Available online at www.derpharmachemica.com

ISSN 0975-413X
CODEN (USA): PCHHAX

Der Pharma Chemica, 2016, 8(1):275-281
(http://derpharmachemica.com/archive.html)

Synthesis and antimicrobial evaluation of some novel malononitrile derivatives from N-phenylpyrrolidine-2, 5-diones under microwave irradiation

R. S. Dhivare[1]* and S. S. Rajput[2]

[1]Department of General Science, JSPM's, J.S.Polytechnic, Hadapsar, Dist - Pune, (M.S.), India
[2]Department of Chemistry, SVS's DadasahebRawal College, Dondaicha, Dist-Dhule, (M.S.), India

---

ABSTRACT

The purpose of study was to synthesize the focused library of new malononitrile derivative of substituted N-phenylpyrrolidine-2, 5-dione as potential new hybrid antifungal molecules. These hybrid molecules were synthesized in a coupling reaction of substituted N-phenylpyrrolidine-2, 5-dione with dicyanomethane using solvent free ecofriendly microwave assisted method. The 2, 5-diones were prepared by the reaction of succinic anhydride with substituted aryl amines in presence of benzene and acetyl chloride. All the synthesized molecules were persisted and vetted for antimicrobial activities. Most of the molecules showed potential antifungal activity against Candida albicans and Aspergillusniger.

Keywords:N-phenylpyrrolidine-2, 5-dione, dicyanomethane, malononitrile derivative, antimicrobial activities

---

INTRODUCTION

Malononitrile plays a very important role in the development of heterocyclic synthesis. The malononitrile [1] derivatives were synthesized by Knoevenagel condensation reaction by using active methylene groups with different substituted ketone, aldehydes [2], hetero-aromatic aldehydes or ketones and indole derivatives. These are prepared by several methods for instance of aqueous media [3]. Chemo-selective heterogeneous catalyst by solvent free method [4], eco-friendly single pot aqueous synthesis [5], catalytic agent of potassium hydroxide or sodium hydroxide [6], zinc oxide promoter [7] and silica supported ammonium acetate catalyst [8], ionic liquid media [9] and tamarind juice catalyst [10]. The L-proline catalyzed malononitrile derivatives exhibited the significant biological activities [11], riot-control moiety of chloro-benzylidenemalononitrile [12], antimicrobial moiety of chromene [13], aryl alkene malononitrile [14], anti-tubercular inhibitory activity of methoxynicotinonitrile analogs [15] and urease inhibitory activities of pyrano-pyrimidine dione derivatives [16]. Along with these malononitrile derivatives correspondingly possesses a beneficial antiproliferative [17],Mollucicidal [18], anti-inflammatory [19], anticancer [20], anti-oxidant and antitumor [21] activities so on.Knoevenagel condensation is the standard reaction between carbon-carbon bonds formation occur in cyclic ketones, aldehydes by using active methylene malononitrile group in the solvent free or catalytic or organic solvent synthesis. Due to higher acidity of active methylene groups will converts to nitrile derivatives. Certain malononitrile derivatives for example cyanomethyl group [22], cyanoacetanilides [23], benzopyranones [24], cyanohexylidenemalononitrile [25], benzopyranes [26], carbo-nitriles [27] from glycine [28] are easily synthesized with active methylene group by using Knoevenagel condensation [29] in conventional, grindstone [30] method, solvent less single or multicomponent systems and microwave assisted [31] neat or solvent free eco-friendly methods.

MATERIALS AND METHODS

Melting points of all the synthesized compounds were recorded in an open glass capillaries and were uncorrected. IR spectra in (KBr pallets) were chronicled on Shimadzu FTIR-8400S and ATR Brucker alpha FT-IR spectrophotometer. ^{1}HNMR spectra were recorded on 400 MHz and 500.13 MHz by Brucker spectrophotometer. The reaction was monitored by TLC which was accomplished by using pre-coated silica gel aluminium plates with the mixture of diethyl ether and ethyl acetate 7:3 proportion or benzene. Commercially purchased succinic anhydride, substituted anilines, acetyl chloride, benzene, dicyanomethane, neutral alumina (Al_2O_3) and ethanol were used for the preparation.

Preparation of substituted bis-heterocyclic chalcones:
The N-substituted Phenylpyrrolidine-2, 5-diones or N-phenyl succinimides are conventionally synthesized by succinic anhydride and substituted anilines. Then afforded succinimides were employed for the preparation of bis-chalcone derivatives by microwave synthesis. The experimental method of conventional to microwave synthesis is schematically represented in figure 1;

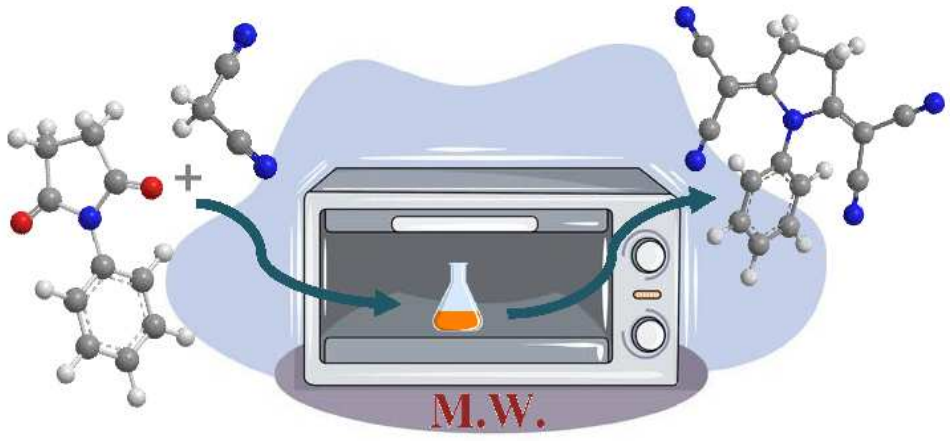
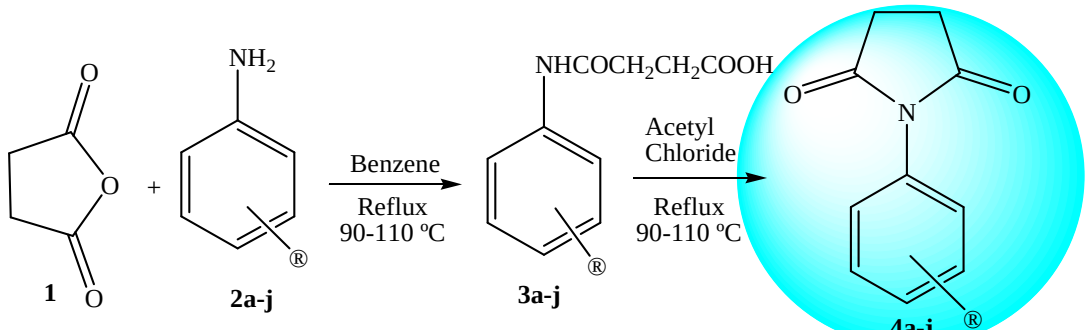


Figure 1 Experimental design of conventional to microwave method

General Procedure for the Synthesis of N-phenyl-pyrrolidine-2, 5-dione or N-Phenyl Succinimides:
To accomplish the work succinic anhydride (0.1 moles) benzene was added and heated under reflux with constant stirring for 15 to 20 min till the solution becomes clear. Into this solution the primary aromatic amines (0.2 moles) in 5 ml benzene was slowly poured with constant stirring for 15- 20 min till the solution becomes homogenized. On the vaporization of benzene amorphous powder of 3-(N-phenyl) propanoic acid was obtained. Further the mixture of 3-(N-phenyl) propanoic acid and acetyl chloride (0.9 moles) was reflux for 15-20 min by thoroughly evolution of HCl fumes. The reaction mixture was cooled at room temp the solid product was obtained and recrystallized by ethanol as shown in the **scheme 1**.



® , **a** = -H, **b** = -4Br, **c** = -4Cl, **d** = -4CH_3, **e** = -4OCH_3,
f = -4F, **g** = -4NO_2, **h** = -phenyl, **i** = -3Cl,-4F, **j** = -2,4,5Cl

Scheme -I: Synthesis of N-phenylpyrrolidine-2, 5-dione

Phenylpyrrolidine-2, 5-dione (4a): White Crystals; M. F.: $C_{10}H_9NO_2$; Yield: 79.91%; M. W.: 175.06; M. P. (ºC): 154-156 ºC; FTIR: 1708, 1774, 2937, 1291, 1457, 1502 and 1595 cm^{-1}

(4-bromophenyl) pyrrolidine-2, 5-dione (4b): Whitish Brown Crystals; M. F.: $C_{10}H_8BrNO_2$; Yield: 89.78%; M. W.: 254.08; M. P. (ºC): 174-176 ºC; FTIR: 1707, 1766, 2998, 1295, 1455, 1488, 1588 and 1070 cm^{-1}

1-(4-chlorophenyl) pyrrolidine-2, 5-dione (4c): Whitish Crystals; M. F.: $C_{10}H_8ClNO_2$; Yield: 76.60%; M. W.: 209.63; M. P. (ºC): 159-161 ºC; FTIR: 1711, 1773, 2985, 1302, 1495, 1527, 1589 and 1093 cm^{-1}

1-p-tolylpyrrolidine-2, 5-dione (4d): Cream White Crystals; M. F.: $C_{11}H_{11}NO_2$; Yield: 62.73%; M. W.: 189.21; M. P. (ºC): 150-152 ºC; FTIR: 1710, 1774, 2995, 1288, 1450, 1519 and 1589 cm^{-1}

1-(4-methoxyphenyl) pyrrolidine-2, 5-dione (4e): Whitish Crystals; M. F.: $C_{11}H_{11}NO_3$; Yield: 78.91%; M. W.: 205.21; M. P. (ºC): 160-162 ºC; FTIR: 1708, 1770, 2963, 1302, 1476, 1512, 1606 and 1178 cm^{-1}

1-(4-fluorophenyl) pyrrolidine-2, 5-dione (4f): White Crystals; M. F.: $C_{10}H_8FNO_2$; Yield: 62.90%; M. W.: 193.17; M. P. (ºC): 176-178 ºC; FTIR: 1712, 1767, 3000, 1290, 1456, 1513, 1604 and 1178 cm^{-1}; Elemental Anal: C, 62.38; H, 4.09; N, 6.87; ^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 7.16-7.36 (m, 4H, Ar-H), 2.94 (s, 4H, imide)

1-(4-nitrophenyl) pyrrolidine-2, 5-dione (4g): Pale Yellow Solid; M. F.: $C_{10}H_8N_2O_4$; Yield: 88.86%; M. W.: 220.18; M. P. (ºC): 219-221 ºC; FTIR: 1617, 1679, 2883, 1300, 1501, 1564, 1596 and 1501 cm^{-1}

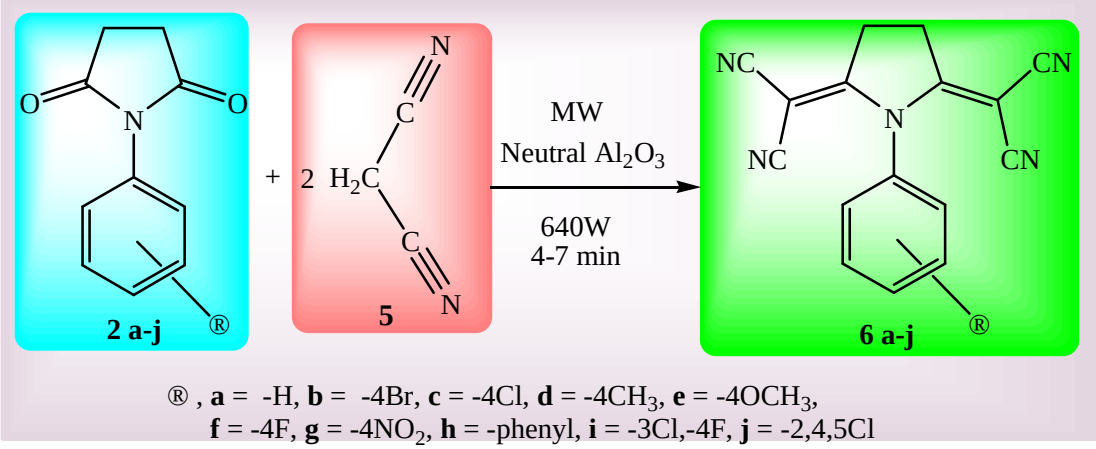
1-(naphthalen-4-yl) pyrrolidine-2, 5-dione (4h): Whitish Solid; M. F.: $C_{14}H_{11}NO_2$; Yield: 99.11%; M. W.: 225.24; M. P. (ºC): 148-150 ºC; FTIR:1700, 1776, 2939, 1291, 1463, 1509and 1595 cm^{-1}; Elemental Anal: C, 75.04; H, 3.89; N, 6.26; ^{1}H NMR (300 MHz, $CDCl_3$, δ ppm): 7.30-8.03 (m, 7H, napthyl), 3.06 (s, 4H, imide)

1-(3-chloro-4-fluorophenyl) pyrrolidine-2, 5-dione (4i): White Solid; M. F.: $C_{10}H_7ClFNO_2$; Yield: 79.91%; M. W.: 227.62; M. P. (ºC): 158-160 ºC; FTIR: 1698, 1776, 2937, 1294, 1490, 1502, 1595, 1070, 1173and 1059 cm^{-1}; Elemental Anal: C, 53.01; H, 3.32; N, 6.20; ^{1}H NMR (500.13 MHz, $CDCl_3$, δ ppm): 7.25-7.44 (m, 3H, Ar-H), 2.92 (s, 4H, imide)

1-(2, 4, 5-trichlorophenyl) pyrrolidine-2, 5-dione (4j): White Solid; M. F.: $C_{10}H_6Cl_3NO_2$; Yield: 75.56%; M. W.: 278.52; M. P. (ºC): 196-198 ºC; FTIR: 1660, 1700, 2993, 1356, 1454, 1508, 1570 and 1072 cm^{-1}; Elemental Anal: C, 43.04; H, 3.01; N, 5.27; ^{1}H NMR (500.13 MHz, $CDCl_3$, δ ppm): 7.28-7.57 (m, 2H, Ar-H), 2.27 (s, 4H, imide)

General Procedure for the Synthesis of Malononitrile Derivatives from N-Phenyl Succinimides:

To achieve the target molecule malononitrile**(6a-j)** derivatives were synthesized by the mixture of 5 mmole of afforded N-phenyl succinimides**(4a-j)** and 10 mmole of dicyanomethane in 2 gm of neutral Al_2O_3 under the microwave assisted solvent free conditions on 640W power for 4-7 minutes. The afforded brownish and coffee coloured compounds were recovered and recrystallized by ethanol **Scheme – II**.



Scheme -II: 2-(5-dicyanomethylene-N-phenyl-pyrrolidin-2-ylidene)-malononitrile (6a-j)

2-(5-dicyanomethylene-1-phenyl-pyrrolidin-2-ylidene)-malononitrile (6a): Coffee Coloured Solid;M. F.: $C_{16}H_9N_5$; Yield: 55.55%; M. W.: 271.28; M. P. (ºC): 138-140 ºC; Elemental Anal:C, 71.34; H, 3.68; N, 25.98; FTIR (ATR): 2194, 2918, 1379, 1499, 1550 and 1683 cm^{-1}; ^{1}H NMR (300.06 MHz, DMSO-d^6, δ ppm): 2.76 (s, 4H, imide), 7.27-7.47 (m, 5H, Ar-H)

2-(5-dicyanomethylene-4-bromophenyl-pyrrolidin-2-ylidene)-malononitrile (6b): Dark Brown Solid; M. F.: $C_{16}H_8BrN_5$; M. W.: 350.17; Yield: 45.71%; M. P. (ºC): 130-132 ºC; Elemental Anal:C, 54.98; H, 2.86; N, 21.16; FTIR (KBr) 2207, 2931, 1296, 1458, 1488, 1594 and 1070 cm^{-1}; ^1H NMR (500.13 MHz, DMSO-d^6, δ ppm): 2.78 (s, 4H, imide), 7.24 (dd, 2H, Ar-H), 7.71 (dd, 2H, Ar-H), HRMS (300 MHz, $CDCl_3$, δ ppm): M^+ 348.14 (100)

2-(5-dicyanomethylene-4-chlorophenyl-pyrrolidin-2-ylidene)-malononitrile (6c): Blackish Solid; M. F.: $C_{16}H_8ClN_5$; M. W.: 305.72; Yield: 65.57%; M. P. (ºC): 105-107 ºC; Elemental Anal:C, 62.99; H, 2.79; N, 23.26; FTIR (KBr): 2338, 2882, 1317, 1495, 1542, 1653 and 1085 cm^{-1}

2-(5-dicyanomethylene-1-p-tolyl-pyrrolidin-2-ylidene)-malononitrile (6d): Brown Solid; M. F.: $C_{17}H_{11}N_5$; M. W.: 285.3; Yield: 59.29%; M. P. (ºC): 113-115 ºC; Elemental Anal:C, 71.84; H, 4.17; N, 24.77; FTIR (KBr): 2206, 2940, 1289, 1516, 1561 and 1607 cm^{-1}

2-(5-dicyanomethylene-4-4-methoxyphenyl-pyrrolidin-2-ylidene)-malononitrile (6e): Brownish Solid;M. F.: $C_{17}H_{11}N_5O$; M. W.: 301.3; Yield: 26.91%; M. P. (ºC): 118-120 ºC; Elemental Anal:C, 67.81; H, 3.88; N, 23.77; FTIR (KBr): 2205, 2924, 1305, 1512, 1559, 1617 and 1179 cm^{-1}

2-(5-dicyanomethylene-4-fluorophenyl-pyrrolidin-2-ylidene)-malononitrile (6f): Brownish Solid; M. F.: $C_{16}H_8FN_5$; M. W.: 289.27; Yield: 47.05%; M. P. (ºC): 129-131 ºC; Elemental Anal:C, 66.71; H, 2.94; N, 24.46; FTIR (KBr): 2338, 2953, 1314, 1458, 1514, 1653 and 1187 cm^{-1}

2-(5-dicyanomethylene-4-nitrophenyl-pyrrolidin-2-ylidene)-malononitrile (6g): Brownish Yellow Solid;M. F.: $C_{16}H_8N_6O_2$; Yield: 28.48%; M. W.: 316.27; M. P. (ºC): 160-162 ºC; Elemental Anal:C, 61.26; H, 2.95; N, 26.87; FTIR (KBr): 2338, 2955, 1341, 1559, 1597, 1619 and 1505 cm^{-1}; ^1H NMR (500.13 MHz, DMSO-d^6, δ ppm): 2.82 (s, 4H, imide), 7.81 (dd, 2H, Ar-H), 8.21 (dd, 2H, Ar-H)

2-(5-dicyanomethylene-naphthalen-4-yl-pyrrolidin-2-ylidene)-malononitrile (6h): Purple Solid; M. F.: $C_{20}H_{11}N_5$; Yield: 72.89%, M. W.: 321.33; M. P. (ºC): 80-82 ºC; Elemental Anal:C, 74.97; H, 3.68; N, 21.86; FTIR (KBr): 2214, 2940, 1343, 1463, 1513, 1543, 1654 cm^{-1} and 1707 cm^{-1}

2-(5-dicyanomethylene-3-chloro-4-fluorophenyl-pyrrolidin-2-ylidene)-malononitrile (6i): Dark Brown Solid; M. F.: $C_{16}H_7ClFN_5$; Yield: 63.46%, M. W.: 323.71, M. P. (ºC): 143-145 ºC; Elemental Anal:C, 59.55; H, 2.78; N, 21.77; FTIR (KBr): 2214, 2954, 1397, 1504, 1543, 1651, 1181 and 1063 cm^{-1}

2-(5-dicyanomethylene-2,4,5-trichlorophenyl-pyrrolidin-2-ylidene)-malononitrile (6j): Saw Dust Coloured Solid; M. F.: $C_{16}H_6Cl_3N_5$; Yield: 53.47%; M. W.: 374.61; M. P. (ºC): 175-177 ºC; Elemental Anal:C, 51.49; H, 1.98; N, 18.86; FTIR (KBr): 2213, 2923, 1364, 1513, 1573, 1676 and 1078 cm^{-1}

RESULTS AND DISCUSSION

Chemistry:

The starting compounds N-phenyl-pyrrolidine-2, 5-dione **4a-j** were prepared by the reaction of substituted anilines and succinic anhydride using benzene and acetyl chloride. The series of 2-(5-dicyanomethylene-1-phenyl-pyrrolidin-2-ylidene)-malononitriles **6a-j** were synthesized in reasonable yields by the microwave irradiation of cyclic imides **4a-j** with dicyanomethane in presence of neutral alumina in solvent free condition. The structure of phenyl succinimide and malononitrile was confirmed by IR, ^{1}HNMR, ^{13}CNMR, HRMS and elemental analysis.

Antimicrobial activities (4a-j and 6a-j):

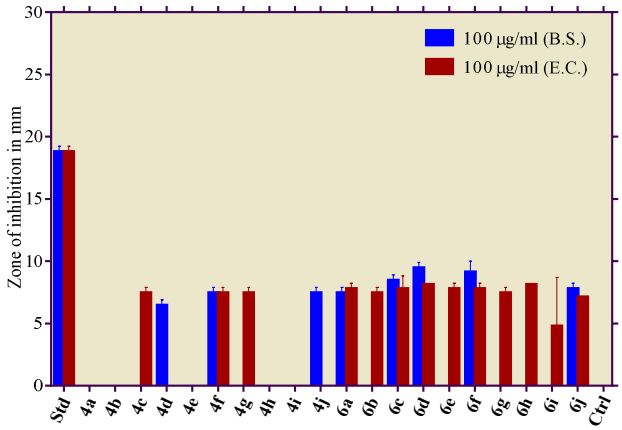
All the synthesized compounds **4a-j** and **6a-j**from this chapter were evaluated *in-vitro* for antibacterial activity against bacterial strains gram positive *Bacillus subtilis*(MCMB-310)and gram negative *Escherichia coli*(MCMB-301)at the concentrations of 100µg/ml by bore plate method using DMF as solvent and nutrient agar was employed as culture media. After 48 hrs of incubation at 37ºC, the results were obtained in the form of clearing zone and were noted after the period of incubation was over. Similarly the same compounds **4a-j**and **6a-j** were evaluated *in-vitro* for antifungal activity against fungal strains *Candida albicans*(NCIM-3471) and *Aspergillusniger*(NCIM- 545) at the concentration 100µg/ml per disc by paper disc diffusion method using DMSO as solvent. The yeast *Candida albicans* cultured using a malt extract, glucose yeast extract peptone agar medium (MGYP medium) and for fungi *Aspergillusniger* potato dextrose agar medium was used. After 3-7 days of incubation at 30ºC. The diameters of inhibition zones were measured and tabulated in the table–1. Ampicillin was used as a standard drug for antibacterial activities and Amphotericin-B used for antifungal activities.

Table-1: Antimicrobial activities of N-phenyl Succinimides and Malononitriles

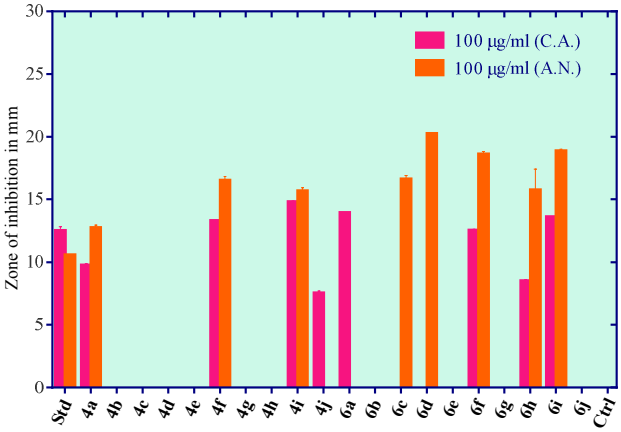
Compd Code	Zone diameter calculated in mm and tabulated by (Mean±S.D.)			
	Bacillus subtilis	***Escherichia coli***	***Candida albicans***	***Aspergillusniger***
	100 µg/ml	100 µg/ml	100 µg/ml	100 µg/ml
4a	--	--	9.63 ± 0.23 **	12.62 ± 0.33 **
4b	--	--	--	--
4c	7.33±0.57 **	7.33±0.57 **	--	--
4d	7±0 **	--	--	--
4e	--	--	--	--
4f	7.33±0.57 **	7.33±0.57 **	13.19 ± 0.15 *	16.41 ± 0.42 **
4g	4.66±4.04 **	7.33±0.57 **	--	--
4h	--	--	--	--
4i	--	--	14.68 ± 0.18 **	15.56 ± 0.37 **
4j	--	--	7.41 ± 0.27 **	--
6a	7.33±0.57 **	7.66±0.57 **	13.83 ± 0.05 **	--
6b	--	7.33±0.57 **	--	--
6c	7..33±0.57 **	7.66±1.15 **	--	16.50 ± 0.41 **
6d	9.33±0.57 **	8±0 **	--	20.13 ± 0.19 **
6e	--	7.66±0.57 **	--	--
6f	9±1 **	7.66±0.57 **	12.41 ± 0.21 **	18.48 ± 0.34 **
6g	--	7.33±0.57 **	--	--
6h	--	8±0 **	8.40 ± 0.22 **	15.63 ± 1.80 **
6i	--	4.66±4.04 **	13.48 ± 0.17 **	18.76 ± 0.23 **
6j	7.66±0.57 **	7±0 **	--	--
Ctrl	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
Std	18.33±0.57	18.33±0.57	12.40 ± 0.43	10.45 ± 0.11
Keynote: Zone of inhibition measured in mm (Mean±S.D.) (N=3) ('--' means no zone)				

Statistical Analysis:

The entire results of the synthesized compound **4a-j** and **6a-j** series were calculated by triplicate methods N=3 with the mean plus standard deviation stated in the graph-01 and graph -02. The statistical tests were performed by using Graph Pad prism-6 trial version software. The statistical significance was accessed by one way ANOVA ensured by Dunnett Multiple Comparisons Test will performed by standard drug against synthesized compounds. P value < 0.05 was considered as statistically significant remarked by *p<0.05, **p<0.01, ***p<0.001, ****p<0.0001 compared to standard groups.



Graph 01: Antibacterial activities of 4a-j and 6a-j (B. S. and E.C.) Mean±SD



Graph 02: Antifungal activities of 4a-j and 6a-j (C.A. and A.N.) Mean±SD

CONCLUSION

The comprehensive ecofriendly microwave centered green method of synthesis of themalononitrile derivatives **6a-j** has been accumulated in the form of good yields. These synthones were found significantly active against gram positive *Bacillus subtilis* and gram negative *Escherichia coli* bacterial strains. In the same way they showed the prominent antifungal activity against *Candida albicans* and *Aspergillusniger* fungal strains. These synthesized compounds might be utilized for the fabrication of various heterocyclic systems.

REFERENCES

[1] R. S. Dhivare,S. S.Rajput, *International Letters of Chemistry, Physics and Astronomy*,**2015**,57, 126-144
[2] S.S. Rajput,*International Journal of Advances in Pharmacy, Biology and Chemistry*, **2012**, 1(2), 242-246
[3] M. A. Gouda, A. A.Abu-Hashem, *Green Chemistry Letters and Reviews*, **2012**, 5(2), 203-209
[4] B.Tamami,A.Fadavi, *Iranian Polymer Journal*,**2006**,15(4), 331-339
[5] F.Fringuelli, O. Piermatti, F.Pizzo, *Journal of Chemical Education*,**2004**, 81(6), 874-876
[6] H.Sheibani, A. S.Saljoogi, *Heteroletters*,**2012**, 2(4), 389-393
[7] M.Basude, P.Sunkara, V. S.Puppala, *Journal of Chemical and Pharmaceutical Research*,**2013**,5(9), 46-50
[8] R.Gupta, M.Gupta, S.Paul, R.Gupta, *Bull. Korean Chem. Soc*.,**2009**, 30(10), 2419-2421
[9] A.Rajendran, C.Karthikeyan, K.Rajathi, *International Journal of ChemTech Research*,**2011**,3(2), 858-863
[10] R.Pal, *International Journal of Advanced Chemistry*, **2014**,2(1), 27-33
[11] S.Jain, N. R. Bhimireddy, S. R.Kolisetty, *International Journal of ChemTech Research*,**2011**,3(2), 817-824
[12] P. K.Gutch, P.Kumar, M. V. S. Suryanarayana, R. C.Malhotra, *Defense Science Journal*,**2005**,55(4): 447-457
[13] M.Abdel-Megid, M.Ahmed Ibrahim, N. M. Gabr, El-Gohary, Y. A. El-Hossain, (Ed.)15th International Electronic Conference on Synthetic Organic Chemistry (ECSOC-15),**2011**,1-30
[14] M.Jeyachandran, K.Shriram, *International Journal of Applied Biology and Pharmaceutical Technology*, **2011**,2(2), 349-353
[15] R.Manikannan, S.Muthusubramanian, P.Yogeeswari, D.Sriram, *Bioorganic and Medicinal Chemistry Letters*, **2010**, 20, 3352-3355

[16] G. M.Ziarani, S.Faramarzi, S.Asadi, A.Badiei, R. Bazl, M.Amanlou, *DARU Journal of Pharmaceutical Sciences*, **2013**, 21(3), 1-13.
[17] M. S.Rao, B. S.Chhikara, R.Tiwari, A. N.Shirazi, K.Parang, A.Kumar, *Chemistry and Biology Interface*,**2012**, 2(6): 362-372
[18] F. M.Abdelrazek, F. A. Michael, S. F.El-Mahrouky, *International Journal of Physical Sciences*, **2007**, 2(8), 2012-216
[19] K. D. Niranjane, M. A.Kale, *Der Pharmacia Letter*, **2011**,3(2), 276-283
[20] A.El-Shekeil, A. O. Obeid, S. Al-Aghbari, *European Journal of Chemistry*,**2012**, 3(3), 356-358
[21] A. A.Fadda, M. A.Berghot, F. A.Amer , D. S.Badawy,N. M.Bayoumy, *Archiv Der Pharmazie*,**2012**,345(5), 378-385
[22] H. B.Ammar, M. T. Kaddachi, P. H. Kahn, *Phys. Chem. News*, **2003**,9, 137-139
[23] A. A.Fadda, S.Bindock, R. Rabie, H. A.Etman, *Turk J. Chem*.,**2008**, 32, 259-286
[24] M. A. M.Gomaa, *Chemical Science Transactions*,**2013**, 2(3), 964-968
[25] V. D.Dyachenko,Y. Y.Pugach, *Russian Journal of General Chemistry*,**2013**,83(5), 979-982
[26] A.Hasaninejad, N.Jafarpour, M.Mohammadnejad, *E-Journal of Chemistry*,**2012**,9(4), 2000-2005
[27] J.Khalafy, M.Rimaz, S.Farajzadeh,M.Ezzati, S. *Afr. J. Chem*.,**2013**, 66, 179-182
[28] A. A. Sayed, M.Maddahi, *International journal of Advanced Biological and Biomedical Research*,**2013**, 1(11), 1364-1367
[29] G.Wang,G.Cheng, *ARKIVOC*, **2004**,ix, 4-8
[30] M. A.Pasha, K.Manjula, V. P.Jayashankara, *Indian Journal of Chemistry*,**2010**,49(B), 1428-1431
[31] A.Dandia, R.Singh, H.Sachdeva, R.Gupta, S.Paul, *Journal of Chinese Chemical Society*,**2003**,50, 273-278.