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An Intrinsic Assessment of Bioactive Potentiality of Mangroves Actinomycetes

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Abstract
In the wake of emptying of the bioactive potentiality of terrestrial Actinomycetes, which prompts the actinomycetologists to explore the under and unexplored regions/ecosystems like Mangroves, by exploring the same enables us to equip to manoeuvre the emergence of super bugs and varied mutant viral strains. The Review Intrinsically assesses the Mangroves Actinomycetes bioactivity, so as to envisage it as an indomitable source of bioactive secondary metabolites. Different works suggests that mangroves actinomycetes bioactivity is versatile, in the way of its Industrial enzymes production, Antitumour, Antimicrobial, Antiangiogenesis, Enzyme inhibition, Probiotics and other notable bioactive metabolites. Finally, the review concludes that in order to explore the bioactivity of mangroves actinomycetes, there is an indispensable need of effective conservation of mangroves by the stringent implementation of Coastal regulation norms as in the Indian context, with the aid of vital players which paves the way to the sustainable development of mangroves.

Keywords: Mangroves, Actinomycetes, Industrial enzymes and Antimicrobial

Introduction
In the era of Evolution of Superbugs– Multidrug resistant bacteria, evolution of different novel viral strains leading to havoc of pandemics and exhaust of known compounds from already overexploited ecosystems, which all pose challenge to the very existence of human health welfare. In order to equip ourselves to the growing threat, search for novel natural compounds and regions becomes indispensable without second thought. Therefore, the present review put upon the view that mangroves actinomycetes may serve as indomitable and unending source of novel compounds, to support the same relevant works has intrinsically assessed to signify its bioactivity. In this review, we shall discuss systematically the environ of mangroves, actinomycetes basics and its proven bioactivity, which all adds to our knowledge about a prudent source. Mangroves (Fig.1) are woody plant communities in habituating the extreme transitional zone of aquatic and terrestrial ecosystems and evolving adaptations with respect to hypersalinity, hypoxic conditions and fluctuations of tides, all in tune of extreme environ (Miththapala, 2008) [1]. Mangroves sprawls along varied ecosystems of sea – land interface, which embodies lagoons, backwaters, mudflats, marshes, estuaries, creeks and sheltered shores (MoEF–2014-15) [2]. The occupancy rate of mangroves across the world surface is > 1% (Saenger, 2002 as cited in Anonymous, n.d.). Majorly mangroves prevail between Tropic of Capricorn and Tropic of Cancer which amounts to 75% of global tropical coastline (Anonymous, n.d.) [3]. The coastline of India stretches to nearly 7516.6 km embodying territories of islands (Anonymous, 1984 as cited in Singh *et al*., 2012) with nearly 6,749 km^2 of mangroves cover, which is the fourth highest in global mangroves (Naskar and Mandal, 1999 as cited in Singh *et al*., 2012) (Singh *et al*., 2012) [4]. The Government of India has identified 38 regions of mangroves across the entire country for intensive management and conservation viz…Sunderbans of West Bengal, Bhitarkanika of Orissa, Coringa of Andhra Pradesh (MoEF – 2011-12) [5]. Overexploitation severely affects the Indian mangroves, for instance the mangroves of gulf of kachchh has been severely subjected to overexploitation due to arid climatic features and lack of alternative sources for fodder, fuel and timber (Untawale and Wafar, 1991) [6]. The severity of loss of mangroves has been evidenced in the way of loss of 35% of global mangroves since past two decades (Mathew *et al*., 2010) [7].
Mangroves environ harbors a variety of microbes where in, Actinomycetes are one among them. Mangroves Actinomycetes are versatile in terms of its bioactivity, which actually motivates us to intrinsically assess its bioactive potentiality.

A Bioactive compound can be described as a compound encompassing an effect on, causing a biological reaction, or triggering a biological response in the living tissue (Guaadaoui *et al*., 2014) [8]. Bioactivities of Mangroves Actinomycetes are manifold ranging from Production of Industrial enzymes, Antimicrobial activity, Antitumour activity to Enzyme inhibitors and other notable bioactivities. The paper assesses different works done by mangroves actinomycetologists across the globe with bioactivity research carried out in countries viz…India, Malaysia, Brazil and China has been discussed to present a broader picture of bioactivity of mangroves actinomycetes. With lowering yield of novel bioactivity products from overexploited microbes from terrestrial region in the last couple of decades, have constrained the production of novel bioactive substances having medicinal value (Debbab *et al*., 2010 as cited in Xu *et al*., 2014) [9], which prompts the actinomycetologists to undergo a paradigm shift to extreme and unique ecosystems viz… Deserts (Bull and Asenjo, 2013 as cited in Xu *et al*., 2014), Deep oceans (Thornburg *et al*., 2010; Abdel *et al*., 2010 as cited in Xu *et al*., 2014) and Mangroves (Amrita *et al*., 2012 as cited in Xu *et al*., 2014). Actinomycetes (Fig.2) are gram positive, filamentous bacteria possessing a distinct complex life cycle classified under the phylum Actinobacteria, a taxonomic unit representing as one of the largest among the currently recognized 18 major lineages under the head of bacterial domain (Ventura *et al*., 2007 as cited in Mukesh, 2014) [10]. Under the lab conditions, Actinomycetes grows well over the agar surface extending branches both on and under the surface as aerial hyphae and substrate hyphae respectively [10]. Actinomycetes in habituates terrestrial and aquatic ecosystems, especially their role in terrestrial soil is significant as they decompose the complex polymers of varied dead biota, there by releasing nutrients into the soil which sustains the entire ecosystem [10]. The DNA of Actinomycetes possesses a high content of Guanine – Cytosine (Yoshida *et al*., 2008 as cited in Selvakumar, 2010) [11].

Present Knowledge

Bioactive potential studies of actinomycetes in the Indian subcontinent is scarce, which has been evidenced by just 41 actino bacterial species belonging to 8 genera has explored for the said study (Siva kumar *et al*., 2007 as cited in Suthindhiran and Kannabiran, 2010) [12]. Nearly one half of the reported secondary metabolites are produced from Actinomycetes (Bull, 2004; Berdy, 2005 as cited in Selvakumar, 2010) noteworthy are antibiotics (Strohl, 2004 as cited in Selvakumar, 2010) enzymes (Pecznska – czoch and Mordarski, 1998; Oldfield *et al*., 1998 as cited in Selvakumar, 2010) immunosuppressive agents (Mann, 2001 as cited in Selvakumar, 2010) and anti tumour agents (Olano *et al*., 2009 as cited in Selvakumar, 2010). The adequate exploration of the versatility of marine actinomycetes are yet to be done (Stach *et al*., 2003; Magarvey *et al*., 2004 as cited in Selvakumar, 2010).

The versatility of actinomycetes with respect to secondary metabolite production has been evidenced by their quantum of metabolite production in the way of, out of nearly 23000 metabolites yielded by varied microbes, 10000 are reported from Actinomycetes summing up to 45% of entire production (Berdy, 2005 as cited in Mukesh, 2014). The genus streptomyces alone contributes nearly 7600 metabolites out of 10000 (Berdy, 2005 as cited in Mukesh, 2014). The majority of reported secondary metabolites are active antibiotics [10]. The crux point for versatility of actinomycetal metabolite production are due to its large genome (Salami, 2004; Padmadhas and Raghunathan, 2010 and Santos *et al*., 2012 as cited in Raghunathan and Padhmadas, 2013) [13]. Regular environmental changes in mangroves ecosystem by way of variations in salinity and tidal gradient (Hong *et al*., 2009; Long *et al*., 2005 as cited in Lee., *et al* 2014) [14]. Presence of NRPS – Non Ribosomal Polyketide synthase and PKS – Polyketide synthase pathways (Li and Piel, 2002; Salmon *et al*., 2003 as cited in Selvakumar, 2010) and huge genome with adequate transcription factors which regulates the expression of genes, which acts in tune with specific requirements (Bonjar *et al*., 2005) [15]. In this review, we shall discuss varied bioactive potentialities of mangroves actinomycetes which has relevance to human welfare.

Objectives of the intrinsic assessment

- To Review the Industrial enzyme productivity of Mangroves Actinomycetes as crucial for varied Industries.
- To Review the Antimicrobial activity of Mangroves Actinomycetes as a promising source for novel antibiotics
- Assessing the Anticancer bioactivity of Mangroves Actinomycetes as a crux for novel anticancer therapeutics.
- Assessing varied bioactivities of Mangroves Actinomycetes viz…Enzyme inhibition, Probiotics and others.
- To Outline the Conservation measures for Mangroves.

Methodology of the assessment

The current intrinsic assessment evaluates different bioactive studies of Mangroves Actinomycetes across the globe, and is carefully interwoven and integrated in the discussion part, so as to envisage that the Mangroves Actinomycetes are the indomitable source of varied novel bioactive substances.

Discussion

Industrial enzymes production

Marine Actinomycetes, especially of mangrove origin has proven bioactivity with respect to the production of varied industrial enzymes viz…Amylases, Proteases, Cellulases, Lipases with its applicability in a wide range of industries – Paper, Pulp, Agriculture, Textile, Detergent and serving as a promising Indomitable candidate of Industrial enzymes. Regarding the specific applications of industrial enzymes, α Amylase – endo –1-α-D- glucano hydrolases – EC 3.2.1.1 degrading starch having varied biotechnological applications such as fermentation, paper, textile and food industries (Selvam *et al* ., 2011) [16]. Cellulase - endo – 1, 4-β – glucanase, EC 3.2.1.4 catalyzes glucosidic bonds of cellulose and its derivatives, it has applications in the laundry, textiles, paper, pulp and agriculture industries [16]. Lipase – Triacylglycerol acyl hydrolase – EC 3.1.1.3 – lipases hydrolytic activity aids in the esters synthesis from glycerol and long chain fatty acids and found its applications in food, agrochemical and detergent industries (Selvam *et al* ., 2011) [16], (Ahmed, 2013) [17] . L – glutaminase used in the treatment of leukemia and also used as enzyme sensor and flavor enhancer (Balagurunathan *et al*., 2010) [18]. L- Asparaginase, a potential candidate for antileukemia (Deepthi and Devamma, 2012) [19], and Laccases are oxidizing enzymes, especially of phenolic compounds (Niladevi *et al*., 2006) [20]. In this regards, we shall discuss different works done in varied

regions in support of the review. Ramesh and Mathivanan (2009) [21] isolated 208 actinomycetal isolates along different marine ecosystems of Bay of Bengal, India one of which is mangroves and suggests that 68, 72, 116, 157 and 183 isolates produced Amylase, Cellulase, Gelatinase, Caseinase and Lipase enzymes. Dias *et al*. (2009) [22] has isolated 238 bacterial isolates including actinomycetes from different sampling stations in mangrove regions of Ilha do Cardoso – Cananeia, Brazil and reported that isolates of actinomycetes produced industrially important enzymes – Amylase, Lipase, Esterase and Protease. Kumar *et al*. (2011) [23] explored Streptomyces sp.- SBU 1 from marine sediments of the coast of Cape Comorin, India and found to be a potent source of L – Glutaminase, which is an anticancer substance. Raghunathan and Padhmadas (2013) [13] isolated a novel Actinomycetes Streptomyces spp. PDSI from Western Ghats of Tamil Nadu, India and reported that the novel strain was found to be an excellent producer of α Amylase which cleaves α 1-4 linkages between glucose units. Ramesh *et al*. (2009) [24] isolated 191 varied marine actinomycetes from divergent marine ecosystems along the Bay of Bengal, India viz…Mangroves water, Mangroves sediments, Sea shore sediments, Marine animals wherein, 108 isolates produced both gelatinase and caseinase, 113 produce only gelatinase and 157 produce caseinase. An isolate Streptomyces fungicidicus MML1614 found to be an excellent source of thermo stable alkaline protease which has applicability in detergent industries. Balagurunathan *et al*. (2010) [18] isolated 20 streptomycetes strains from Rhizosphere portions of Rhizophora apiculata located in Parangipettai coastal region of Tamil Nadu, India. It was found that all 20 streptomycetes strains exhibited L – glutaminase activity which is used in the treatment of leukemia. Ahmed (2013) [17] isolated actinomycetes from rhizospheres of young, old mangroves and non-mangrove rhizosphere in Jazan province of Saudi Arabia and reported to exhibiting Amylolytic, Lipolytic and Cellulolytic activities. Selvam *et al*. (2011) [16] isolated 56 strains of Actinomycetes from various marine sediments of South Indian coast, out of which 9 isolates exhibited Amylolytic, Cellulolytic and Lipolytic activities. Usha *et al*. (2014) [25] evaluated enzyme production ability of Actinomycetes of Nizampatnam and Coringa Mangroves of Andhra Pradesh, India they have isolated 55 Actinomycetes strains and suggests that actinomycetal isolates serve as excellent sources of Cellulase, L- asparaginase and Amylase. Niladevi *et al*. (2006) [20] isolated streptomyces psammoticus MTCC 7334 from mangrove swamps and suggested that it was a potential source of laccase production. Balakrishnan *et al*. (2013) [26] isolated 26 actinomycetal isolates from various marine sediments of Bay of Port Blair, India and suggests that strains of Actinomycetes have the potential of producing Amylase, Protease, Cellulase, Gelatinase, Lipase, DNase and Urease phosphatase. Sivasankar *et al*. (2013) [27] isolated a specific strain of streptomyces from Bay of Bengal, India and reported that it produces significantly I – asparaginase, a pharmaceutical enzyme used in the cancer treatment – antileukemia as it converts I – asparaginase to I – aspartic acid and ammonia leading to the death of tumor cells. Arunachalam *et al*. (2010) [28] isolated a specific strain of streptomyces from South Western Ghats, Tamil Nadu, India and suggests that the strain has a potential ability to produce cellulase. Narayanan *et al*. (2005)[29] isolated 20 actinomycetes from the west coast of India embodying mangroves areas and suggests that actinomycetal strains have the potentiality of producing ligninolytic enzymes (lignin degrading enzymes) – Laccase, Lignin peroxidase and Manganese peroxidase (MnP), particularly MnP which the researchers has specifically examined. Deepthi and Devamma (2012) [19] isolated 40 strains of actinomycetes and suggests that actinomycetal strains are the potent sources of L-asparaginase which is the potent antileukemia enzyme.

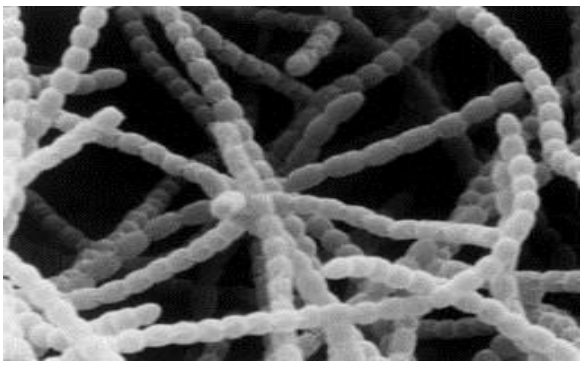
Anti-microbial activity

Mangroves Actinomycetes reported as a potential source of excellent antagonistic activity against a broader spectrum of microorganisms and serving as a promising source for future exploration of the same. Patil *et al*. (2011) [30] isolated mangrove actinomycetes from mangroves regions sprawled along Achara, Malvan located in Maharashtra, India wherein, 4 actinomycetal isolates exhibited antibacterial activity. Usha *et al*. (2010) [31] isolated actinomycetal isolates from pichavaram mangroves of Tamil Nadu, India and reported that one isolate Streptomyces parvulus KUAP 106 found to exhibit broad spectrum antibiotic activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Streptococcus faecalis*, *Pseudomonas aeruginosa*, *Proteus vulgaris* and *Escherichia coli.* Subramani and Narayanasamy (2009) [21] isolated 208 actinomycetal isolates along different marine ecosystems of Bay of Bengal, India one of which is mangroves and reported that 111 out of 208 actinomycetal isolates showed bioactivity against Human pathogens *Pseudomonas aeruginosa*, *E.coli*, *Bacillus subtilis*, *Staphylococcus epidermidis* and *Candida albicans* and isolate 4 exhibited bioactivity against all 5 human pathogens, they also reported that 151 out of 208 isolates exhibited bioactivity against fungal plant pathogens *Rhizoctonia Solani* and *Alternaria alternata* wherein, 54 isolates exhibited bioactivity against both fungal pathogens. Lee *et al*. (2014) [32] isolated 87 actinobacterial isolates from mangrove forests of Tanjung Lumpur – Malaysia and reported that out of 87 actinomycetal isolates 9 showed anti-bacterial activity against *MRSA*, *Bacillus cereus*, *Acinetobacter calcoaceticus* and *Salmonella typhi*. Usha *et al*. (2012) [33] isolated rare Actinomycetes Pseudonocardia sp. VUK – 10 from mangrove regions of Nizampatnam – A.P, India and suggests that the isolate exhibits a broad spectrum anti-bacterial activity against *Staphylococcus aureus MTCC 3160*, *Streptococcus mutans MTCC 497*, *Bacillus subtilis ATCC 6633*, *E.coli ATCC 35218*, *Enterococcus faecalis MTCC 439* and *Pseudomonas aeruginosa ATCC 9027*. The reported isolate also exhibited broad spectrum antifungal activity against *Candida albicans ATCC 10231*, *Fusarium oxysporum MTCC 3075 and Aspergillus niger*. Valli *et al*. (2012) [34] isolated 21 actinomycetal strains from different mangroves environs of Tamilnadu, India out of which C11 and C12 found to be potent strains of antibiotics against Vibrio harveyi, Pseudomonas sp, Staphylococcus sp, and Bacillus subtilis, Staphylococcus sp, Pseudomonas sp, Vibrio harveyi respectively. Usha *et al*. (2014) [25] evaluated antibacterial potentiality of Actinomycetes of Nizampatnam and Coringa mangroves located in A.P, India and isolated 55 Actinomycetes, of which 28 exhibited antimicrobial activity against *E. coli*, *Staphylococcus aureus* and *Candida albicans*. Balakrishnan (2013) [26] isolated 26 actinomycetal isolates from various marine sediments of Bay of Port Blair, India and suggests that strains of Actinomycetes have the potential antibacterial activity. Arifuzzaman *et al*. (2010) [35] isolated 55 actinomycetal strains from Sunderbans region and suggests that actinomycetal strains exhibit a broader spectrum antibiotic activity. Sivasankar *et al* (2013) [27] isolated 75 actinobacterial strains from Bay of Bengal, India and reported

that actinomycetal strains have a noticeable antibiotic activity. Mitra *et al*. (2008) [36] isolated actinomycetal strains from sunderbans mangroves and suggests that Actinomycetes have significant antimicrobial potentiality. Sengupta *et al*. (2015) [37]. Isolated 54 actinomycetal strains from Sunderbans mangroves and reported that actinomycetal strains have potential broad range anti-microbial activity. Sathiyaseelam and Stella (2011) [38] has isolated actinomycetal strains from muthupet mangroves of Tamilnadu, India and reported that the actinomycetal strains were a promising candidate as an antibiotic source against *Pseudomonas sp, E.coli*, *Bacillus sp* and *Klebsiella sp*. Santhi and Jebakumar (2011) as cited in Thatoi *et al*. (2012) [39] isolated Streptomyces sp. from sediments of mangroves of Manakudi estuary, India and suggests that it had potential antagonistic activity against Staphylococcus aureus – Methicillin resistant and S.aureus and Salmonella typhi – Methicillin susceptible.

https://en.wikipedia.org/wiki/Mangrove#/media/File:Mangroves.jpg

Fig 1: Mangroves



https://microbiologyglossary.wikispaces.com/Streptomyces+griseus

Fig. 2: Streptomyces griseus

Anti-cancer activity

In the versatile armour of mangrove actinomycetes bioactivity, anticancer activity is the one which depicting it as a potential candidate for natural chemotherapeutic drugs, different studies suggest this. Huang *et al*. (2011) as cited in Azman *et al*. (2015) [40] isolated Micromonospora sp. M2DG17 from mangrove sediments of Haikou of china and discovered 5 novel compounds, of which one proven to exhibit potent anti-tumor effect on human carcinoma of the human colon; HCT 116 cell lines. Ding *et al*. (2011) as cited in Xu *et al*. (2014) [9] isolated Divergolide D from Streptomyces sp.HKI0576 (endophyte) of *Bruguiera gymnorrhiza* located in china, where in Divergolide D found to exhibit significant anti-tumor activity against pancreatic cancer – PANC – 1, Lung cancer – LXFA 629L, Sarcoma – Saos 2 and Renal cancer – RXK 486L. Feling *et al*. (2003) as cited in Azman *et al*. (2015) [40] isolated *Salinispora tropica* CNB – 392 from mangrove region of chub cay, Bahamas which yields Salinosporamide A which was found to exhibit anti-tumor potentiality. Fu *et al*. (2012) as cited in Xu *et al*. (2014) [9] isolated Streptocarbazole B from Streptomyces sp. FMA collected from mangrove sediments located in Sanya of Hainan province, china and found to exhibit cytotoxic activity against HeLa cells and P 388 and proved as a potential anti-cancer candidate. Izumikawa *et al*. (2012) as cited in Azman *et al*. (2015) [40] isolated from mangroves sediments of Nosoko, Ishigaki island of Japan, an actinomycetal isolate – *Saccharopolyspora* sp.RL78 which reported to produce a new compound JBIR – 102 which have the potential anti-tumor effect against ACC – MESO – 1- Human malignant pleural mesothelioma cell line and HeLa cells.

Enzyme inhibition potentiality

The dynamic functional ability of mangrove Actinomycetes reflects in its enzyme inhibition bioactivity which possesses far-reaching implications on human health welfare. Molecules having the ability to bind to enzymes and declines their catalytic activities referred to as enzyme inhibitors. Enzyme inhibition activity in mangrove Actinomycetes has been reported by different workers. Good fellow *et al*. (1988) as cited in Dilip *et al*. (2013) [41] reported that Reverse transcriptase has been inhibited by revistin which was isolated from Streptomyces sp. Imada and Simidu (1988) as cited in Selvakumar (2010) [11] isolated inhibitor of α Amylase from *Streptomyces corchorusii* sub sp. rhodomarinus sub sp. Nov. Good fellow *et al*. (1988) as cited in Dilip *et al*. (2013) [41] suggests that Carboxypeptidase B has been inhibited by Alistragin which was isolated from *Streptomyces roseoviridis*. Aoyagi *et al*. (1992) as cited in Selvakumar (2010) [11] isolated Pyrizinostatin which inhibits Pyroglutamyl peptidase from Streptomyces sp.SA – 2289 cultures. Good fellow *et al*. (1988) as cited in Dilip *et al*. (2013) [41] reported that Metallo – Proteases has been inhibited by phosphoramiden, isolated from Streptomyces tanashiensi. Aoyama *et al*. (1995); Imada (2004; 2005) as cited in Selvakumar (2010) [11] isolated Pyrostatin A &B which inhibits N – acetyl β – glucosaminidase from Streptomyces sp.SA – 3501.

Probiotics bioactivity

Continuing the multifacetal bioactive role of Actinomycetes, it is also known for Probiotics production. Streptomyces has been considered as a primary source of probiotics, that may be utilized in marine aquaculture, You *et al*. (2005) as cited in Selvakumar (2010) [11] suggests that streptomyces has the potentiality of producing probiotics which act against Vibrio spp–a shrimp pathogen. Kumar *et al*. (2006) as cited in Selvakumar (2010) [11] suggests that marine streptomyces exhibits probiotic potentiality against white spot syndrome virus which effects penaeid shrimps. You *et al*. (2007) as cited in Selvakumar (2010) [11] suggests that marine streptomyces possess the probiotic potentiality against biofilms yielded by Vibrio sp.

Anti-Angiogenesis activity

Mangrove Actinomycetes is known for its unique bioactivity in the way of its antiangiogenesis activity. Usha *et al*. (2010) [31] isolated Actinomycetal isolates from Pichavaram mangroves of Tamilnadu, India and suggests that one actinomycetal isolate Streptomyces parvulus KUAP106 exhibited anti angiogenesis activity based on experiments done on fertile eggs.

Mangroves Actinomycetes: A hub of notable bioactive metabolites

Menaquinones – MK – 9 (H6), MK – 9 (H4) and fatty acids reported from *Streptomyces xiamenensis* which was explored from mangrove reserve forests of china's Fujian province (Xu *et al*., 2009 as cited in Selvakumar, 2010) [11]. Marine streptomyces reported to exhibiting the SCP (single cell protein) potentiality, which increments the growth of juvenile shrimp, prawn and fish there by incorporating it in the supplementary feed given to juvenile prawns (Selvakumar, 2010) [11]. Ding *et al*. (2010) as cited in Xu *et al*. (2014) [9] isolated a novel Xiamycin compound from *Bruguiera gymnorrhiza* (endophyte) located in Xiamen of china. The isolated compound Xiamycin reported exhibiting anti HIV potentiality. Studies were done by Balakrishnan *et al*. (2013) [26] suggests that strains of Actinobacteria acted as Bio surfactants by exhibiting potential surfactant production which was depicted by its Hemolytic studies.

Deforestation of Mangroves, as a detrimental to the exploration of mangroves Actinomycetes

Mangroves have been considered as a hub of resources – Food, Fodder, Timber, Fuel wood and other vital products like Honey [1] but this adds to its disadvantage as the people start deforesting the mangroves to overly exploit the said products. Apart from it, industrial developmental driven deforestation was a huge bearing on mangroves. Loss of global mangroves cover stood at 35% particularly, in countries like the Philippines, Vietnam and India loss of mangroves amounts to 50% [42]. Such deforestation of mangroves severely affects the microbes which harbor in its niche there by becoming detrimental to the mangroves actinomycetal bioactive exploration.

Conclusion

It is clear from the discussed intrinsic assessment of bioactive studies of Mangroves Actinomycetes, that its potential is indomitable and may serve as a promising candidate for future bioactive studies. Since the existing bioactive pool of Actinomycetes from terrestrial region has been exhausting and in the midst of emergence of mutant strains of human pathogens, need of unexplored and extreme regions where the probability of exploring dynamic bioactive metabolites is high has been given a paramount importance, under this head, mangroves may serve as a potential ecosystem to harbour versatile Actinomycetes, upon which the review has intrinsically assessed. The review would gesticulate that growing incidents of mangroves deforestation across the globe in major mangroves hubs like the Philippines is a disturbing trend. Such reports are also coming from Indian mangroves. In order to explore the mangroves Actinomycetes to its fuller potentiality, conservation of mangroves has to be done on a war footing, for that, effective enforcement of conservation laws has to be seriously dealt. In Indian context stringent implementation of Coastal regulation norms under Environmental protection act, 1986 is the dire requirement for conservation of mangroves. It has to be done by a coherent administrative network by including vital players ranging from GoI (Government of India) – State governments – Students and Scholars – NGO's and Media to the local communities, which are the indispensable link between human and nature, which ultimately leads to the sustainable development of mangroves, this component has to be given vital importance because the dynamic and versatile productive ability of mangroves actinomycetes shall be adequately explored only when its mother base – Mangroves ecosystem is suitably conserved.

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References

1. Miththapala S. Mangroves. Coastal Ecosystems Series Colombo, Sri Lanka: Ecosystems and Livelihoods Group Asia, IUCN. 2008; 2(iii):1-28
2. MOEF (Ministry of Environment and Forests), Government of India, Annual Report 2014-15.
3. Anonymous, Mangroves in general, n. d. (http: //wgbis. ces.iisc. ernet.in/ biodiversity/ sahyadri_enews/ newsletter/issue40/article1/mangroves_introduction.pdf).
4. Singh AK, Abubakar Ansari, Dinesh Kumar, Sarkar UK. Status, Biodiversity and Distribution of Mangroves in India: An overview, Uttar Pradesh state biodiversity board, International Day for Biological Diversity, Marine Biodiversity, 2012.
5. MOEF (Ministry of Environment and Forests), Government of India, Annual Report, 2011-12.
6. Untawale AG, Wafar S. Socio-economic Significance of Mangroves in India, proceedings of the symposium on the significance of Mangroves Pune, 1990,1991.
7. Mathew Grace, Jeyabaskaran R, Prema D. *Mangrove Ecosystems in India and their Conservation.* In: Coastal Fishery Resources of India – Conservation and sustainable utilization. Society of Fisheries Technologists, 2010, 186-196.
8. Abdelkarim Guaadaoui, Soumaya Benaicha, Naima Elmajdoub, Mohammed Bellaoui, Abdellah Hamal. What is a Bioactive Compound? A Combined Definition for a Preliminary Consensus. International Journal of Nutrition and Food Sciences. 2014; 3(3):174-179. doi: 10.11648 /j.ijnfs. 2014 0303.16
9. Dong-Bo Xu, Wan-Wan Ye, Ying Han, Zi-Xin Deng, Kui Hong. Natural Products from Mangrove Actinomycetes Mar. Drugs 2014; 12:2590-2613; doi:10.3390/md12052590
10. Mukesh Sharma. Actinomycetes: Source, Identification, and Their Applications -Int. J. Curr. Microbiol. App. Sci. 2014; 3(2):801-832
11. Selvakumar Dharmaraj. Marine Streptomyces as a novel source of bioactive substances, World J Microbiol Biotechnol. 2010; 26:2123-2139.
12. Krish Suthindhiran, Krishnan Kannabiran. Diversity and exploration of bioactive marine Actinomycetes in the Bay of Bengal of the Puducherry coast of India - Indian J Microbiol 2010; 50(1):76-82 DOI: 10.1007/s12088-010-0018-9
13. Ragunathan R, Padhmadas-Production R, purification and characterization of – amylase using Streptomyces spp. PDS1 and Rhodococcus spp. Isolated from Western Ghats - Int. J. Curr. Microbiol. App. Sci 2013; 2(8):206-214
14. Learn-Han Lee, Nurullhudda Zainal, Adzzie-Shazleen Azman, Shu-Kee Eng, Bey Hing Goh, Wai-Fong Yin *et al*. Diversity and Antimicrobial Activities of Actinobacteria Isolated from Tropical Mangrove

Sediments in Malaysia, Hindawi Publishing Corporation, Scientific World Journal. 2014, Article ID 698178, 14 pages, http://dx.doi.org /10.1155 /2014 /698178
15. Shahidi Bonjar, Aghighi GHS, Ayatollahi Mousavi A, Shahrokhi N, Shafii Bafti S, Kalantarzadeh M *et al*. Biotechnological Potential of Iranian Actinomycetes in Production of Agrobioproducts - The 4th National Biotechnolo0gy Congress, Islamic republic of Iran, Kerman, 2005.
16. Selvam K, Vishnupriya B, Subhash V, Chandra Bose. Screening and Quantification of Marine Actinomycetes Producing Industrial Enzymes Amylase, Cellulase and Lipase from South Coast of India - International Journal of Pharmaceutical & Biological Archives. 2011; 2(5):1481-1487
17. Ahmed M. Reyad - Diverse of enzymatically active Actinomycetes associated with mangrove Rhizospher in Jazan coast - Annals of Biological Research. 2013; 4(4):100-108
18. Balagurunathan R, Radhakrishnan M, Somasundaram ST, glutaminase L. Producing Actinomycetes from Marine Sediments –Selective Isolation, Semi Quantitative Assay and Characterization of Potential Strain - Australian Journal of Basic and Applied Sciences. 2010; (5):698-705,
19. Kavya Deepthi M, Nagalakshmi M, Devamma L. Asparaginase activity of Pseudonocardia sp. isolated from mangrove soils along the east coast of Southern India, Current Biotica 2012; 6(2):189-197,
20. Niladevi KN, Rajeev K, Sukumaran, Nicemol Jacob, Anisha GS, Prema P. – Optimization of laccase production from a novel strain-Streptomyces psammoticus using response surface methodology, Microbiological Research 2009; 164:105-113.
21. Subramani Ramesh, Narayanasamy Mathivanan. Screening of marine Actinomycetes isolated from the Bay of Bengal, India for antimicrobial activity and industrial enzymes - World J Microbiol Biotechnol 2009; 25:2103- 2111 - DOI 10.1007/s11274-009-0113-4
22. Armando CF Dias, Fernando Dini Andreote, Francisco Dini-Andreote, Paulo T Lacava, Andre´ LB Sa, Itamar S *et al*. Diversity and biotechnological potential of culturable bacteria from Brazilian mangrove sediment, World J Microbiol Biotechnol. 2009; 25:1305-1311, DOI 10.1007/s11274-009-0013-7
23. Krishnakumar S, Alexis Rajan R, Ravikumar S. Extracellular production of L Glutaminase by marine alkalophilic Streptomyces sp. – SBU 1 isolated from Cape camorin coast, Indian Journal of Geo – Marine Sciences. 2011; 40(5):717-721.
24. Subramani Ramesh, Mahalingam Rajesh, Narayanasamy Mathivanan – Characterization of a thermostable alkaline protease produced by marine Streptomyces fungicidicus MML1614 - Bioprocess Biosyst Eng 2009; 32:791-800 DOI 10.1007/s00449-009-0305-1
25. Usha Kiranmayi Mangamuri, Muvva Vijayalakshmi, Sudhakar Poda. Exploration of Actinobacteria from Mangrove Ecosystems of Nizampatnam and Coringa for Anti-microbial Compounds and Industrial Enzymes, British Biotechnology Journal. 2014; 4(2):173-184.
26. Balakrishnan Meena, Lawrance Anbu Rajan, Nambali Valsalan Vinithkumar Ramalingam Kirubagaran. Novel marine actinobacteria from emerald Andaman & Nicobar Islands: a prospective source for industrial and pharmaceutical byproducts- BMC Microbiology 2013; 13:145.
27. Palaniappan Sivasankar, Shanmugam Sugesh, Packiyaraj Vijayanand, Kannan Sivakumar, Shanmugam Vijayalakshmi, Thangavel Balasubramanian and Packium Mayavu Efficient production of l-asparaginase by marine *Streptomyces* sp. isolated from Bay of Bengal, India - African Journal of Microbiology Research 2013; 7(31):4015-4021, 2 August, DOI: 10.5897/AJMR12.2184
28. Arunachalam R, Wesely EG, George J, Annadurai G. Novel Approaches for Identification of Streptomyces noboritoensis TBG-V20 with cellulose production - Current Research in Bacteriology 2010; 3(1):15-26.
29. Kizhekkedathu, Narayana Niladevi, Parukuttyamma. Prema - Mangrove Actinomycetes as the Source of Lignolytic Enzymes - Actinomycetologica 2005; 19(2):40-47.
30. Rajesh C Patil, Abhishek D Mule1, Gajanan V Mali, Rajmahammad R Tamboli, Rahul M Khobragade, Sanjay K Gaikwad *et al*. Isolation of Marine Actinomycetes from the Mangrove Swamps for Biotechnological Exploration Journal of Life Sciences 2011; 5:1030-1036.
31. Usha R, Ananthaselvi P, Venil CK, Palaniswamy M. Antimicrobial and Antiangiogenesis Activity of Streptomyces Parvulus KUAP106 from Mangrove soil European journal of Biological Sciences. 2010; 2(4):77-83.
32. Learn-Han Lee, Nurullhudda Zainal, Adzzie-Shazleen Azman, Shu-Kee Eng, Bey-Hing Goh, Wai-Fong Yin *et al*. Diversity and Antimicrobial Activities of Actinobacteria Isolated from Tropical Mangrove Sediments in Malaysia, Hindawi Publishing Corporation, Scientific World Journal. 2014, Article ID 698178, 14 pages, http:// dx.doi. org/10. 1155/2014 /698178
33. Usha Kiranmayi Mangamuri, Vijayalakshmi Muvva, Sudhakar Poda, Sreenivasulu Kamma. Isolation, Identification and Molecular Characterization of Rare Actinomycetes from Mangrove Ecosystem of Nizampatnam - Malaysian Journal of Microbiology, 2012; 8(2):83-91
34. Valli S, Suvathi Sugasini S, Aysha OS, Nirmala P, Vinoth Kumar P, Reena A. Antimicrobial potential of Actinomycetes species isolated from marine environment - Asian Pac J Trop Biomed. 2012; 2(6):469-473.
35. Arifuzzaman M, Khatun MR, Rahman H. Isolation and screening of Actinomycetes from Sundarbans soil for antibacterial activity - African Journal of Biotechnology. 2010; 9(29):4615-4619.
36. Anindita Mitra, Subhas Chandra Santra, Joydeep Mukherjee. Distribution of Actinomycetes, their antagonistic behaviour and the physico-chemical characteristics of the world's largest tidal mangrove forest - App l Microbiol Biotechnol 2008; 80:685-695 DOI 10.1007/s00253-008-1626-8
37. Sohan Sengupta, Arnab Pramanik, Abhrajyoti Ghosh, Maitree Bhattacharyya. Antimicrobial activities of Actinomycetes isolated from unexplored regions of Sundarbans mangrove ecosystem - Sengupta *et al*. BMC Microbiology 2015; 15:170 DOI 10.1186/s12866-015-0495-4
38. Sathiyaseelan K, Stella D. Isolation, Identification and Antagonistic Activity of Marine Actinomycetes Isolated From the Muthupet Mangrove Environment – International Journal of Pharmaceutical & Biological Archives. 2011; 2(5):1464-1468.
39. Hrudayanath Thatoi, Bikash Chandra Behera, Rashmi

Ranjan Mishra, Sushil Kumar Dutta. Biodiversity and biotechnological potential of microorganisms from mangrove ecosystems: a review- Ann Microbiol- DOI 10.1007/s13213-012-0442-7

40. Adzzie-Shazleen Azman, Iekhsan Othman, Saraswati S Velu, Kok-Gan Chan, Learn-Han Lee. Mangrove rare actinobacteria: taxonomy, natural compound, and discovery of bioactivity - Frontiers in Microbiology- August 2015; 6:856.
41. Chavan Dilip V, Mulaje SS, Mohalkar RY. A REVIEW ON Actinomycetes and Their Biotechnological Application - International Journal of Pharmaceutical Sciences and Research - IJPSR, 2013; 4(5):1730-1742.
42. http://wwf.panda.org/about_our_earth/blue_planet/coasts/mangroves/mangrov e_threats/ (Access time: 29-11-2016; 12:30 pm)