). ^{1}H NMR: δ 2.21 (s, 9H, CH_3), 2.95 (d, $J = 5.9$ Hz, 9H, $CH = CHCH_3$), 3.85 (d, $J = 5.2$ Hz, 3H, NCH), 6.00 (dd, $J = 6.4$ Hz, $J = 6.3$ Hz, 3H, CH), 6.71 (dq, $J_1 =$ 3.2 Hz, $J_2 = 3.0$ Hz, 3H, = CH), 7.74–8.21 (m, 9H, ArH). MS: 648 (M^+). IR: 1150, 1460, 1540, 1586, 1650, 2860, 2900, 3090. Anal. Calcd. for $C_{36}H_{36}N_6S_3$: C, 66.64; H, 5.59; N, 12.95; S, 14.82; Found: C, 66.62; H, 5.57; N, 12.94; S, 14.80.

1,3,5-Tris(6-nitrobenzothiazol-2-yl)hexahydro-1,3,5-triazine (2j). ^{1}H NMR: δ 2.59–2.64 (s, 6H, NCH_2), 7.51–7.99 (m, 9H, ArH). MS: 621 (M^+). IR: 1320, 1330, 1385, 1465, 1505, 1539, 1580. Anal. Calcd. for $C_{24}H_{15}N_9O_6S_3$: C, 46.37; H, 2.43; N, 20.28; O, 15.44; S, 15.47; Found: C, 46.35; H, 2.40; N, 20.22; O, 15.43; S, 15.45.

1,3,5-Tris(6-nitrobenzothiazol-2-yl)-2,4,6-trimethylhexahydro-1,3,5-triazine (2k). ^{1}H NMR: δ 2.17 (d, $J = 6.3$ Hz, 9H, CH_3), 3.64–3.66 (q, $J = 6.8$ Hz, 3H, NCH), 7.55–7.91 (m, 9H, ArH). MS: 663 (M^+). IR: 970, 1215, 1330, 1385, 1465, 1505, 1539, 1580. Anal. Calcd. for $C_{27}H_{21}N_9O_6S_3$: C, 48.86; H, 3.19; N, 18.99; O, 14.46; S, 14.49; Found: C, 48.84; H, 3.17; N, 18.95; O, 14.44; S, 14.47.

1,3,5-Tris(6-nitrobenzothiazol-2-yl)-2,4,6-tri(1-propenyl)hexahydro-1,3,5-triazine (2l). ^{1}H NMR: δ 2.42 (d, $J = 6.0$ Hz, 9H, $CH = CHCH_3$), 3.98 (d, $J = 5.0$ Hz, 3H, NCH), 6.01 (dd, $J = 6.4$ Hz, $J = 6.3$ Hz, 3H, CH), 6.22 (dq, $J_1 = 3.4$ Hz, $J_2 = 3.2$ Hz, 3H, = CH), 7.51–7.95 (m, 9H, ArH). MS: 741 (M^+); IR: 1330, 1385, 1465, 1505, 1539, 1580, 1626, 3025. Anal. Calcd. for $C_{33}H_{27}N_9O_6S_3$: C, 53.43; H, 3.67; N,16.99; O,12.94; S,12.97; Found: C, 53.41; H,3.65; N, 16.94;O, 12.93; S, 12.96.

1,3,5-Tris(6-chlorobenzothiazol-2-yl)hexahydro-1,3,5-triazine (2m). ^{1}H NMR: δ 2.52–2.62 (s, 6H, NCH_2), 7.37–7.93 (m, 9H, ArH). MS: 589 (M^+). IR: 864, 1310, 1450, 1468, 1535, 1580. Anal. Calcd. for $C_{24}H_{15}N_6S_3Cl_3$: C, 48.86; H, 2.56; N, 14.25; S, 16.30; Cl, 18.03; Found: C, 48.83; H, 2.52; N, 14.22; S, 16.29; Cl, 18.01.

1,3,5-Tris(6-chlorobenzothiazol-2-yl)-2,4,6-trimethylhexahydro-1,3,5-triazine (2n). ^{1}H NMR: δ 1.95 (d, $J = 5.6$ Hz, 9H, CH_3), 3.54–3.59 (q, $J = 7.0$ Hz, 3H, NCH), 7.34–7.99 (m, 9H, ArH). MS: 635 (M^+). IR: 817, 1100, 1310, 1320, 1466, 1479, 1528, 1587. Anal. Calcd. for $C_{27}H_{24}N_6S_3Cl_3$: C, 51.07; H, 3.81; N, 13.23; S, 15.14; Cl, 16.75; Found: C, 51.05; H, 3.80; N, 13.21; S, 15.12; Cl, 16.72.

1,3,5-Tris(6-chlorobenzothiazol-2-yl)-2,4,6-tri(1-propenyl)hexahydro-1,3,5-triazine (2o). ^{1}H NMR: δ 2.23 (d, $J = 6.2$ Hz, 9H, CH = CHCH_3), 4.12 (d, $J = 5.0$ Hz, 3H, NCH), 6.02 (dd, $J = 6.5$ Hz, $J = 6.4$ Hz, 3H, CH), 6.30 (dq, $J_1 = 3.5$ Hz, $J_2 = 3.4$ Hz, 3H, = CH), 7.31–7.96 (m, 9H, ArH). MS: 710 (M^+). IR: 864, 1310, 1450, 1535, 1580, 1625, 3010. Anal. Calcd. for $C_{33}H_{27}N_6S_3Cl_3$: C, 55.81; H, 3.83; N, 11.83; S, 13.54; Cl, 14.98; Found: C, 55.80; H, 3.80; N, 11.81; S, 13.52; Cl, 14.96.

1,3,5-Tris(6-bromobenzothiazol-2-yl)hexahydro-1,3,5-triazine (2p). ^{1}H NMR: δ 2.55–2.65 (s, 6H, NCH_2), 7.21–7.89 (m, 9H, ArH). MS: 723 (M^+). IR: 856, 1320, 1340, 1460, 1465, 1531, 1588. Anal. Calcd. for $C_{24}H_{15}N_6S_3Br_3$: C, 39.85; H, 2.09; N, 11.62; S, 13.30; Br, 33.14; Found: C, 39.81; H, 2.08; N, 11.60; S, 13.29; Br, 33.13.

1,3,5-Tris(6-bromobenzothiazol-2-yl)-2,4,6-trimethylhexahydro-1,3,5-triazine (2q). ^{1}H NMR: δ 1.85 (d, $J = 6.0$ Hz, 9H, CH_3), 3.55–3.60 (q, $J = 7.0$ Hz, 3H, NCH), 7.23–7.85 (m, 9H, ArH). MS: 768 (M^+). IR: 854, 1110, 1320, 1350, 1460, 1531, 1589. Anal. Calcd. for $C_{27}H_{24}N_6S_3Br_3$: C, 42.20; H, 3.15; N, 10.94; S, 12.52; Br, 31.20; Found: C, 42.18; H, 3.12; N, 10.90; S, 12.51; Br, 31.16.

1,3,5-Tris(6-bromobenzothiazol-2-yl)-2,4,6-tri(1-propenyl)hexahydro-1,3,5-triazine (2r). ^{1}H NMR: δ 2.21 (d, $J = 6.1$ Hz, 9H, CH = CHCH_3), 4.18 (d, $J = 4.9$ Hz, 3H, NCH), 6.00 (dd, $J = 6.4$ Hz, $J = 6.1$ Hz, 3H, CH), 6.44 (dq, $J_1 = 3.6$ Hz, $J_2 = 3.4$ Hz, 3H, = CH), 7.23–7.88 (m, 9H, ArH). MS: 843 (M^+). IR: 854, 1320, 1460, 1531, 1582, 1620, 3025. Anal. Calcd. for $C_{33}H_{27}N_6S_3Br_3$: C, 46.99; H, 3.23; N, 9.96; S, 11.40; Br, 28.42; Found: C, 46.96; H, 3.21; N, 9.95; S, 11.37; Br, 28.40.

Antimicrobial Activity

All synthesized compounds were tested for antibacterial activity against *Lactobacillus sp.*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Micrococcus leutius*, and *Kocuria rosea*, and antifungal activity against *Aspergillus candidus* and *Aspergillus niger* using the paper disc method. (See the Supplemental Materials.)

Acaricidal Activity

The acaricidal activity of these compounds was carried out by the leaf dip method.[36,37] (See the Supplemental Materials.)

Antifeedant Activity

The antifeedant activity of these compounds was also carried out by the leaf dip method[36,37] using fourth instars larvae of *Spodoptera litura*. (See the Supplemental Materials.)

REFERENCES

1. S. N. Pandeya and P. R. Naik, *J. Indian Chem. Soc.*, **73**, 363 (1996).
2. H. M. El-Shaaer, S. A. Abdel-Aziz, H. A. Allimony, U. F. Ali, and R. M. Abdel-Rahman, *Pharmazie*, **52,** 585 (1997).
3. A. S. Ansari and J. C. B. Banerji, *J. Indian Chem. Soc.*, **75,** 108 (1998).
4. P. Desai, A. C. Champaneri, and K. R. Desai, *Asian J. Chem.*, **12,** 308 (2000).

5. P. P. Hankare, A. H. Jagtap, S. S. Chavan, P. S. Battare, and S. R. Naravane, *J. Indian Chem. Soc.*, **78,** 417 (2001).
6. E. Sidoova, H. Bujdakova, and K. Kralova, SK Pat. 278076 (1995); *Chem. Abstr.*, **126,** 186073 (1997).
7. A. Phor, I. Singh, and J. S. Phor, *Phosphorus, Sulfur, and Silicon*, **97,** 183 (1994).
8. M. S. Shingare, D. V. Mane, D. B. Shinde, S. N. Thore, and S. B. Bhawsar, *Asian J. Chem.*, **8,** 225 (1996).
9. H. Kucukbay, and B. Durmaz, *Arzneimittel-Forsch./Drug Res.*, **47,** 667 (1997).
10. L. V. G. Nargund, *Indian Drugs*, **36,** 137 (1999).
11. W. Reifschneider, Dow Chemical Co., U.S. Patent 3,336,329,(1967); *Chem. Abstr.*, **68,** 95803 (1968).
12. S. R. Nagarajan, C. G. A. De, D. P. Getman, H. F. Lu, J. A. Sikorski, J. L. Walker, J. J. McDonald, K. A. Houseman, G. P. Kocean, N. Kishore, P. P. Metha, C. L. Funkes-Shippy, and L. Blystone, *Bioorg. Med. Chem.*, **11,** 4769 (2003).
13. L. Racane, V. Tralic-Kulenovic, L. Fisher-Jakic, D. W. Boykin, and G. Karminski-Zamola, *Heterocycles*, **55,** 2085 (2001).
14. G. Wells, T. D. Bradshaw, P. Diana, A. Seaton, D. F. Shi, A. D. Westwell, and M. F. G. Stevens, *Bioorg. Med. Chem. Lett.*, **10,** 513 (2000).
15. V. Beneteau, T. Besson, J. Guillard, S. Leonce, and B. Pfeiffer, *Eur. J. Med. Chem.*, **34,** 1053 (1999).
16. Z. Q. Shao, W. Seffens, W. Mulbry, and R. M. Behki, *J. Bacteriol.*, **177,** 5748 (1995).
17. H. O. Esser, G. Dupuis, E. Eliert, C. Vogel, and G. J. Marco, In *Herbicides: Chemistry, Degradation and Mode of Action*, P. C. Kearney and D. D. Kaufman, eds. (Dekker, New York, 1975), p. 129.
18. H. J. Sanders, *Chem. Eng. News*, **59**(31)**,** 26 (1981).
19. K. Sztanke, K. Pasternak, B. Rajtar, M. Sztanke, M. Majek, and M. P. Dacewicz, *Bioorg. Med. Chem.*, **15,** 5480 (2007).
20. R. Angelucci, D. Artini, P. N. Giraldi, W. Logemann, and G. Nannini, *Farmaco[Sci]*, 663 (1961).
21. S. Matsumoto, F. J. Stanfield, M. Y. Goore, and R. F. Haff, *Proc. Soc. Exp. Biol. Med.*, **139,** 455 (1972).
22. G. Schuster, W. Horinqklee, H. Winter, G. Esser, U. Steinke, W. Kochman, W. Kramer, and W. Steinke, *Acta Virol.*, **23,** 412 (1979).
23. A. Kreutzberger and U. Rose, *Arzneimittel-Forsch.*, **36,** 626 (1986).
24. N. C. Desai, J. J. Bhatt, B. R. Shah, P. B. Trivedi, and N. K. Undavia, *Indian J. Exp. Biol.*, **34,** 584 (1996).
25. Z. Brzozowski, F. S. Czewski, and M. Gdaniec, *Eur. J. Med. Chem.*, **35,** 1053 (2000).
26. F. Saczewski, A. Bulakowska, P. Bednarski, and R. Grunert, *Eur. J. Med. Chem.*, **41,** 219 (2006).
27. J. Spychala, *Monath. Chem./Chemical Monthly*, **137,** 1203 (2006).
28. E. Pomarnacka, P. Bednarski, R. Grunert, and P. Reszka, *Acta Pol. Pharma.*, **61,** 461 (2004).
29. R. M. A. RahmanMorsy, F. Hanafy, and H. A. Amene, *Pharmazie*, **54,** 347 (1999).
30. O. Bekircan, M. Kuxuk, B. Kahveci, and S. Kolayli, *Arch. Pharmaz.*, **338,** 365 (2005).
31. R. Lakhan, S. Mehrotra, and P. K. Srivastava, *Indian J. Heterocylic Chem.*, **10,** 245 (2001).
32. J. M. E. Quirke, In *Comprehensive Heterocyclic Chemistry: Structure, Reactivity, Synthesis and Uses*, A. J. Boulton and A. Mckillop, eds. (Pergamon Press, Oxford, UK, 1984), vol. 3, p. 457.
33. R. R. Gupta and S. K. Jain, *Bull. Chem. Soc. Jpn.*, **49,** 2026 (1976).
34. K. G. Ojha, Ph.D. Thesis, University of Rajasthan, Jaipur, India (1980).
35. M. Jeselnik, R. S. Verina, S. Polanac, and M. Koeevar, *Green Chem.*, **4,** 35 (2002).
36. M. Shelton, J. L. Robertson, and J. D. Tang, *J. Econ. Entomol.*, **86,** 697 (1993).
37. H. Jinfeng, L. Pei, S. Xueyan, and G. Xiwu, *J. Insect. Sci.*, **8,** 9 (2008).