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(54) **1, 2, 4-TRIAZOLE DERIVATIVES AND THEIR ANTI-MICROBIAL ACTIVITY**

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(57) **ABSTRACT**

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**Related U.S. Application Data**

(62) Division of application No. 13/634,352, filed on Nov. 16, 2012, now Pat. No. 8,865,910, filed as application No. PCT/IN2011/000172 on Mar. 14, 2011.

Triazole derivatives useful as anti-tubercular compounds; process for preparation of the triazoles and a method for inhibiting growth of *Mycobacterium bovis* BCG and *Mycobacterium tuberculosis* H37Ra using the triazoles.

FIG. 1

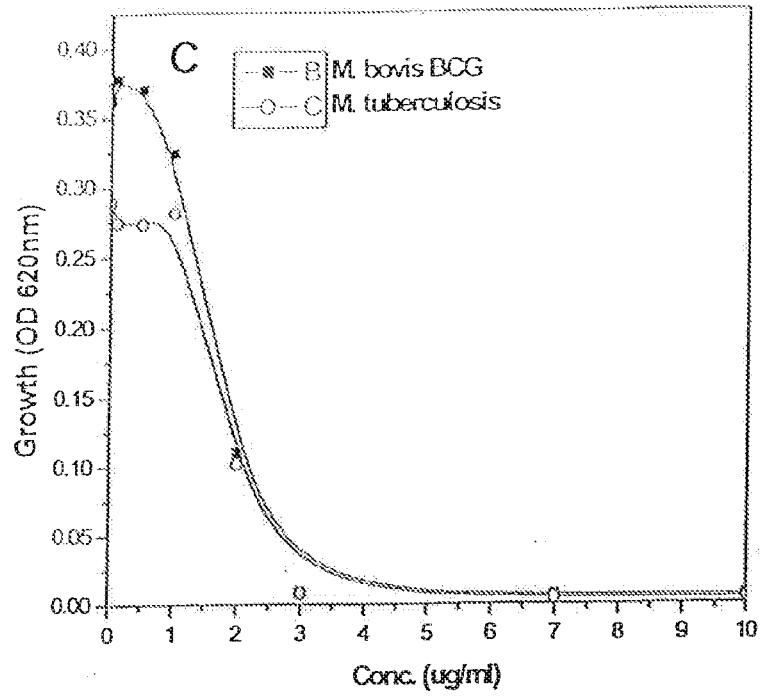


FIG. 2

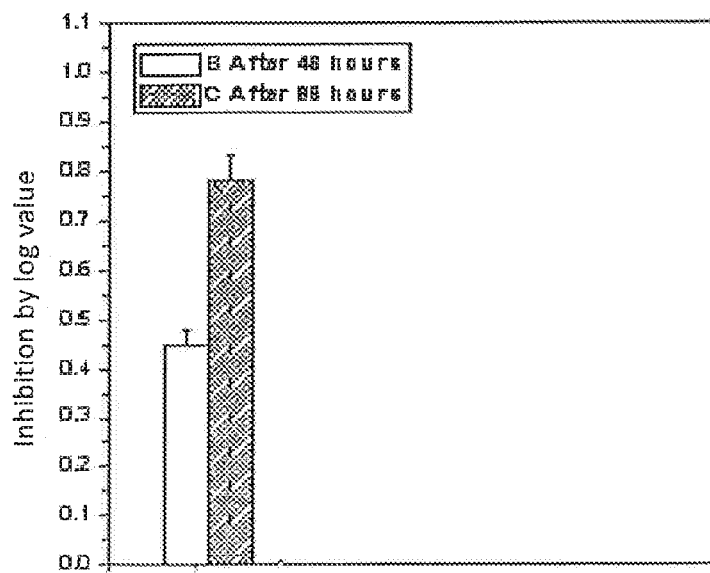
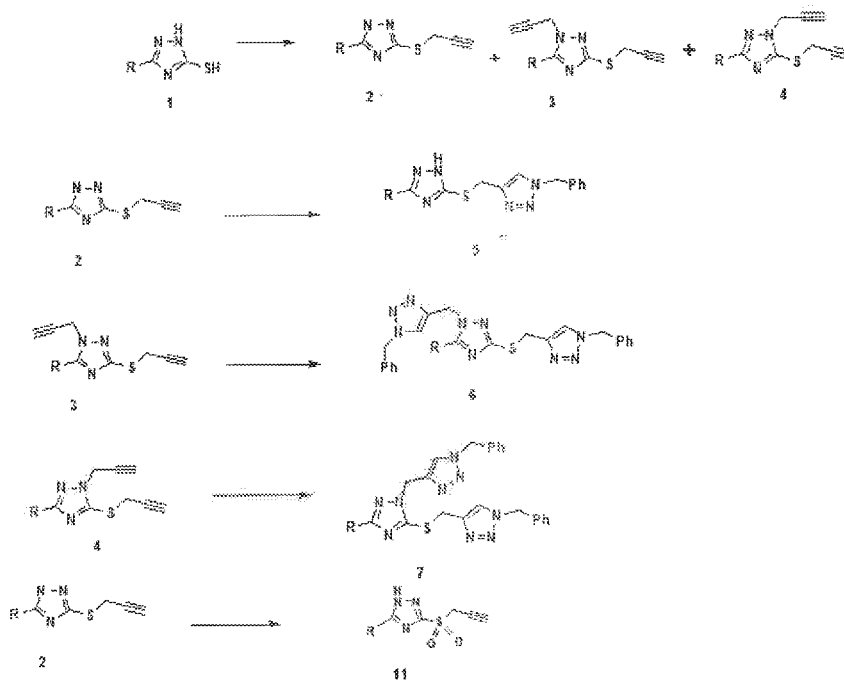
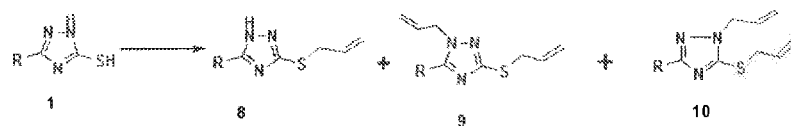


FIG. 3



R,  
 a = H, b = Me. c = t-bu, d = 4-nitrophenyl,  
 e = 4-methoxyphenyl, f = 4-chlorophenyl.

FIG. 4



R,  
 a = H, b = Me. c = t-bu, d = 4-nitrophenyl,  
 e = 4-methoxyphenyl, f = 4-chlorophenyl.

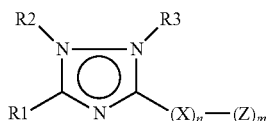
## 1, 2, 4-TRIAZOLE DERIVATIVES AND THEIR ANTI-MICROBIAL ACTIVITY

### CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application is a division of co-pending U.S. patent application Ser. No. 13/634,352, filed Nov. 16, 2012, which is a national stage entry of PCT/IN2011/000172, filed Mar. 14, 2011, which claims foreign priority from Indian Patent Application No. 0574/DEL/2010, filed on Mar. 12, 2010, which is incorporated by reference in its entirety.

### FIELD OF THE INVENTION

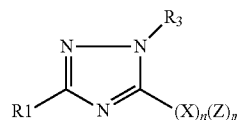
**[0002]** The present invention relates to 1,2,4-triazole derivatives of general formula I and belong to a structural class of propargylated 1,2,4-triazolethiols, allylated 1,2,4-triazolethiols and their sulphones and corresponding 1,2,3-triazole derivatives, to selectively act against dormant pathogenic tuberculi bacilli.



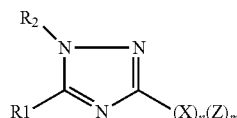
General Formula I

wherein, X is sulfur(S) or a sulphone (O=S=O), n, m represent independently an integer 0 or 1, with the provision that when 'n' is 1, 'm' is 1; R1 is hydrogen; C1-C6 linear or branched alkyl group optionally substituted with aryl group; halogen; or aryl group optionally substituted with —OCH<sub>3</sub>, halogen, and nitro; R2 and R3 are selected from the group consisting of hydrogen, C1-C6 alkyl optionally substituted with heterocyclic ring of 5 to 6 ring atoms containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, which may be substituted with alkyl, arylalkyl, linear or branched alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, allyl propargyl groups consisting of 1 to 6 carbon atoms; Z is C1-C6 alkyl optionally substituted with heterocyclic ring of 1 to 6 ring atoms, containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, which may be substituted with arylalkyl, linear or branched alkenyl, substituted alkenyl, alkynyl, substituted alkynyl allyl or propargyl groups consisting of 1 to 6 carbon atoms; with the provision that when 'm' is 1, and 'n' is zero; R1 is selected from the group consisting of hydrogen, halogen; C1-C6 linear or branched alkyl group optionally substituted with aryl group or aryl group optionally substituted with —OCH<sub>3</sub>, halogen, and nitro, R2 and R3 are selected from the group consisting of hydrogen, C1-C6 alkyl optionally substituted with heterocyclic ring of 5 to 6 ring atoms containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, which may be substituted with alkyl, arylalkyl, linear or branched alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, or allyl or propargyl groups consisting of 1 to 6 carbon atoms; Z is selected from the group consisting of halogen, C1-C6 linear or branched alkyl group optionally substituted with heterocyclic ring of 1 to 6 ring atoms, containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, wherein the heterocyclic ring may further be substituted with halogen, alkyl, arylalkyl.

**[0003]** Present invention further relates to 1,2,4-triazole derivatives of general formula I and the representative compounds are:



Formula I



Formula 2

**[0004]** wherein R1, R2, R3, X, Z, n and m are same as described above.

**[0005]** Present invention further relates to 1,2,4-triazole derivatives of general formula I useful to selectively kill dormant pathogenic tuberculi bacilli.

### BACKGROUND OF THE INVENTION

**[0006]** Tuberculosis (TB) is caused by *Mycobacterium tuberculosis* and remains as a leading cause of mortality worldwide. The treatment is complicated by a long-term administration of few antitubercular agents such as Rifampicin, Isoniazid, Ethambutol and Pyrazinamide in high dosage which intensifies drug side effects, and often results in the development of multidrug resistant strains and thus poor compliance from TB patients. In addition, the disease often attacks immunoaltered individuals. TB together with mycoses is the most common complication and the cause of death in AIDS patients. The failure of anti tubercular therapy is also related to migration of inhabitants from the areas with a higher incidence of TB to the regions with a favorable epidemiologic situation. Thus the current TB treatment is found to be not satisfactorily effective in the eradication of latent TB infection.

**[0007]** Triazoles are known for their antifungal, antiviral and plant growth regulatory activities but their antimycobacterial potential has gained importance only in recent years. Fluconazole and tebuconazole are known for their antimycobacterial activity but have non-specificity and higher MIC values. Moreover, they are not effective against dormant tubercle bacilli.

**[0008]** Further, azole antifungal derivatives such as fluconazole, hexacoazole which are N1 substituted 1,2,4-triazole compounds were found to be ergosterol biosynthesis inhibitors.

**[0009]** There is ample non-patented literature available on development of tubercular drugs as quoted below: References may be made to article "Arch Pharm Res Vol 27, No 5, 502-506, 2004" by Alireza Foroumadi, et al, which discloses two series of 2-(5-nitro-2-furyl)- and 2-(1-methyl-5-nitro-1H-imidazol-2-yl)-5-propyl, allyl and propargyl)thio-1,3,4-thiadiazoles and 2-(5-nitro-2-furyl)- and 2-(1-methyl-5-nitro-1H-imidazol-2-yl)-5-(nitrobenzyl)thio-1,3,4-thiadiazole derivatives which were evaluated against *Mycobacterium tuberculosis*. The compounds 2-(3-Methyl-5-nitro-1H-imidazol-2-yl)-5-(n-propyl)thio-1,3,4-thiadiazole, 2-(5-nitro-2-furyl)-5-(2-propynyl)thio-1,3,4-thiadiazole, 2-(5-nitro-2-furyl)-5-(2-nitrobenzyl)thio-1,3,4-thiadiazole, 2-(5-nitro-2-

furyl)-5-(3-nitrobenzyl)thio-1,3,4-thiadiazole,2-(5-nitro-2furyl)-5-(4-nitro benzyl)thio-1,3,4-thiadiazole displayed significant inhibition effects (90%) in the primary screening (MIC>>6.25 µg/mL) against *M. tuberculosis* H37Rv in the BACTEC 12B medium, using the BACTEC 460 radiometric system.

**[0010]** References may be made to *Journal "Enzyme Inhibition and Medicinal Chemistry, Volume 22, issue 4 Aug. 2007, pages 511-516"* by Gulhan Turan-et al where it discloses another study, wherein a series of 4-arylidenamino-4H-1,2,4-triazole-3-thiol derivatives were synthesized by reaction of 4-amino-4H-1,2,4-triazoles-3-thiol with the respective aldehydes and were evaluated for anti tuberculosis activity against *Mycobacterium tuberculosis* H37Rv (ATCC 27294), using the BACTEC 460 radiometric system and BACTEC 12B medium. Compounds showed an activity at 6.25 µg/mL with 87 percentage inhibition.

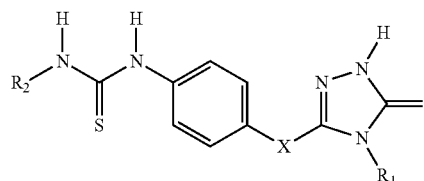
**[0011]** In another article, a series of N-(4-((4-amino-5-sulfanyl-4H-1,2,4-triazol-3-yl)methyl)-1,3-thiazol-2-yl)-2-substituted amide derivatives were synthesized and evaluated for their preliminary in vitro antitubercular activity against *Mycobacterium tuberculosis* H37Rv strain by the MABA assay method.

**[0012]** Compounds such as N-(5-(((1E)-1-aza-2-phenylvinyl)carbamoyl)methylthio)-3-[[2-(acetylamino)(1,3-thiazol-4-yl)methyl](1,2,4-triazol-4-yl)]-acetamide, N-{4-[(5-(((1E)-1-aza-2-phenylvinyl)carbamoyl)methylthio)-4-acetylamino(1,2,4-triazol-3-yl)methyl](1,3-thiazol-2-yl)-2-chloroacetamide and N-(5-[[((1E)-1-aza-2-phenylvinyl)carbamoyl)methylthio]-3-[(2-(phenylamino)(1,3-thiazol-4-yl)methyl](1,2,4-triazol-4-yl)]-acetamide exhibited more than 94% inhibition at 12.5 µg/mL. (Mahendra Shiradkar, et al, General Papers, ARKIVOC 2006 (xiv) 141-154).

**[0013]** A series of 5-amino-4-(5-arylpyrazol-3-yl)-1-(3/4-nitrophenyl)-1,2,3-triazoles that have been synthesized by the base-catalysed condensation of 3/4-nitrophenyl azides with 5-aryl-3-cyanomethylpyrazoles is disclosed as potential antiinvasive and antimycobacterial agents by Ajay Kumar, et al in Indian Journal of Chemistry Sect. B Organic Chemistry including Medicinal Chemistry VOL. 42B NUMBER 8 Aug. 2003 Paper 1950.

**[0014]** References may be made to article "Structural elucidation of propargylated products of 3-substituted-1,2,4-triazole-5-thiols by NMR techniques in Magnetic Resonance Chemistry, 2005 December; 46(12):1168-74" by Chaudhary P M, Chavan S R, Kavitha M having DOI 10.1002/mrc.2307, which discloses synthesis and characterization of mono S-propargyl and S,N-dipropargyl regioisomers, arising from N1/N2 substitution to study their biological activity.

**[0015]** References may be made to *Journal "European Journal of Medicinal Chemistry Volume 43, Issue2, February 2008, Pages 381-392"* by Ilkay Küçkgüzel, et al, which discloses heterocyclic derivatives of 5-[(4-aminophenoxy)methyl]-4-alkyl/aryl-2,4-dihydro-3H-1,2,4-triazole-3-ylthiones and N-alkyl/aryl-N'-{4-[(4-alkyl/aryl-5-thioxo-4,5-dihydro-1H-1,2,4-triazol-3-yl)methoxy]phenyl}thioureas.



**[0016]** The above compound showed 79% Inhibition against *M. tuberculosis* H37Rv where R<sub>1</sub> is CH<sub>2</sub>CH=CH<sub>2</sub>, R<sub>2</sub> is C<sub>6</sub>H<sub>5</sub>, X is —O—CH<sub>2</sub>—.

**[0017]** References may be made to *Journal "Indian Journal of Chemistry Sect. B Organic Chemistry including Medicinal Chemistry VOL. 42B No. 8 August 2003 Paper 2010"* by B Shivarama Holla, Veerendra, M K Shivananda & N Sucheta Kumari, which discloses synthesis and antibacterial activity of Schiff bases and bis-triazolothiadiazoles derived from bis-1,2,4-triazole.

**[0018]** References may be made to Article "UDC 547.791'796.07" by L. I. Vereshchagin, et al, which discloses a number of corresponding 1- and 2-propargylazoles which were obtained by propargylation of 5-substituted tetrazoles and 1,2,3-triazoles with various degrees of substitution. These polyazole structures with a system of two to five uncondensed azole rings were synthesized by the reaction of 1- and 2-propargyl azoles with organic azides, diazides, and azoles, as well as by oxidative dimerization. The uncondensed polynitrogenous heterocyclic compounds were shown to exhibit pesticidal activity.

**[0019]** There still remains a need to develop antitubercular compounds to overcome the limitations encountered in the tuberculosis drug discovery programme as evident from the prior art.

**[0020]** Thus the present inventors felt a need to develop novel azole derivatives which are capable of inhibiting the growth of dormant tuberculi bacilli such as *Mycobacterium bovis* BCG and *M. tuberculosis* completely.

#### OBJECTIVE OF THE INVENTION

**[0021]** The main object of the present invention is to provide 1,2,4-triazole derivatives of general Formula I.

**[0022]** Another objective of the present invention is to provide 1,2,4-triazole derivatives specifically belonging to a structural class of propargylated 1,2,4-triazolethiols and their sulphones and corresponding 1,2,3-triazole derivatives to selectively kill pathogenic *M. tuberculosis*.

**[0023]** Another objective of the present invention is to provide process for the preparation of 1,2,4-triazole derivatives of Formula I and II which are effectively used against dormant tubercle bacilli, *Mycobacterium bovis* BCG and *Mycobacterium tuberculosis* H37Ra.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

**[0024]** FIG. 1 is a graph showing dose response effect of compound 4f on the growth of *M. bovis* BCG and *M. tuberculosis* He7Ra.

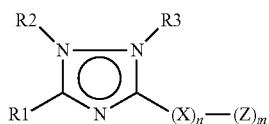
**[0025]** FIG. 2 is a graph showing effect of compound 4f at MIC of aerobic stage on the viability of *M. tuberculosis* H37Ra.

**[0026]** FIG. 3 represents Scheme I, the flow diagram for the preparation of compounds 2-7 and 11.

[0027] FIG. 4 represents Scheme 2, the flow diagram for the preparation of compounds 8-10.

## SUMMARY OF THE INVENTION

[0028] Accordingly, present invention provides Compounds of General Formula I,



wherein, X is sulfur (S) or a sulphone (O=S=O), n, m represent independently an integer 0 or 1, with the provision that when 'n' is 1, 'm' is 1; R1 is hydrogen; C1-C6 linear or branched alkyl group optionally substituted with aryl group; halogen; or aryl group optionally substituted with —OCH<sub>3</sub>, halogen, and nitro; R2 and R3 are selected from the group consisting of hydrogen, C1-C6 alkyl optionally substituted with heterocyclic ring of 5 to 6 ring atoms containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, which may be substituted with alkyl, arylalkyl, linear or branched alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, or allyl or propargyl groups consisting of 1 to 6 carbon atoms; Z is C1-C6 alkyl optionally substituted with heterocyclic ring of 1 to 6 ring atoms, containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, which may be substituted with arylalkyl, linear or branched alkenyl, substituted alkenyl, alkynyl, substituted alkynyl or propargyl groups consisting of 1 to 6 carbon atoms;

[0029] with the provision that when 'm' is 1, and 'n' is zero; R1 is selected from the group consisting of hydrogen, halogen; C1-C6 linear or branched alkyl group optionally substituted with aryl group or aryl group optionally substituted with —OCH<sub>3</sub>, halogen, and nitro, R2 and R3 are selected from the group consisting of hydrogen, C1-C6 alkyl optionally substituted with heterocyclic ring of 5 to 6 ring atoms containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, which may be substituted with alkyl, arylalkyl, linear or branched alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, or allyl or propargyl groups consisting of 1 to 6 carbon atoms; Z is selected from the group consisting of halogen, C1-C6 linear or branched alkyl group optionally substituted with heterocyclic ring of 1 to 6 ring atoms, containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, wherein the heterocyclic ring may further be substituted with halogen, alkyl, arylalkyl.

[0030] In an embodiment of the present invention, representative compounds comprising:

[0031] 1-benzyl-4-((1-((1-benzyl-1H-1,2,3-triazol-4-yl)methyl)-3-(4-chlorophenyl)-1H-1,2,4-triazol-5-ylthio)methyl)-1H-1,2,3-triazole 3f;

[0032] 3-(allylthio)-5-methyl-1H-1,2,4-triazole 4b;

[0033] 3-(allylthio)-5-tert-butyl-1H-1,2,4-triazole 4c;

[0034] 3-(allylthio)-5-(4-methoxyphenyl)-1H-1,2,4-triazole 4e;

[0035] 3-(allylthio)-5-(4-chlorophenyl)-1H-1,2,4-triazole 4f;

[0036] 1-allyl-3-(allylthio)-1H-1,2,4-triazole 5a;

[0037] 1-allyl-3-(allylthio)-5-(4-methoxyphenyl)-1H-1,2,4-triazole 5e;

[0038] 1-allyl-3-(allylthio)-5-(4-chlorophenyl)-1H-1,2,4-triazole 5f;

[0039] 1-allyl-5-(allylthio)-1H-1,2,4-triazole 6a;

[0040] 1-allyl-5-(allylthio)-3-(4-methoxyphenyl)-1H-1,2,4-triazole 6e;

[0041] 5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole 7a;

[0042] 3-tert-butyl-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole 7c;

[0043] 3-(4-nitrophenyl)-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole 7d;

[0044] 3-(4-methoxyphenyl)-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole 7e,

[0045] 3-(4-chlorophenyl)-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole 7f;

[0046] 1-allyl-3-tert-butyl-5-(prop-2-ynylthio)-1H-1,2,4-triazole 8a;

[0047] 1-allyl-5-tert-butyl-3-(prop-2-ynylthio)-1H-1,2,4-triazole 8b;

[0048] 5-(allylthio)-3-tert-butyl-1-(prop-2-ynyl)-1H-1,2,4-triazole 8c;

[0049] 3-(allylthio)-5-tert-butyl-1-(prop-2-ynyl)-1H-1,2,4-triazole 8d;

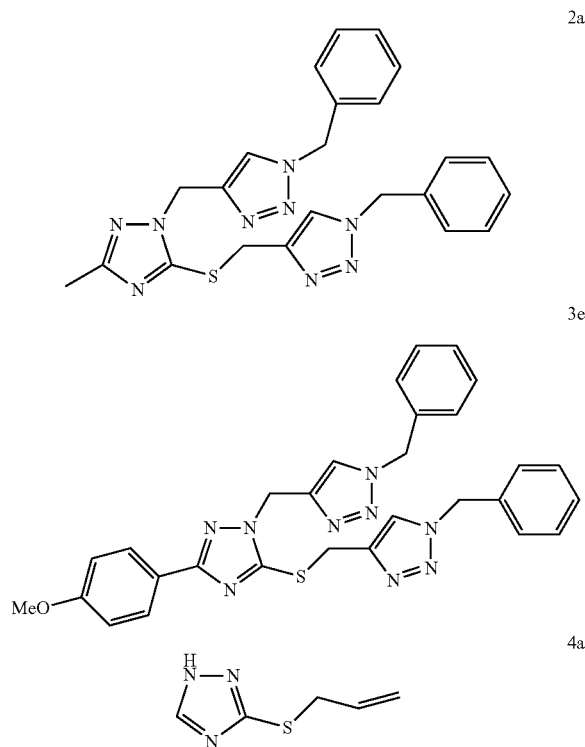
[0050] 3,5-dibromo-1-(prop-2-ynyl)-1H-1,2,4-triazole 11a;

[0051] 1-allyl-5-methyl-3-(prop-2-ynylthio)-1H-1,2,4-triazole 10b;

[0052] 1-allyl-3-(prop-2-ynylthio)-1H-1,2,4-triazole 9b;

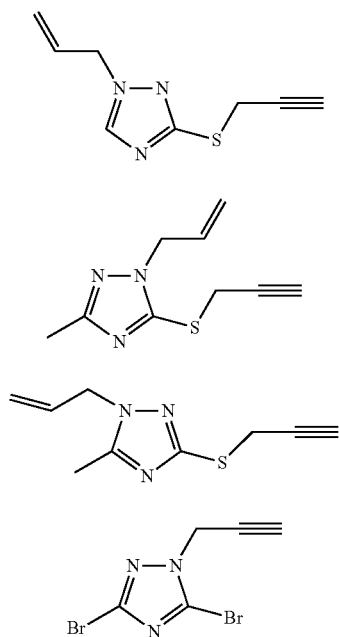
[0053] 1-allyl-5-(prop-2-ynylthio)-1H-1,2,4-triazole 9a;

[0054] In yet another embodiment of the present invention, structural formula of the representative compound are:



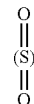


-continued



9b

wherein,

**[0061]** X is sulfur(S) or a sulphone

10a

**[0062]** n, m represent independently an integer 0 or 1.

**[0063]** with the provision that when 'n' is 1, 'm' is 1; R1 is hydrogen; C1-C6 linear or branched alkyl group optionally substituted with aryl group; halogen; or aryl group optionally substituted with —OCH<sub>3</sub>, halogen, and nitro; R2 and R3 are selected from the group consisting of hydrogen, C1-C6 alkyl optionally substituted with heterocyclic ring of 5 to 6 ring atoms containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, which may be substituted with alkyl, arylalkyl, linear or branched alkenyl, substituted alkenyl, alkynyl substituted alkynyl, or allyl or propargyl groups consisting of 1 to 6 carbon atoms; Z is C1-C6 alkyl optionally substituted with heterocyclic ring of 1 to 6 ring atoms, containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, which may be substituted with arylalkyl, linear or branched alkenyl, substituted alkenyl, alkynyl, substituted alkynyl allyl or propargyl groups consisting of 1 to 6 carbon atoms;

10b

11a

**[0055]** In yet another embodiment of the present invention, said compounds are antitubercular and are active against actively growing as well as dormant bacilli of *Mycobacterium bovis* BCG and *Mycobacterium tuberculosis*, H37Ra.

**[0056]** In yet another embodiment of the present invention, a process for the preparation of compounds of General formula I and the said process comprising the steps of:

**[0057]** i. reacting 5-substituted 1,2,4-triazole-3-thiols with propargyl bromide, in presence of K<sub>2</sub>CO<sub>3</sub> at temperature in the range of 25 to 30° C. to give S-monopropargylated and N,S-dipropargylated products;

**[0058]** ii. oxidizing S-monopropargylated compounds to give sulphone derivatives of formula 7a-f;

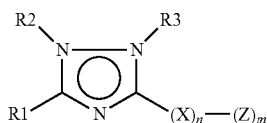
**[0059]** iii. alternately, treating the terminal alkyne group of all the S-monopropargylated and NS-dipropargylated 1,2,4-triazole thiols with benzyl azide in presence of Cu(I) catalyst at temperature in the range of 25 to 30° C., to form 1,2,3-triazole derivatives of formula 1a-1c, 2a-2c, 2e, 2f, 3a-3f.

**[0064]** with the provision that when 'm' is 1, and 'n' is zero; R1 is selected from the group consisting of hydrogen, halogen; C1-C6 linear or branched alkyl group optionally substituted with aryl group or aryl group optionally substituted with —OCH<sub>3</sub>, halogen, and nitro, R2 and R3 are selected from the group consisting of hydrogen, C1-C6 alkyl optionally substituted with heterocyclic ring of 5 to 6 ring atoms containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, which may be substituted with alkyl, arylalkyl, linear or branched alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, or allyl or propargyl groups consisting of 1 to 6 carbon atoms; Z is selected from the group consisting of halogen, C1-C6 linear or branched alkyl group optionally substituted with heterocyclic ring of 1 to 6 ring atoms, containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, wherein the heterocyclic ring may further be substituted with halogen, alkyl, arylalkyl.

**[0065]** Present invention provides compounds of general formula I wherein representative compounds of general formula I are:

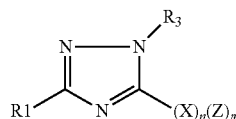
## DETAILED DESCRIPTION OF THE INVENTION

**[0060]** Present invention provides 1, 2, 4 triazole derivatives as anti-tubercular compounds of general formula I

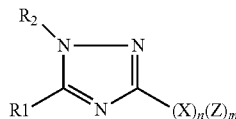


General Formula I

Formula I



Formula 2



**[0066]** wherein R1, R2, R3, X, Z, n and m are as described above.



[0067] Present invention describes process for preparation of the compounds of Formula I and II as depicted in Scheme I wherein R=R1, wherein R1 is as described above.

[0068] Accordingly, the general process for the preparation of Formula I and II comprises of the following steps:

[0069] (a) reacting 5-substituted 1,2,4-triazole-3-thiols with propargyl bromide in presence of  $K_2CO_3$  at room temperature to give S-monopropargylated and N,S-dipropargylated products; and

[0070] (b) oxidizing S-monopropargylated compounds to give sulphone derivatives (7a-f).

[0071] (c) alternately, treating the terminal alkyne group of all the S-monopropargylated and NS-dipropargylated 1,2,4-triazole thiols with benzyl azide in presence of

Cu(I) catalyst at room temperature to form 1,2,3-triazole derivatives 1a-1c, 2a-2c, 2e, 2f, 3a-3f.

[0072] The propargylated derivatives are purified by flash column chromatography.

[0073] Alkylation was carried out on these thiols as depicted in Scheme 2 to yield various regioisomers which were tested for their antitubercular activity.

[0074] Total of 50 derivatives (Table 1) were synthesized using the method illustrated in Scheme 1 and Scheme 2.

[0075] The anti tubercular activity of the compounds of the present invention is observed by in-vitro experiment as depicted in table 1 below.

[0076] The antimycobacterial activity against dormant bacilli was observed at concentration of less than 100  $\mu\text{g/ml}$  in in-vitro culture conditions.

TABLE 1

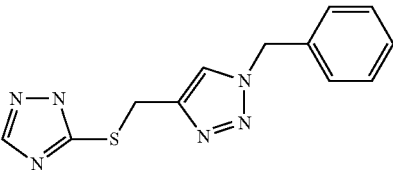
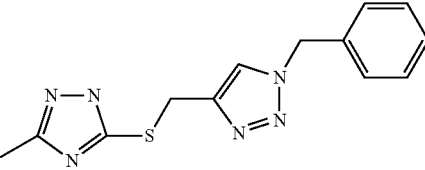
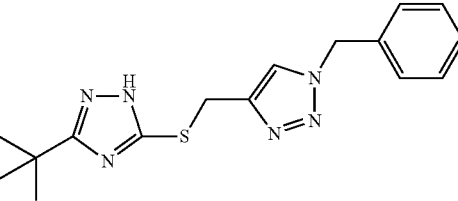
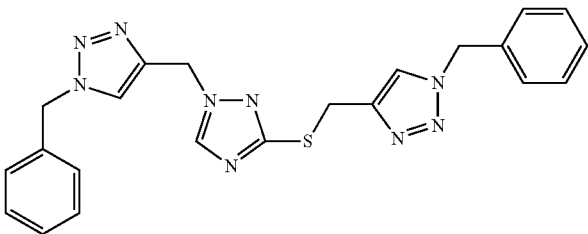
In-vitro antimycobacterial activity of triazole derivatives against <i>M. bovis</i> BCG.					
S.N.	Chemical Structure	com- pound	Spectral data	Antimycobac- terial activity@ % Inhibition at 100 $\mu\text{g/ml}$	
				Aer- obic/ Active stage	Anaer- obic/ Dormant stage
1.		1a	$^1\text{H NMR } \delta$ 8.06 (s, 1H), 7.42 (s, 1H), 7.18-7.27 (m, 5H), 5.37 (s, 2H), 4.29 (s, 2H);	03	04
2.		1b	$^1\text{H NMR } \delta$ 7.51 (s, 1H), 7.36-7.20 (m, 5H), 5.48 (s, 2H), 4.38 (s, 2H), 2.43 (s, 3H);	10	14
3.		1c	$^1\text{H NMR } \delta$ 7.42 (s, 1H), 7.43 (m, 5H), 5.39 (s, 2H), 4.29 (s, 2H), 1.27 (s, 9H);	03	11
4.		2a	$^1\text{H NMR } \delta$ 8.06 (s, 1H), 7.59 (s, 1H), 7.45 (s, 1H), 7.25 (m, 10H), 5.49 (s, 2H), 5.42 (s, 2H), 5.33 (s, 2H), 4.36 (s, 2H);	11	18

TABLE 1-continued

		In-vitro antimycobacterial activity of triazole derivatives against <i>M. bovis</i> BCG.		Antimycobacterial activity <sup>Ⓢ</sup> % Inhibition at 100 µg/ml	
S.N.	Chemical Structure	compound	Spectral data	Aerobic/Active stage	Anaerobic/Dormant stage
5.		2b	<sup>1</sup> H NMR δ 7.52 (s, 1H), 7.38 (s, 1H), 7.11-7.30 (m, 10H), 5.41 (s, 2H), 5.35 (s, 2H), 5.18 (s, 2H), 4.26 (s, 2H), 2.39 (s, 3H);	08	12
6.		2c	<sup>1</sup> H NMR δ 7.63 (s, 1H), 7.43 (s, 1H), 7.10-7.3 (m, 10H), 5.44 (s, 2H), 5.4 (s, 2H), 5.38 (s, 2H), 4.29 (s, 2H), 1.43 (s, 9H);	08	15
7.		2e	<sup>1</sup> H NMR δ 7.63 (s, 1H), 7.67 (s, 2H), 7.47 (s, 1H), 7.29 (m, 9H), 7.19 (bs, 2H), 6.98 (d, 2H, J = 8 Hz), 5.49 (s, 2H), 5.41 (s, 2H), 5.36 (s, 2H), 4.39 (s, 2H), 3.84 (s, 3H);	01	08
8.		2f	<sup>1</sup> H NMR δ 7.71 (s, 1H), 7.72 (s, 1H), 7.68 (s, 1H), 7.47-7.43 (m, 8H), 5.49 (s, 2H), 5.41 (s, 2H), 5.34 (s, 2H), 4.39 (s, 2H);	21	17
9.		3a	<sup>1</sup> H NMR δ 7.9 (s, 1H), 7.59 (s, 1H), 7.45 (s, 1H), 7.20 (m, 10H), 5.49 (s, 2H), 5.35 (s, 2H), 5.2 (s, 2H), 4.4 (s, 2H)	08	03

TABLE 1-continued

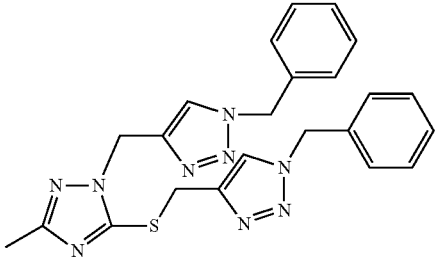
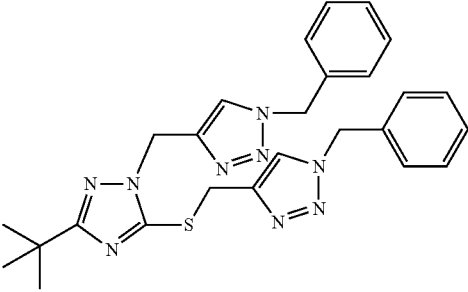
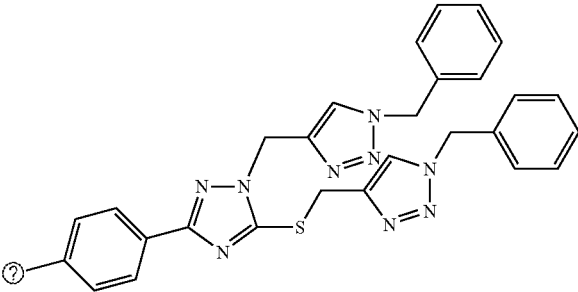
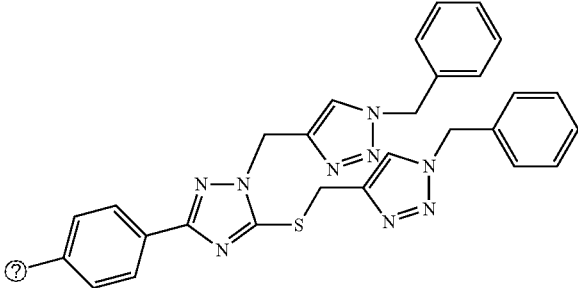
		In-vitro antimycobacterial activity of triazole derivatives against <i>M. bovis</i> BCG.		Antimycobacterial activity <sup>Ⓢ</sup> %	
				Inhibition at 100 µg/ml	
S.N.	Chemical Structure	com- pound	Spectral data	Aer- obic/ Active stage	Anaer- obic/ Dormant stage
10		3b	<sup>1</sup> H NMR δ 7.39 (s, 1H), 7.36 (s, 1H), 7.32-7.1 (m, 6H), 7.24-7.20 (m, 2H), 7.6-7.10 (m, 2H), 5.43 (s, 2H), 5.41 (s, 2H), 5.19 (s, 2H), 4.39 (s, 2H), 2.23 (s, 3H);	85	76
11		3c	<sup>1</sup> H NMR δ 7.32 (s, 1H), 7.29 (s, 1H), 7.04-7.25 (m, 10H), 5.38 (s, 2H), 5.34 (s, 2H), 5.15 (s, 2H), 4.33 (s, 2H), 1.16 (s, 9H);	10	13
12		3d		13	11
13		3e	<sup>1</sup> H NMR δ 7.84 (d, 2H, J = 8 Hz), 7.23-7.10 (m, 12H), 6.83 (d, 2H, J = 8 Hz), 5.38 (s, 2H), 5.32 (s, 2H), 5.24 (s, 2H), 4.43 (s, 2H), 3.7 (s, 3H);	86	82

TABLE 1-continued

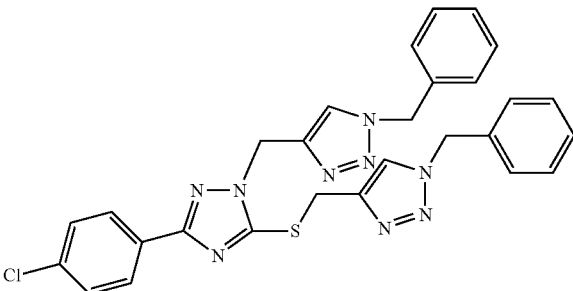
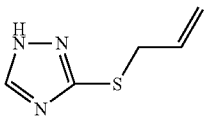
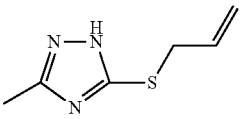
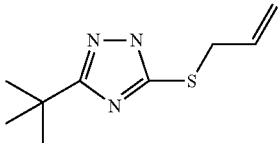
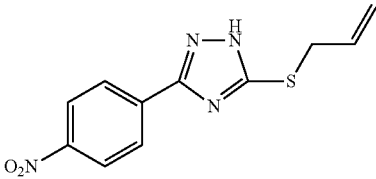
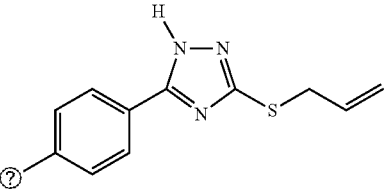
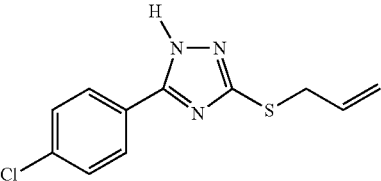
In-vitro antimycobacterial activity of triazole derivatives against <i>M. bovis</i> BCG.					
S.N.	Chemical Structure	com- pound	Spectral data	Antimycobac- terial activity <sup>Ⓢ</sup> % Inhibition at 100 µg/ml	
				Aer- obic/ Active stage	Anaer- obic/ Dormant stage
14		3f	<sup>1</sup> H NMR δ 7.84 (s, 1H), 7.80 (s, 1H), 7.30-7.10 (m, 12H), 7.04 (m, 2H), 5.38 (s, 2H), 5.32 (s, 2H), 5.23 (s, 2H), 4.42 (s, 2H);	31	04
15		4a	<sup>1</sup> H NMR δ 8.17 (s, 1H), 5.91 (m, 1H), 5.24 (d, 1H), 5.075 (s, 2H), 3.75 (dd, 1H).	51	32
16		4b		98	97
17		4c	<sup>1</sup> H NMR δ 5.87 (m, 1H), 4.79 (d, 2H), 3.63 (d, 2H), 1.30 (s, 9H)	57	39
18		4d	<sup>1</sup> H NMR δ 8.27 (m, 4H), 6.02 (m, 1H), 5.36 (m, 2H), 4.86 (dd, 2H)	25	14
19		4e	<sup>1</sup> H NMR δ 8.01 (d, 2H), 6.91 (d, 2H), 6.01 (m, 1H), 5.35 (m, 2H), 4.78 (m, 2H), 3.85 (s, 3H)	94	93
20		4f	<sup>1</sup> H NMR δ 8.04 (d, 2H), 7.37 (d, 2H), 6.03 (m, 1H), 5.35 (m, 2H), 4.81 (m, 2H)	98	91

TABLE 1-continued

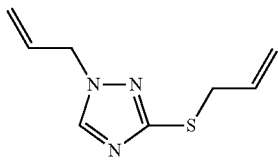
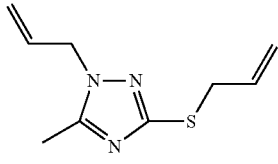
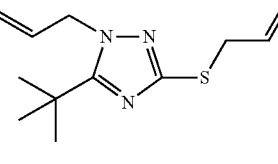
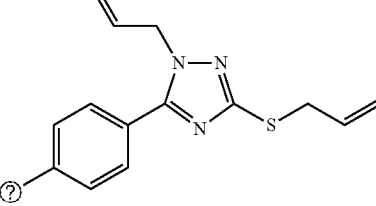
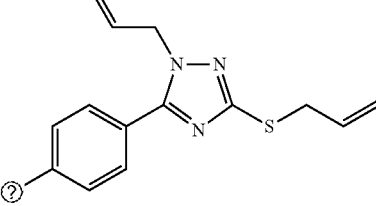
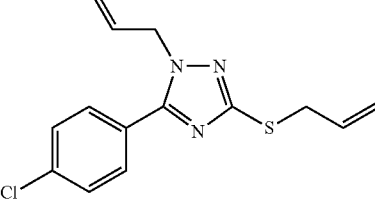
In-vitro antimycobacterial activity of triazole derivatives against <i>M. bovis</i> BCG.					
S.N.	Chemical Structure	com- pound	Spectral data	Antimycobac- terial activity <sup>Ⓢ</sup> % Inhibition at 100 µg/ml	
				Aer- obic/ Active stage	Anaer- obic/ Dormant stage
21		5a	<sup>1</sup> H NMR δ 7.85 (s, 1H), 5.87 (m, 2H), 5.17 (m, 4H), 4.68 (d, 2H), 3.80 (d, 2H)	58	42
22		5b		25	15
23		5c	<sup>1</sup> H NMR δ 5.87 (m, 2H), 5.17 (m, 4H), 4.75 (d, 2H), 3.63 (d, 2H), 1.28 (s, 9H)	45	36
24		5d	<sup>1</sup> H NMR δ 8.20 (m, 4H), 5.90 (d, 2H), 5.16 (d, 4H), 4.68 (m, 2H), 3.90 (d, 2H)	15	18
25		5e	<sup>1</sup> H NMR δ 8.01 (d, 2H), 6.93 (d, 2H), 5.94 (m, 2H), 5.25 (m, 4H), 4.78 (m, 2H), 3.86 (d, 2H), 3.83 (s, 3H)	89	84
26		5f	<sup>1</sup> H NMR δ 8.04 (d, 2H), 7.37 (d, 2H), 3.95 (d, J = 8 Hz, 2H), 4.76 (d J = 6 Hz, 2H), 5.2 (m, 4H), 5.94 (m, 2H)	94	91

TABLE 1-continued

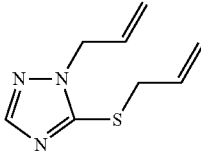
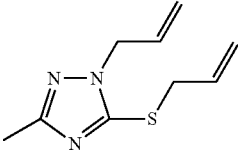
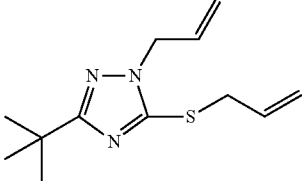
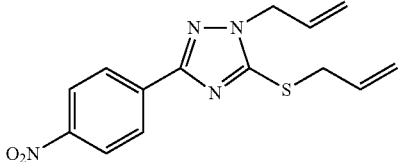
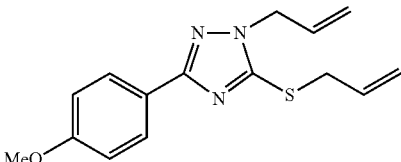
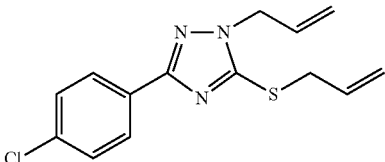
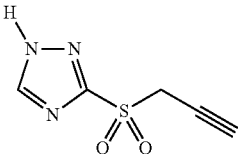
In-vitro antimycobacterial activity of triazole derivatives against <i>M. bovis</i> BCG.					
S.N.	Chemical Structure	com- pound	Spectral data	Antimycobac- terial activity % Inhibition at 100 µg/ml	
				Aer- obic/ Active stage	Anaer- obic/ Dormant stage
27		6a	$^1\text{H NMR } \delta$ 7.97 (s, 1H), 5.93 (m, 2H), 5.89 (s, 1H), 5.17 (m, 4H), 4.69 (d, 2H), 3.71 (d, 2H)	65	60
28		6b	$^1\text{H NMR } \delta$ 5.83 (m, 2H), 5.13 (m, 4H), 4.59 (d, 2H), 3.76 (d, 2H), 2.31 (s, 3H)	22	10
29		6c	$^1\text{H NMR } \delta$ 5.87 (m, 2H), 5.17 (m, 4H), 4.64 (d, 2H), 3.73 (d, 2H), 1.28 (s, 9H)	30	33
30		6d	$^1\text{H NMR } \delta$ 8.25 (d, 4H), 5.93 (d, 2H), 5.26 (m, 4H), 4.78 (m, 2H), 3.90 (d, 2H)	40	12
31		6e	$^1\text{H NMR } \delta$ 8.01 (d, 2H), 6.93 (d, 2H), 6.01 (m, 2H), 5.25 (m, 4H), 4.74 (m, 2H), 3.83 (s, 3H), 3.77 (d, 2H)	88	83
32		6f	$^1\text{H NMR } \delta$ 8.04 (d, 2H), 7.37 (d, 2H), 5.95 (m, 2H), 5.21(m, 4H), 4.75 (d 2H, J = 8 Hz), 3.95 (d 2H, J = 8 Hz)	26	14
33		7a	IR: 1461, 1375 $\text{cm}^{-1}$	42	23

TABLE 1-continued

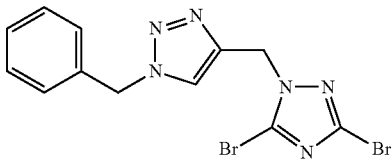
		In-vitro antimycobacterial activity of triazole derivatives against <i>M. bovis</i> BCG.		Antimycobacterial activity <sup>Ⓢ</sup> % Inhibition at 100 µg/ml	
S.N.	Chemical Structure	com- pound	Spectral data	Aer- obic/ Active stage	Anaer- obic/ Dormant stage
34		7b	Mass spectrum m/z 361.1515 (dl), 153.0338 (m <sup>Ⓢ</sup> 32)	92	82
35		7c	<sup>1</sup> H NMR δ 4.03 (m, 2H), 2.60 (s, 1H), 1.22 (s, 9H)	76	74
36		7d	IR: 1458, 1377 cm <sup>-1</sup>	96	91
37		7e	IR: 1461, 1375 cm <sup>-1</sup>	88	82
38		7f		88	86
39		8a		76	74
40		8b		96	91

TABLE 1-continued

In-vitro antimycobacterial activity of triazole derivatives against <i>M. bovis</i> BCG.					
S.N.	Chemical Structure	com- pound	Spectral data	Antimycobac- terial activity② % Inhibition at 100 µg/ml	
				Aer- obic/ Active stage	Anaer- obic/ Dormant stage
41		8c		98	79
42		8d		98	82
43		9b	<sup>1</sup> H NMR δ 8.04 (s, 1H), 6.00 (m, 1H), 5.32 (m, 2H), 4.74 (m, 2H), 3.85 (d, 2H), 2.20 (t, 1H)	98	96
44		9a	<sup>1</sup> H NMR δ 7.90 (s, 1H), 5.90 (m, 1H), 5.25 (dd, 2H), 4.74 (m, 2H), 3.93 (d, 2H), 2.24 (t, 1H)	40	22
45		10a	<sup>1</sup> H NMR δ 5.92 (m, 1H), 5.22 (m, 2H), 4.63 (m, 2H), 3.93 (d, 2H), 3.03 (s, 3H), 2.24 (t, 1H)	98	93
46		10b	<sup>1</sup> H NMR δ 5.92 (m, 1H), 5.22 (m, 2H), 4.66 (m, 2H), 3.82 (d, 2H), 2.38 (s, 3H), 2.19 (t, 1H)	98	92
47		11a	<sup>1</sup> H NMR δ 4.93 (d, 2H), 2.49 (t, 1H)	97	20
48		11b	<sup>1</sup> H NMR δ 4.71 (d, 2H), 5.26 (M, 2H), 5.86 (m, 1H)	12	21
49		11c		09	19



TABLE 1-continued

In-vitro antimycobacterial activity of triazole derivatives against <i>M. bovis</i> BCG.					
S.N.	Chemical Structure	com- pound	Spectral data	Antimycobac- terial activity <sup>Ⓢ</sup> % Inhibition at 100 µg/ml	
				Aer- obic/ Active stage	Anaer- obic/ Dormant stage
50		11d	<sup>1</sup> H NMR δ 7.56 (s, 1H), 7.38 (m, 4H), 5.52 (s, 2H), 5.44 (s, 2H)	2	13

<sup>Ⓢ</sup> indicates text missing or illegible when filed

**[0077]** Chemical name of the representative compounds are:

**[0078]** 4-benzyl-1-[(1H-1,2,4-triazol-3-ylthio)methyl]-1,2,3-triazole-methane (1:1) 1a;

**[0079]** 4-benzyl-1-[[5-methyl-1H-1,2,4-triazol-3-ylthio)methyl]-1H-1,2,3-triazole-methane (1:1) 1b;

**[0080]** 4-benzyl-1-[[5-(tert-butyl-1H-1,2,4-triazol-3-ylthio)methyl]-1H-1,2,3-triazole-methane (1:1) 1c;

**[0081]** 4-benzyl-1-[[5-(tert-butyl-1H-1,2,4-triazol-3-ylthio)methyl]-1H-1,2,3-triazole-methane (1:1) 2c;

**[0082]** 1-benzyl-4-((1-(1-benzyl-1H-1,2,3-triazol-4-ylmethyl)-5-methyl-1H-1,2,4-triazol-3-ylthio)methyl)-1H-1,2,3-triazole 2b;

**[0083]** 1-benzyl-4-((1-(1-benzyl-1H-1,2,3-triazol-4-ylmethyl)-5-tert-butyl-1H-1,2,4-triazol-3-ylthio)methyl)-1H-1,2,3-triazole 2a;

**[0084]** 1-benzyl-4-((1-(1-benzyl-1H-1,2,3-triazol-4-ylmethyl)-5-(4-methoxyphenyl)-1H-1,2,4-triazol-3-ylthio)methyl)-1H-5-1,2,3-triazole 2e;

**[0085]** 1-benzyl-4-((1-(1-benzyl-1H-1,2,3-triazol-4-ylmethyl)-5-(4-chlorophenyl)-1H-1,2,4-triazol-3-ylthio)methyl)-1H-1,2,3-triazole 2f;

**[0086]** 1-benzyl-4-((1-(1-benzyl-1H-1,2,3-triazol-4-ylmethyl)-1H-1,2,4-triazol-5-ylthio)methyl)-1H-1,2,3-triazole 3a;

**[0087]** 1-benzyl-4-((1-(1-benzyl-1H-1,2,3-triazol-4-ylmethyl)-3-methyl-1H-1,2,4-triazol-5-ylthio)methyl)-1H-1,2,3-triazole 3b;

**[0088]** 1-benzyl-4-((1-(1-benzyl-1H-1,2,3-triazol-4-ylmethyl)-3-tert-butyl-1H-1,2,4-triazol-5-ylthio)methyl)-1H-1,2,3-triazole 3c;

**[0089]** 1-benzyl-4-((1-(1-benzyl-1H-1,2,3-triazol-4-ylmethyl)-3-(4-nitrophenyl)-1H-1,2,4-triazol-5-ylthio)methyl)-1H-1,2,3-triazole 3d;

**[0090]** 1-benzyl-4-((1-(1-benzyl-1H-1,2,3-triazol-4-ylmethyl)-3-(4-methoxyphenyl)-1H-1,2,4-triazol-5-ylthio)methyl)-1H-1,2,3-triazole 3e;

**[0091]** 1-benzyl-4-((1-(1-benzyl-1H-1,2,3-triazol-4-ylmethyl)-3-(4-chlorophenyl)-1H-1,2,4-triazol-5-ylthio)methyl)-1H-1,2,3-triazole 3f;

**[0092]** 3-allylthio-1H-1,2,4 triazole 4a;

**[0093]** 3-(allylthio)-5-methyl-1H-1,2,4-triazole 4b;

**[0094]** 3-(allylthio)-5-tert-butyl-1,2,4-triazole 4c;

**[0095]** 3-(allylthio)-5-(4-nitrophenyl)-1H-1,2,4-triazole 4d;

**[0096]** 3-(allylthio)-5-(4-methoxyphenyl)-1H-1,2,4-triazole 4e;

**[0097]** 3-(allylthio)-5-(4-chlorophenyl)-1H-1,2,4-triazole 4f;

**[0098]** 1-allyl-3-(allylthio)-1H-1,2,4-triazole 5a;

**[0099]** 1-allyl-3-(allylthio)-5-methyl-1H-1,2,4-triazole 5b;

**[0100]** 1-allyl-3-(allylthio)-5-tert-butyl-1H-1,2,4-triazole 5c;

**[0101]** 1-allyl-3-(allylthio)-5-(4-nitrophenyl)-1H-1,2,4-triazole 5d;

**[0102]** 1-allyl-3-(allylthio)-5-(4-methoxyphenyl)-1H-1,2,4-triazole 5e;

**[0103]** 1-allyl-3-(allylthio)-5-(4-chlorophenyl)-1H-1,2,4-triazole 5f;

**[0104]** 1-allyl-5-(allylthio)-1H-1,2,4-triazole 6a;

**[0105]** 1-allyl-5-(allylthio)-3-methyl-1H-1,2,4-triazole 6b;

**[0106]** 1-allyl-5-(allylthio)-3-tert-butyl-1H-1,2,4-triazole 6c;

**[0107]** 1-allyl-5-(allylthio)-3-(4-nitrophenyl)-1H-1,2,4-triazole 6d;

**[0108]** 1-allyl-5-(allylthio)-3-(4-methoxyphenyl)-1H-1,2,4-triazole 6e;

**[0109]** 1-allyl-5-(allylthio)-3-(4-chlorophenyl)-1H-1,2,4-triazole 6f;

**[0110]** 5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole 7a;

**[0111]** 3-methyl-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole 7b;

**[0112]** 3-tert-butyl-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole 7c;

**[0113]** 3-(4-nitrophenyl)-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole 7d;

**[0114]** 3-(4-methoxyphenyl)-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole 7e;

**[0115]** 3-(4-chlorophenyl)-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole 7f;

**[0116]** 1-allyl-3-tert-butyl-5-(prop-2-ynylthio)-1H-1,2,4-triazole 8a;

[0117] 1-allyl-5-tert-butyl-3-(prop-2-ynylthio)-1H-1,2,4-triazole 8b;

[0118] 5-(allylthio)-3-tert-butyl-1-(prop-2-ynyl)-1H-1,2,4-triazole 8c;

[0119] 3-(allylthio)-5-tert-butyl-1-(prop-2-ynyl)-1H-1,2,4-triazole 8d;

[0120] 1-allyl-3-(prop-2-ynylthio)-1H-1,2,4-triazole 9a;

[0121] 1-allyl-5-(prop-2-ynylthio)-1H-1,2,4-triazole 9b;

[0122] 1-allyl-3-methyl-5-(prop-2-ynylthio)-1H-1,2,4-triazole 10a;

[0123] 1-allyl-5-methyl-3-(prop-2-ynylthio)-1H-1,2,4-triazole 10b;

[0124] 3,5-dibromo-1-(prop-2-ynyl)-1H-1,2,4-triazole 11a;

[0125] 1-allyl-3,5-dibromo-1H-1,2,4-triazole 11b;

[0126] 3,5-dibromo-1-(2-methylallyl)-1H-1,2,4-triazole 11c;

[0127] 1-benzyl-4-((3,5-dibromo-1H-1,2,4-triazol-1-yl)methyl)-1H-1,2,3-triazole 11d.

[0128] The triazole derivatives of the present invention can advantageously be used to treat the pathological conditions or the diseases caused by *Mycobacterium bovis* BCG and *Mycobacterium tuberculosis* H37Ra, The nitrate reductase activity was used to represent the dormant stage whereas absorbance of the culture at 620 nm was used to represent the active stage of the bacilli in this screening protocol. Compound of Formula 4f [5-(4-chlorophenyl)-{3-(prop-3-en-yl thiol)}-S-2H-1,2,4 triazole] is effective against both active as well as dormant stage of the bacilli of *M. bovis* BCG and *M. tuberculosis*.

[0129] Invention relates to a pharmaceutical composition comprising of the active ingredient of Formula I and II or their pharmaceutically acceptable salts, as defined above either alone or as its salts along with pharmaceutically acceptable excipients. The pharmaceutical composition according to the invention can be in the form of a solid, for example, powders, granules, tablets, capsules or can be present in the liquid form such as solutions, emulsions, suspensions etc or as an injectable composition. The invention also provides methods for the treatment of the disorder discussed above. The triazole derivatives of the formula I and II and pharmaceutical compositions containing them may, according to the invention, be administered using any amount, any form of pharmaceutical composition and any route of administration effective for the treatment. After formulation with an appropriate pharmaceutically acceptable carrier in a desired dosage, as known by those of skill in the art, the pharmaceutical compositions of this invention can be administered by any means that delivers the active pharmaceutical ingredient(s) to the site of the body whereby it can exert a therapeutic effect on the patient.

#### EXAMPLES

[0130] Following examples are given by way of illustration therefore should not construed to limit the scope of the invention.

[0131] Chemistry

[0132] All the solvents used were purified according to literature procedures. Thin layer chromatography was performed on E. merk pre coated 60F 254 plate and the spot were rendered visible by using iodine and UV light as detector. IR spectra were recorded (in chloroform as solution and nujol as mull) on a Shimadzu FTIR-8400 spectrometer. NMR spectra were recorded on Bruker AC 200 spectrometer. Chemical shift reported are referred to internal tetramethylsilane as standard. All melting points are uncorrected and were deter-

mined using a Buchi B-540 melting point apparatus. Mass spectra were recorded on Applied Biosystems, API-Q\* Pulsar, X-ray were recorded on Smart-Apex X-ray diffractometer.

[0133] Chemicals, Media and Strains

[0134] Unless otherwise mentioned, all the chemicals were purchased from Sigma, USA. Dubos broth base, Dubos albumin supplements were purchased from Difco, USA. Minimal essential medium, Fetal bovine serum and Feta calf serum were purchase from GIBCO, USA. Sulphanilic acid and naphthyl ethylene diaminedihydrochloride (NEDD) were purchased from Merck, India. *M. bovis* BCG (ATCC 35745) and *M. smegmotis* (ATCC 607) were obtained from AstraZeneca, India and *M. tuberculosis* H37Ra (ATCC 25177) was obtained from MTCC, India. *E.coli* DH5  $\alpha$  was obtained from the NCIM, India. THF-1 cell line was obtained from National cell repository, NCCS India. Sub culturing of mycobacterial strains was routinely done in Dubos albumin agar slants or plates. Liquid inoculums were prepared in Dubos tween albumin broth medium, incubated in a shaker incubator rotating at a speed of 150 rpm at 37° C.

#### Example 1

[0135] Preparation of Triazole 1c

[0136] 3-(t-butyl)-5-(prop-2-ynylthio)1H-1,2,4-triazole (700 mg) was taken in t-butanol (7 ml) and water (3 ml) mixture. To this solution benzyl oxide (572 mg) was added followed by the addition of CuSO<sub>4</sub> (24 mg) and sodium ascorbate (40 mg). This reaction mixture was stirred at room temperature for 5 hr. Reaction completion was checked by TLC. t-Butanol was removed and remaining mixture extracted with ethyl acetate. Ethyl acetate layer was washed with water and brine, finally dried over NaSO<sub>4</sub> and concentrated to get solid product. This product was purified by column chromatography to get 1c. (1.1 gm).

#### Example 2

[0137] Preparation of Ditrizoles 2c

[0138] 5-(t-butyl)-1-(prop-2-ynyl)3-(prop-2-ynylthio)1H-1,2,4-triazole (237 mg) was taken in t-butanol (7 ml) and water (3 ml) mixture. To this solution benzyl azide (310 mg) was added followed by the addition of CuSO<sub>4</sub>(48 mg) and sodium ascorbate (80 mg). This reaction mixture was stirred at room temperature for 5 hr. Reaction completion was checked by TLC. t-Butanol was removed and remaining mixture was extracted with ethyl acetate. Ethyl acetate layer was washed with water and brine, finally dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated to get solid product. This product was purified by column chromatography to get 2c (450 mg).

#### Example 3

##### Preparation of Ditrizoles 3c

[0139] 3-(t-butyl)-1-(prop-2-ynyl)5-(prop-2-ynylthio)1H-1,2,4-triazole (237 mg) was taken in t-butanol (7 ml) and water (3 ml) mixture. To this solution benzyl azide (310 mg) was added followed by the addition of CuSO<sub>4</sub> (48 mg) and sodium ascorbate (80 mg). This reaction mixture was stirred at room temperature for 5 hr. Reaction completion was checked by TLC. t-Butanol was removed and remaining mixture was extracted with ethyl acetate. Ethyl acetate layer was washed with water and brine, finally dried over Na<sub>2</sub>SO<sub>4</sub> and

concentrated to get solid product. This product was purified by column chromatography to get 3c (420 mg).

#### Example 4

##### Preparation of Allyl Derivatives 4e, 5e and 6e

**[0140]** 3-p-methoxyphenyl-1,2,4-triazole-5-thiol (1 gm) and  $K_2CO_3$  (1.46 gm) was taken in DMF (10 ml). To this solution, allyl bromide (1.28 gm) was added dropwise. Then reaction mixture was stirred further for 4 hrs. Completion of the reaction was checked by TLC. DMF was removed and residue was extracted with ethyl acetate, organic layer was washed successively with water and brine, further dried over anhydrous  $Na_2SO_4$  and concentrated to get product, which was the mixture of 3 compounds as seen by TLC, which was further separated by column chromatography to get 6e (0.700 gm), 5e (0.23 gm) and 4e (0.085 gm).

#### Example 5

##### Preparation of Sulfone 7e

**[0141]** 3-(4-methoxyphenyl)-5-prop-2-ynylthio)1H-1,2,4-triazole, (300 mg) was dissolved in 50% aq. acetone and cooled to 0° C. To this solution Oxone (1.01 gm) was added and reaction mixture was stirred at room temperature for 2 hrs. The reaction mixture was neutralized by adding aq.  $NaHCO_3$  to pH-7, quenched by adding sodium metabisulphite. Reaction mixture was extracted with ethyl acetate, organic layer was washed successively with water and brine, further dried over anhydrous  $Na_2SO_4$  and concentrated to get sulfone 7e (250 mg)

#### Example 6

##### **[0142]** Primary Screening Results

**[0143]** Above synthesized 50 triazole derivatives were first screened against *M. bovis* BCG using a newly developed whole cell based assay. This assay could identify the inhibitors of active as well as dormant stage inhibitor molecules. In primary screening 100 ug/ml of compound concentration was applied in order to select the hit molecules showing biological activity against *M. bovis* BCG. Out of 50 different triazole derivatives, only 25 showed more than 60% inhibition on growth of active bacilli (Table 1). These hits were further taken up for secondary screening in order to confirm their activity and select the molecules showing the maximum inhibition at lowest concentration. Subsequently, dose response effect was monitored for all these 25 actives applying a concentration range between 100 and 1  $\mu$ g/ml against same aerobically growing *M. bovis* BCG.

#### Example 7

##### **[0144]** Biological Screening of Compounds for Antimycobacterial Activity

**[0145]** A protocol which can identify inhibitors of active as well as dormant tubercle bacilli, was used to screen the compounds. Nitrate reductase activity was used to represent the dormant stage whereas absorbance of the culture at 620 nm was used to represent the active stage of the bacilli in this screening protocol. 2.5  $\mu$ l microliters of compound solution in DMSO was aseptically transferred to individual wells of sterile 96-well plates, 247.5  $\mu$ l of *M. bovis* BCG culture containing approximately  $10^5$  cells/ml, supplemented with 40 mM  $NaNO_3$  was aseptically transferred to each well to make

up the total volume to 250  $\mu$ l and the plate was covered with a sealer. 125  $\mu$ l space was left in each well to make the headspace culture volume ratio exactly 0.5. After sealing, these culture plates were incubated at 37° C. in an incubator. After 8 days of incubation, culture OD was read at 620 nm. Then, 80  $\mu$ l of culture was taken out from each well and transferred to a separate 96 well plate by using a multichannel pipette. 80  $\mu$ l of 1% sulphanic acid solution and 80  $\mu$ l of 0.1% NEDD solution were added in each well of the plate and incubated for 15 minutes at room temperature to develop pink color. The color was read in Spectramax 384plus (Molecular Devices Inc. USA) at 540 nm to measure NR activity. Inhibition of aerobic and dormant phase in presence of the compounds was calculated by using equation 1 and 2.

$$\% \text{ Inhibition of active phase} = \frac{A_{620} \text{ of culture in presence of compound} - \text{blank}}{A_{620} \text{ of negative control} - \text{blank}} \times 100 \quad (1)$$

$$\% \text{ inhibition of dormant phase} = \frac{NR \text{ activity in presence of compound} - \text{blank}}{NR \text{ activity of negative control} - \text{blank}} \times 100 \quad (2)$$

#### Example 8

##### **[0146]** Antimycobacterial Activity Against Dormant Bacilli

**[0147]** Active stage inhibitor can also be a dormant stage inhibitor, could not be identified from the above used assay. This could be identified by adding the active stage inhibitor in tube culture model of dormancy. The compound was added by syringe to a culture after 8 days of inoculation when it has already reached to dormant stage. It was then further incubated for 4 days in presence of compound and effect on viability was checked by plating the culture and determining CFU/ml.

#### Example 9

##### Determination of Antitubercular Activity Against Active Replicating Bacilli

**[0148]** Inhibitory activity of the compounds against growing *M. bovis* BCG and *M. tuberculosis* H<sub>37</sub>Ra bacilli was carried but by incubating the cells in aerobic condition in 100 ml flask containing 50 ml medium, shaking at 150 rpm and 37° C. (Thermo electron Model No. 481) for the time period of 8 days. Compounds were added at the time of inoculation and growth was measured by reading absorbance at 620 nm as well as by determining CFU/ml (colony forming unit) after 8 days of incubation at which it reaches to stationary phase. The lowest concentration of drugs, yielding a differential absorbance ( $A_{620}$ ) of approximately zero or less was defined as MIC. In order to determine the Minimum Bactericidal Concentration, 100  $\mu$ l of the culture with appropriate serial dilution was identified spread on Dubos agar (1.5%) plate for monitoring colony counts after 21 days of incubation at 37° C. within 90% humidified incubator to find the effect of the inhibitors. The result was expressed as reduction in log value with respect to the vehicle control. Refer table 1.

#### Example 10

**[0149]** Determination of Antituberculous Activity Against Hypoxia Induced Dormant Bacilli

[0150] Inhibitory activity of the compounds against dormant bacilli was examined by using Wayne's 0.5 HSR (head space ratio) model. The Wayne's hypoxic model is based on gradual depletion of oxygen from mycobacterial cells to achieve the non-replicating dormant stage. Briefly, 17.5 ml diluted culture of *M. bovis* BCG containing about  $10^5$  cells per ml was transferred to 20×125 mm tubes. Culture tubes were then sealed with rubber septa and gently stirred with the help of 8 mm magnetic beads rotating at 100 rpm on a magnetic stirring platform at 37° C. for a time period for 8 days. Attainment of cells hypoxic non replicating dormant stage was confirmed by constant CFU/ml as well as by decolorization of methylene blue (1.5 µg/ml) dye in Wayne culture system. Once all the cells reached to non-replicating phase, 170 µl of compound solutions with 100× MIC level of aerobic culture were added by using a Hamilton syringe with a 24-gauge needle and incubated for another 4 days, 100 µl of culture samples with serial dilution were then spread on Dubos agar plates and colonies were enumerated on day 21 to examine the effect of compound on dormant stage. The result was expressed as reduction in log value with respect to the vehicle control. Refer table 1.

#### Advantages of the Invention

[0151] The invention provides novel compounds which are shown to anti tubercular in activity.

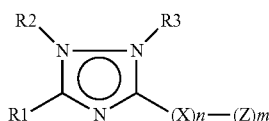
[0152] The novel compounds provided can be evaluated for other activities

[0153] The compounds of the invention are useful in active as well as dormant phase of mycobacterium.

[0154] The compounds can be used to formulate various pharmaceutical dosage forms.

We claim:

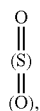
#### 1. Compounds of General Formula I



General Formula I

wherein,

X is sulfur (S) or a sulphone



n, m represent independently an integer 0 or 1, with the provision that when n is 1, m is 1;

R1 is selected from the group consisting of hydrogen; C<sub>1</sub>-C<sub>6</sub> linear or branched alkyl group optionally substituted with aryl group; halogen; and aryl group optionally substituted with —OCH<sub>3</sub>, halogen, or nitro;

R2 and R3 are selected from the group consisting of hydrogen, and C<sub>1</sub>-C<sub>6</sub> alkyl optionally substituted with heterocyclic ring of 5 to 6 ring atoms containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, which may be substituted with alkyl, arylalkyl, linear or

branched alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, or allyl or propargyl groups consisting of 1 to 6 carbon atoms; and

Z is C<sub>1</sub>-C<sub>6</sub> alkyl optionally substituted with heterocyclic ring of 5 ring atoms, containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, which may be substituted with arylalkyl, linear or branched alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, allyl or propargyl groups consisting of 1 to 6 carbon atoms.

with the provision that when 'm' is 1, and 'n' is zero; R1 is selected from the group consisting of hydrogen, halogen; C<sub>1</sub>-C<sub>6</sub> linear or branched alkyl group optionally substituted with aryl group or aryl group optionally substituted with —OCH<sub>3</sub>, halogen, and nitro, R2 and R3 are selected from the group consisting of hydrogen, C<sub>1</sub>-C<sub>6</sub> alkyl optionally substituted with heterocyclic ring of 5 to 6 ring atoms containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, which may be substituted with alkyl, arylalkyl, linear or branched alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, or allyl or propargyl groups consisting of 1 to 6 carbon atoms; Z is selected from the group consisting of halogen, C<sub>1</sub>-C<sub>6</sub> linear or branched alkyl group optionally substituted with heterocyclic ring of 3 to 6 ring atoms, containing one to three hetero atoms selected from oxygen, sulfur, nitrogen, wherein the heterocyclic ring may further be substituted with halogen, alkyl, arylalkyl.

2. A compound of claim 1 selected from the group consisting of:

3-(allylthio)-5-(4-methoxyphenyl)-1H-1,2,4-triazole,

3-(allylthio)-5-(4-chlorophenyl)-1H-1,2,4-triazole,

1-allyl-3-(allylthio)-1H-1,2,4-triazole,

1-allyl-3-(allylthio)-5-(4-methoxyphenyl)-1H-1,2,4-triazole,

1-allyl-3-(allylthio)-5-(4-chlorophenyl)-1H-1,2,4-triazole, and

1-allyl-5-(allylthio)-3-(4-methoxyphenyl)-1H-1,2,4-triazole.

3. A compound of claim 1 selected from the group consisting of:

5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole,

3-tert-butyl-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole,

3-(4-nitrophenyl)-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole,

3-(4-methoxyphenyl)-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole and

3-(4-chlorophenyl)-5-(prop-2-ynylsulfonyl)-1H-1,2,4-triazole.

4. A compound of claim 1 selected from the group consisting of:

1-allyl-3-tert-butyl-5-(prop-2-ynylthio)-1H-1,2,4-triazole and

1-allyl-5-tert-butyl-3-(prop-2-ynylthio)-1H-1,2,4-triazole.

5. A compound of claim 1 selected from the group consisting of:

5-(allylthio)-3-tert-butyl-1-(prop-2-ynyl)-1H-1,2,4-triazole,

3-(allylthio)-5-tert-butyl-1-(prop-2-ynyl)-1H-1,2,4-triazole,

1-allyl-5-(prop-2-ynylthio)-1H-1,2,4-triazole,  
1-allyl-3-(prop-2-ynylthio)-1H-1,2,4-triazole, and  
1-allyl-5-methyl-3-(prop-2-ynylthio)-1H-1,2,4-triazole.

6. A compound of claim 1 selected from the group consisting of: 1-Benzyl-4-((1-((1-benzyl)-1H-1,2,3-triazol-4-yl)methyl)-5-tert-butyl-1H-1,2,4-triazol-3-ylthio)methyl)-1H-1,2,3-triazole and 1-benzyl-4-((1-((1-benzyl)-1H-1,2,3-triazol-4-yl)methyl)-3-tert-butyl-1H-1,2,4-triazol-5-ylthio)methyl)-1H-1,2,3-triazole.

7. A compound of claim 1 selected from the group consisting of: 4-benzyl-1-[(1H-1,2,4-triazol-3-ylthio)methyl]-1H-1,2,3-triazole, 4-benzyl-1-[[5-methyl-1H-1,2,4-triazol-3-yl]thio]methyl)-1H-1,2,3-triazole and 4-benzyl-1-[[5-tert-butyl-1H-1,2,4-triazol-3-yl]thio]methyl)-1H-1,2,3-triazole.

8. The compounds as claimed in claim 1, wherein said compounds are antitubercular and are active against actively growing as well as dormant bacilli of *Mycobacterium bovis* BCG and *Mycobacterium tuberculosis* H37Ra.

9. A process for the preparation of compounds of General formula 1 as claimed in claim 1, comprising the steps of:

- i. reacting 5-substituted 1,2,4-triazole-3-thiols with propargyl bromide in presence of  $K_2CO_3$  at temperature in the range of 25-30° C. to give S-monopropargylated and N,S-dipropargylated products;
- ii. oxidizing S-monopropargylated compounds to give sulphone derivatives or,
- iii. alternately, treating the terminal alkyne group of all the S-monopropargylated and N,S-dipropargylated 1,2,4-triazole thiols with benzyl azide in presence of Cu(I) catalyst at temperature in the range of 25-30° C. to form 1,2,3-triazole derivatives.

10. A method for inhibiting the growth of *Mycobacterium bovis* BCG and *Mycobacterium tuberculosis* H37Ra comprising administering a pharmaceutically effective amount of a compound of claim 1 to a subject in need thereof.

11. The method of claim 10 wherein the compound is 1-benzyl-4-((1-((1-benzyl)-1H-1,2,3-triazol-4-yl)methyl)-5-(4-methoxyphenyl)-1H-1,2,4-triazol-3-ylthio)methyl)-1H-1,2,3-triazole.

\* \* \* \* \*