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Synthesis, characterization and anti-bacterial activity of 5-(alkenyl)-2-amino- and 2-(alkenyl)-5-phenyl-1,3,4-oxadiazoles

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Abstract. Fatty acid hydrazides of undec-10-enoic, (*Z*)-octadec-9-enoic, (*Z*)-12-hydroxyoctadec-9-enoic and (*Z*)-9-hydroxyoctadec-12-enoic acids are used as cheap starting materials in the synthesis of important biologically active 5-(alkenyl)-2-amino-1,3,4-oxadiazole and 2-(alkenyl)-5-phenyl-1,3,4-oxadiazole using cyanogen bromide and benzoyl chloride or benzoic acid as reagents, respectively. The structure of these compounds was confirmed by IR, ^{1}H NMR, ^{13}C NMR and Mass spectra. All the newly synthesized compounds were screened for their antibacterial activity. Compounds **2c**, **2d**, **3a**, **3c** and **3d** showed good antimicrobial activity against *E. coli* where as compounds **2a** and **2d** were found active against all the bacteria.

Keywords. 1,3,4-Oxadiazoles; antibacterial activity; MIC; IR; NMR; mass spectra.

1. Introduction

The emergence of multi-drug resistant strains of bacteria is a problem of ever increasing significance. Consequently, the development of new antimicrobial agents will remain an important challenging task for medicinal chemists. There are two basic approaches to develop a new drug: (a) synthesis of analogues, modifications or derivatives of existing compounds for shortening and improving treatment and (b) searching for novel structures, that the bacteria has never been presented before. To pursue this goal, our research efforts are directed to synthesize new pharmacophores. Substituted 1,3,4-oxadiazoles are of considerable pharmaceutical importance, which is documented by several number of publications and patents. A large number of drugs used clinically have oxadiazole ring as a structural building block. Literature survey reveals that 1,3,4-oxadiazoles have wide range of biological activities ranging from antibacterial,[1–5] antifungal[6,7] to anti-inflammatory.[8] Derivatives of 1,3,4-oxadiazole with suitable substitution at 2,5-position have been reported to possess considerable pharmacological activities. 2-Amino-1,3,4-oxadiazole acts as muscle relaxant[9] and also shows antimitotic activity.[10] 5-Aryl-2-hydroxymethyl-1,3,4-oxadiazole derivatives act as analgesic, anti-inflammatory, anticonvulsive, diuretic[11] and 2-hydroxyphenyl-1,3,4 oxadiazole possess hypnotic and sedative[12] activities. Some material applications of 1,3,4-oxadiazole derivatives lie in the field of liquid crystals[13] and photosensitizer.[14]

Many seed oils, fatty acids and their derivatives are known for their pesticidal,[15] antimicrobial[16,17] and antifungal activities.[18] Thus fatty acids on derivatization to these heterocyclic compounds can be used as valuable oleo-chemicals. These observations and our interest in the chemistry of heterocycles prompted us to synthesize different 1,3,4-oxadiazoles with different substituents at 2- and 5-positions. These compounds have been also screened for their *in vitro* antibacterial activity.

2. Experimental

2.1 *Materials and methods*

Undec-10-enioc (purity 98%) and (*Z*)-octadec-9-enoic (97%) acids were purchased from Fluka Chemicals (Bucks, Switzerland). (*Z*)-12-hydroxyoctadec-9-enoic acid (ricinolic acid, 98%) and (*Z*)-9-hydroxyoctadec-12-enoic acid (isoricinolic acid, 98%) were isolated from *Ricinus communis* and *Wrightia tinctoria* seed oils respectively following Gunstone's

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partition procedure.[19] Benzoic acid and benzoyl chloride were purchased from Merk, Mumbai, India. Phosphorus oxychloride and hydrazine hydrate (80%) were purchased from Sd fine-chem (Mumbai, India). Thin layer chromatography was done on glass plates (20 × 5 cm) with a layer of silca gel G (Merk, Mumbai, India, 0·5 mm thickness). Mixture of petroleum ether-diethyl ether-acetic acid (80 : 20 : 1, v/v) were used as developing solvents. Column chromatography was carried out on silca gel (Merk, Mumbai, India, 60–120 mesh). ^{1}H NMR was recorded with Bruker DRX 300 spectrometer at 300 MHz and ^{13}C NMR was recorded at 75 MHz in $CDCl_3$. Chemical shifts (δ) are quoted in ppm. The FAB mass spectra were recorded on a JEOL-SX 102/DA-600 mass spectrometer employing electron impact technique at 70 eV. Melting points were taken in on open capillary and are uncorrected.

Undec-10-enoic hydrazide **1a**, (*Z*)-octadec-9-enoic hydrazide **1b**, (*Z*)-12-hydroxyoctadec-9-enoic hydrazide **1c** and (*Z*)-9-hydroxyoctadec-12-enoic hydrazide **1d** were prepared from undec-10-enoate, (*Z*)-octadec-9-enoate, (*Z*)-12-hydroxyoctadec-9-enoate and (*Z*)-9-hydroxyoctadec-12-enoate respectively following the procedure reported earlier.[20]

2.2 *General method for synthesis of 5-(alkenyl)-2-amino-1,3,4-oxadiazoles* (**2a–d**)

Caution! Considering the toxic nature of CNBr the experiment was carried in fume hood. Safety methods mentioned in safety data sheet of N.I.H. were adapted while handling cyanogen bromide (http://dohs.ors.od.nih.gov/pdf/cyanogens%20bromide.pdf).

A mixture of the corresponding fatty acid hydrazide (0·001 mol) and cyanogen bromide (0·0012 mol) in dry methanol were refluxed at 60°C on oil bath. The resulting solution was cooled and filtered. The filtrate was neutralized with sodium bicarbonate solution. The solid mass separated was filtered, washed with excess water, dried and recrystallized in chloroform-methanol. Yields, melting points and reaction time are given in table 1.

2.2a *5-(Dec-9′-enoyl)-2-amino-1,3,4-oxadiazoles* (**2a**)*:* IR (KBr) ν_{max}: 3112, 2858-2922, 1585, 1187 cm^{-1}; ^{1}H NMR ($CDCl_3$): 1·26 (10H, *br*, *s*, $(CH_2)_5$), 1·69 (2H, *m*, CH_2 β to ring), 2·03 (2H, *m*, CH_2=CH-CH_2), 2·68 (2H, *t*, J = 7·2 Hz, CH_2 α to ring), 4·90 (2H, *br*, *s*, NH_2), 5·01 and 4·95 (2H, *m*, CH_2=CH), 5·81 (1H, *m*, CH_2=CH-CH_2); ^{13}C NMR ($CDCl_3$): δ 167·1, 164·7, 139·0, 114·1, 31·9, 29·7 'one signal hidden', 29·4 'one signal hidden', 29·1 'two signals hidden'; MS: *m*/*z* 224 (M^+, 100), 205 (45), 167 (32), 139 (20), 112 (42), 97 (55).

2.2b *(Z)-5-(Heptadec-8′-enoyl)-2-amino-1,3,4-oxadiazoles* (**2b**): IR (KBr) ν_{max}: 3118, 2850–2921, 1584, 1174 cm^{-1}; ^{1}H NMR ($CDCl_3$): 0·88 (3H, dist. *t*, terminus CH_3), 1·25 (20H, *br*, *s*, $(CH_2)_{10}$), 1·69 (2H, *m*, CH_2 β to ring), 2·03 (4H, *m*, CH_2–CH=CH–CH_2), 2·69 (2H, *t*, J = 7·5 Hz, CH_2 α to ring), 4·86 (2H, *br*, *s*, NH_2), 5·41 (2H, *m*, CH_2–CH=CH–CH_2); ^{13}C NMR ($CDCl_3$): δ 167·0, 164·3, 131·2, 125·5, 31·9 'one signal hidden', 31·7, 29·7 'one signal hidden', 29·6, 29·5, 29·4 'three signals hidden', 29·2, 29·1, 22·7, 14·4; MS: *m*/*z* 322 (M^+, 15), 304 (20), 237(15), 224 (100), 182 (35), 167 (22), 154 (45), 112 (30), 99 (35).

Table1. Appearance, yield and reaction time of various reactions by varying the reactant.

Compound	Appearance	Reactant	m.p. (°C)	Yield (%)	Reaction time (h)	Molecular formula
2a	White powder	CNBr	120–122	73	3–4	$C_{12}H_{21}N_3O$
2b	White crystals	CNBr	133–135	77	3–4	$C_{19}H_{35}N_3O$
2c	White powder	CNBr	137–139	65	3–4	$C_{19}H_{35}N_3O_2$
2d	White flakes	CNBr	131–133	60	3–4	$C_{19}H_{35}N_3O_2$
3a	Offwhite	PhCOCl	107–109	76	4–5	$C_{18}H_{24}N_2O$
	powder	PhCOOH	107–109	69	6–7	$C_{18}H_{24}N_2O$
3b	Offwhite	PhCOCl	195–197	73	4–5	$C_{25}H_{38}N_2O$
	crystals	PhCOOH	195–197	60	6–7	$C_{25}H_{38}N_2O$
3c	Oily	PhCOCl	–	69	5–6	$C_{25}H_{38}N_2O_2$
		PhCOOH	–	55	6–7	$C_{25}H_{38}N_2O_2$
3d	Oily	PhCOCl	–	65	5–6	$C_{25}H_{38}N_2O_2$
		PhCOOH	–	58	6–7	$C_{25}H_{38}N_2O_2$

2.2c *(Z)-5-(11′-Hydroxy-octadec-8′-enoyl)- 2-amino-1,3,4-oxadiazoles* (**2c**): IR (KBr) ν_{max}: 3281, 3112, 2843–2924, 1581, 1187 cm^{-1}; ^1H NMR ($CDCl_3$): 0·88 (3H, dist. *t*, terminus CH_3), 1·27 (18H, *br*, *s*, $(CH_2)_9$), 1·66 (2H, *m*, CH_2 β to ring), 2·07 (4H, *m*, CH_2–CH=CH–CH_2), 2·17 (1H, *br*, *s*, CH-OH), 2·89 (2H, *t*, J = 7·2 Hz, CH_2 α to ring), 3·66 (1H, *m*, CH–OH), 4·90 (2H, *br*, *s*, NH_2), 5·47 (2H, *m*, CH_2–CH=CH–CH_2); ^{13}C NMR ($CDCl_3$): δ 166·8, 163·5, 131·2, 125·5, 77·1, 31·9, 31·8, 29·7 'one signal hidden', 29·6, 29·2, 'three signals hidden', 25·5 'two signals hidden', 22·6, 14·2; MS: *m/z* 337 (M^+, 25), 322 (100), 304 (22), 254 (25), 252 (32), 222 (40), 196 (34), 182 (25), 168 (22), 155 (24), 112 (25), 99 (10).

2.2d *(Z)-5-(8′-Hydroxy-octadec-11′-enoyl)-2-amino-1,3,4-oxadiazoles* (**2d**): IR (KBr) ν_{max}: 3281, 3122, 2841–2925, 1584, 1184 cm^{-1}; ^1H NMR ($CDCl_3$): 0.88 (3H, dist. *t*, terminus CH_3), 1·25 (18H, *br*, *s*, $(CH_2)_9$), 1.72 (2H, *m*, CH_2 β to ring), 2·04 (4H, *m*, CH_2–CH=CH–CH_2), 2·15 (1H, *br*, *s*, CH-OH), 2·71 (2H, *t*, J = 7·2 Hz, CH_2 α to ring), 3·66 (1H, *m*, CH–OH), 4·91 (2H, *br*, *s*, NH_2), 5·45 (2H, *m*, CH_2–CH=CH–CH_2); ^{13}C NMR ($CDCl_3$): δ 167·1, 164·7, 133·4, 127·3, 77·4, 31·9, 31·7, 29·7 'one signal hidden', 29·6, 29·4, 'two signals hidden', 29·2, 25·5, 'two signals hidden', 22·7, 14·3; MS: *m/z* 337 (M^+, 22), 322 (100), 320 (23), 254 (30), 224 (35), 196 (34), 168 (15), 155 (20), 137 (32), 126 (20), 112 (44), 97 (25).

2.3 *General method for synthesis of 2-(alkenyl)-5-phenyl-1,3,4-oxadiazole* (**3a–d**)

A mixture of fatty acid hydrazide (0·001 mol), benzoyl chloride or benzoic acid (0·001 mol) and phosphorus oxychloride (5 ml) in 1,2-dichloroethane were refluxed at 65°C under inert atmospheric conditions. Excess solvent and $POCl_3$ were removed under reduced pressure. The resulting solution was cooled to room temperature, poured into ice cold water and left over night. The solid mass separated was filtered, dried and recrystalized from methanol where as the oily compounds were dissolved in ether and washed with excess cold water, dried and chromatographed over silca gel using petroleum ether-diethyl ether (96 : 4, *v/v*) as eluent. Yields, melting points and reaction time are given in table 1.

2.3a *2-(Dec-9′-enoyl)-5-phenyl-1,3,4-oxadiazole* (**3a**): IR (KBr) ν_{max}: 2850–2926, 1579, 1154 cm^{-1}; ^1H NMR ($CDCl_3$): 1·24 (10H, *br*, *s*, $(CH_2)_5$), 1·76 (2H, *m*, CH_2 β to ring), 2·07 (2H, *m*, CH_2=CH-CH_2), 2.77 (2H, *t*, J = 7·2 Hz, CH_2 α to ring), 5·03 and 4·99 (2H, *m*, CH_2=CH), 5·76 (1H, *m*, CH_2=CH–CH_2), 7·50–8·04 (5H, *m*, Ph-H); ^{13}C NMR ($CDCl_3$): δ 168·2, 153·0, 133·4, 133·2, 130·0, 129·8, 127·9, 114·2, 33·7, 29·3, 29·1, 28·9 'one signal hidden', 28.4 'two signals hidden'; MS: *m/z*: 284 (M^+, 24), 257 (20), 242 (15), 215 (10), 207 (100), 139 (25), 112 (16), 97 (20).

2.3b *(Z)-2-(Heptatadec-8′-enoyl)-5-phenyl-1,3,4-oxadiazole* (**3b**): IR (KBr) ν_{max}: 2842–2918, 1571, 1182 cm^{-1}; ^1H NMR ($CDCl_3$): 0·87 (3H, dist. *t*, terminus CH_3), 1·24 (20H, *br*, *s*, $(CH_2)_{10}$), 1·66 (2H, *m*, CH_2 β to ring), 1·99 (4H, *m*, CH_2-CH=CH–CH_2), 2·79 (2H, *t*, J = 7·5 Hz, CH_2 α to ring), 5·48 (2H, *m*, CH_2–CH=CH–CH_2), 7·49–8·02 (5H, *m*, Ph–H); ^{13}C NMR ($CDCl_3$): δ 168·4, 152·2, 133·5, 130·4, 129·3, 125·6, 123·2, 'one signal hidden', 38·6, 38·4, 31·8, 31·4, 29·2, 28·9, 28·7, 28·4, 28·2, 'three signals hidden', 27·9, 22·6, 14·0; MS: *m/z* 383 (M^+, 100), 367 (25), 353 (35), 311 (10), 269(20), 229(15), 215 (15), 187 (23), 173 (20), 145 (15), 113 (35), 99 (15).

2.3c *(Z)-2-(11′-Hydroxy-octadec-8′-enoyl)-5-phenyl-1,3,4-oxadiazole* (**3c**): IR (KBr) ν_{max}: 3281, 2856–2930, 1550, 1174 cm^{-1}; ^1H NMR ($CDCl_3$): 0·86 (3H, dist. *t*, terminus CH_3), 1·25 (18H, *br*, *s*, $(CH_2)_9$), 1·67 (2H, *m*, CH_2 β to ring), 2·02 (4H, *m*, CH_2–CH=CH–CH_2), 2·26 (1H, *br*, *s*, CH-OH), 2·84 (2H, *t*, J = 7·2 Hz, CH_2 α to ring), 3·60 (1H, *m*, CH-OH), 5·37 (2H, *m*, CH_2–CH=CH–CH_2), 7·43–8·08 (5H, *m*, Ph–H); ^{13}C NMR ($CDCl_3$): δ 167·2, 153·0, 139·8, 139·0, 133·5, 130·0, 129·8, 127·9, 77·1, 38·6, 38·4, 33·5, 31·7, 30·2, 29·9 'one signal hidden', 29·3, 28·7 'two signals hidden', 28·3, 22·4, 14·4; MS: *m/z*: 398 (M^+, 90), 383 (100), 357 (23), 339 (25), 327 (10), 257 (30), 254 (25), 243 (49), 229 (36), 215 (30), 173 (25), 160 (22), 137 (24), 112 (40), 97 (30).

2.3d *(Z)-2-(8′-Hydroxy-octadec-11′-enoyl)-5-phenyl-1,3,4-oxadiazole* (**3d**): IR (KBr) ν_{max}: 3219, 2841–2925, 1594, 1180 cm^{-1}; ^1H NMR ($CDCl_3$): 0·80 (3H, dist. *t*, terminus CH_3), 1·13 (18H, *br*, *s*, $(CH_2)_9$), 1·76 (2H, *m*, CH_2 β to ring), 2·09 (4H, *m*, CH_2–CH=CH–CH_2), 2·26 (1H, *br*, *s*, CH–OH), 2·84 (2H, *t*, J = 7·2 Hz, CH_2 α to ring), 3·79 (1H, *m*, CH–OH), 5·35 (2H, *m*, CH_2–CH=CH–CH_2), 7·43–7·95 (5H, *m*, Ph–H); ^{13}C NMR ($CDCl_3$): δ 165·7, 151·4, 139·1,

Table 2. Antibacterial activity of the newly synthesized compounds *in vitro* (culture).

	Zone of inhibition (mm)							
	Gram-negative bacteria				Gram-positive bacteria			
	E. coli (K 12)		*S. typhimurium* (MTCC 98)		*S. aureus* (MSSA 22)		*B. subtilis* (ATCC 6501)	
Compound	50 (μg/ml)	100 (μg/ml)	50 (μg/ml)	100 (μg/ml)	50 (μg/ml)	100 (μg/ml)	50 (μg/ml)	100 (μg/ml)
2a	++	++	+	++	+	++	+	++
2b	+	++	NT	–	+	++	NT	–
2c	++	+++	+	++	NT	–	+	++
2d	+++	+++	++	++	+	++	++	++
3a	++	+++	+	++	NT	–	NT	–
3b	+	++	NT	–	NT	–	NT	–
3c	++	+++	+	++	+	++	NT	–
3d	++	+++	NT	–	+	++	+	++
Chlormycetin	+++	++++	+++	++++	+++	++++	+++	++++
DMF	–	–	–	–	–	–	–	–

Inhibition zone diameter in mm (+) 1–6; (++) 7–12; (+++) 13–18; (++++) 19–24; (–) no activity. NT = not tested

Table 3. Minimum inhibition concentration (MIC) of newly synthesized compounds.

	MIC (μg/ml)			
	Gram-negative bacteria		Gram-positive bacteria	
Compound	*E. coli* (K 12)	*S. typhimurium* (MTCC 98)	*S. aureus* (MSSA 22)	*B. subtilis* (ATCC 6501)
2a	12·5	25	25	25
2b	25	NT	25	NT
2c	12·5	25	NT	25
2d	6·25	12·5	25	12·5
3a	12·5	25	NT	NT
3b	25	NT	NT	NT
3c	12·5	25	25	NT
3d	12·5	NT	25	25
Chlormycetin	3·125	6·25	6·25	6·25

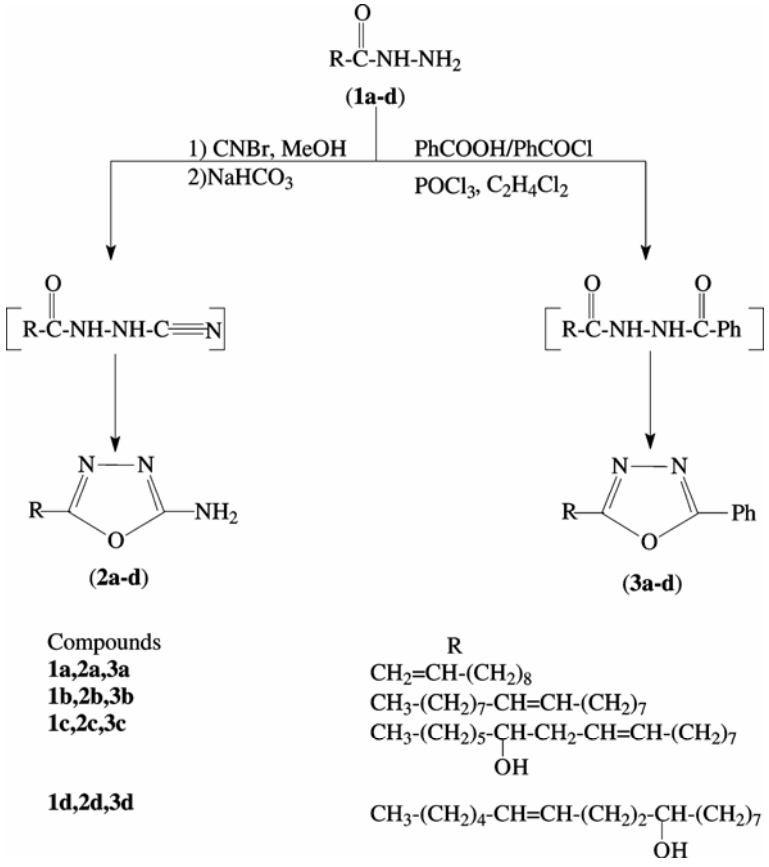
The MIC values were evaluated at concentration range 1·56–50 μg/ml. NT = not tested

139·0, 133·0, 130·7, 129·4, 127·6, 77·3, 38·6, 36·4, 30·4, 31·8, 29·8, 29·6, 29·4 'two signals hidden', 28·9 'one signal hidden', 25·9, 22·2, 14·3; MS: *m/z* 397 (M^+, 20), 381 (100), 369 (22), 357 (20), 341 (35), 327 (15), 321 (25), 271 (30), 257 (45), 243 (15), 229 (15), 215 (30), 201 (10), 187 (25), 165 (15), 152 (25), 145 (15), 138 (28), 98 (15).

2.4 *Antibacterial activity*

The representative compounds **2a–d** and **3a–d** were tested for their antibacterial activity against Gram negative bacteria [*Escherchia coli* (K 12), *Salmonella typhimurium* (MTCC 98)] and Gram positive bacteria [*Staphylococcus aureus* (MSSA 22), *Bacillus subtilis* (ATCC 6501)] employing the cup-plate method[21] at the concentrations of 50 μg/ml and 100 μg/ml of DMF in the nutrient agar media. Standard antibiotic chloromycetin was screened under similar conditions. 100 μl of these solutions were added to each well. One of the wells was used as control by adding 100 μl of DMF. The zone of inhibition, if any, produced by diffusion of the compounds from the cup into the surrounding medium, was measured after incubation at 37°C for 24 h (table 2).

Minimum inhibitory concentrations (MICs) were determined by broth dilution technique. The nutrient broth, which contained logarithmic serially two-fold diluted amount of test compound and controls were inoculated with approximately 5×10^5 c.f.u. of actively dividing bacteria cells. The cultures were incubated for 24 h at 37°C and the growth was monitored visually and spectrophotometrically. The lowest concen-



Scheme 1.

tration (highest dilution) required to arrest the growth of bacteria was regarded as minimum inhibitory concentration (MIC). The minimum inhibitory concentrations are given in table 3. All the experiments were carried out in triplicate and repeated if the results differed.

3. Results and discussion

The reaction sequence leading to formation of title compounds is outlined in scheme 1. The synthesis of 2,5-disubstituted 1,3,4-oxadiazoles was performed in several steps. In the first step fatty acid hydrazides **1a–d** were prepared according to literature method.[20] 5-(Alkenyl)-2-amino-1,3,4-oxadiazoles **2a–d** were obtained in moderate yields by reacting fatty acid hydrazides with cyanogen bromide in dry methanol at 60–65°C. Formation of **2a** was confirmed from its spectral data. IR spectra of the compound **2a** showed absorption bands at 3112 cm^{-1}, 1585 and 1187 cm^{-1} due to NH_2, C=N and C–O–C stretching vibrations. The ^1H NMR showed broad singlet at δ 4·90 corresponding to NH_2 protons at 2-position of oxadiazole ring. Also triplet at δ 2·68 was observed for CH_2 protons α to oxadiazole ring. In ^{13}C NMR peak at 167·1 and 164·7 were observed for ring carbons. Mass spectra also supported the structure. Molecular ion peak M^+ at *m/z* 224 was observed which correspond to the molecular formula $C_{12}H_{21}N_3O$. Similar types of spectral data were observed for **2b–d**.

2-(Alkenyl)-5-phenyl-1,3,4-oxadiazole **3a–d** was prepared by dehydrative cyclization of diacylhydrazide by dehydrating agent, phosphorus oxychloride. Reaction time and the yields were observed by varying the reagents. It is worthy to mention that benzoyl chloride was a better reactant than benzoic acid under inert atmospheric conditions, which is evident from better yields and less reaction time. The build up of **3a–d** is evident from their spectral data. Compound **3a** showed IR absorption bands at 1579 cm^{-1} and 1154 cm^{-1} due to stretching vibrations of C=N and C–O–C functions. The ^1H NMR was more informative in assigning the structure. Multiplet at δ 7·50–8·04 was observed for aromatic protons. Also triplet at δ 2·77 was observed for CH_2 protons α to oxadiazole ring. In ^{13}C NMR peaks at 168·2 and 153·0 were observed for ring carbon. The mass spectra showed molecular ion peak M^+ at *m/z* 284

corresponding to the molecular formula $C_{18}H_{24}N_2O$. Similar types of spectral data were observed for **3b–d**.

3.1 *Biological activity*

The investigation of the antimicrobial screening of compounds **2a–d** and **3a–d** revealed that all the synthesized compounds showed moderate to good antibacterial activity against *E. coli*. Compound **2d** was active against all the bacteria where as **2c** was active against *E. coli*, *S. typhimurium* and *B. subtilis* (table 2). This can be attributed to presence of pharmacologically active $-NH_2$ group attached to oxadiazole ring and –OH group of fatty acid chain. Compound **2a** was moderately active against all the bacteria, where as **3a** was moderately active against gram negative bacteria which were in accordance with our previous observations.[17] It may be noted that compounds **2c**, **2d**, **3a**, **3c** and **3d** showed promising results against *E. coli*. Comparing these results with our previous studies[22], we found that 1,3,4-oxadiazoles substituted with two fatty acid chains at 2 and 5 position of the oxadiazole ring were better antibacterial agents than 1,3,4-oxadiazoles having only one fatty acid chain at 2 or 5 position of the oxadiazole ring.

The results thus obtained reveal that nature of substituent at 2 and 5 position of oxadiazole ring may have a considerable impact particularly the free $-NH_2$ group and the –OH group on fatty acid chain to enhance antibacterial activity. The results indicate that compounds **2a**, **2c**, **2d**, **3a**, **3c** and **3d** may be used as control measures against different bacteria.

4. Conclusion

This study reports the successful synthesis and antibacterial activity of new 2,5-disubstituted-1,3,4-oxadiazoles. The divergence in the antibacterial activity of these compounds validates the significance of this study. The antibacterial activity study revealed that the most of the compounds tested showed moderate to good antibacterial activity. Structure and biological activity relationship of the title compounds showed that the presence of free NH_2 group at position 2 of oxadiazole ring and biologically active group like OH group attached to fatty acid chain are responsible for increased antimicrobial activity in the newly synthesized title compounds. However, the effect of compounds on the host cell and their mode of action remain to be studied.

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