IOSR Journal Of Pharmacy www.iosrphr.org
(e)-ISSN: 2250-3013, (p)-ISSN: 2319-4219
Volume 8, Issue 9 Version. I (September 2018), PP. 49-56

Sponges As Heavy Metal Accumalators And As Cytotoxic Agents

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ABSTRACT: The diversity in chemical structure of sponge derived metabolites is related to an equally diverse pattern of activities.Scientist in the field of natural products chemistry and research suggest that sponges have the potential to provide future drugs againsts important diseases,such as a range of viral diseases,malaria,inflammations,immunesuppressive diseases and various malignant neoplasms.Sponges,the dominant benthic organism has filter feeding mechanism, deposits heavy metals in their tissues.These heavy metals have a major role in many of the biological reactions involved in cytotoxicity.Research findings shows that,Haliclonatenuiramosa,which can be used asbioindicators for heavy metal pollution ,had significantly higher heavy metal concentration at near shore region due to anthropogenic input .

Date of Submission: 27-09-2018 Date of acceptance: 14-10-2018

I. INTRODUCTION

[1]In Pharmaceutical discovery natural products have been the major source for starting material over the past century.from the invetigations marine life proved to be natural products with useful biological properties.Marine sponges have been ranked top among the marine life in providing bioactive compounds with potential applications. [2]The isolation of unusual derivatives from the sponge *Tethyacrypta*in 1950 has been a milestone with this discovery.Apyrrole antibiotic has been isolated from marine bacterium *Psuedomonasbromontilis*.The next discovery was the isolation of prostaglandin derivatives from the Carribbean gorgonian *Plexaurahomomalla*. Many antiviral agents, tumour promoters, anti inflammatory agents, ion channel effectors and central nervous system membrane active toxins have been isolated during the past decades by maine chemists and pharmacologists

By the combinatorial chemistry,chemical libraries of both natural products as well as synthetic compounds have been produced.Studies showed that different components affect the target site by different mechanism. Chemical compunds isolated from these marine organism can act as inhibitors of transcription factors,which are effective against malignancies and viral infections.These bioactive metabolites are inhibitors of intracellular or intercellular messengers which are the cause for many diseases

[3]Sponges are the dominant benthic habitat in marine life.Even though they do not have tissues or sensory organs they have certain type of cells which perform all the bodily functions.Sponges are sessile and have filter feeding mechanism.Due to these characters the secondary metabolites produced by sponges often serve defense purposes to protect themselves from serious predator attacks,microbialinfections,biofouling and over growth by other sessile organism

II. SPONGES AS STRESS INDICATORS

Sponges possessing filter feeding mechanism,filter the marine large volume of sea water and accumulate heavy metals and contaminants .They are sessile and live in the same region for many years.They accumulate huge amount of anthropogenic pollutants over a long period.In addition to abiotic pollutants,large

number of micro organism reside in the extra and intracellular spaces.Since sponges are strongly associated with marine environment,they are sensitive to environmental variations.So they can be used as a tool for environmental monitoring.By monitoring diversity and relative abundance of sponges,the influence of stress in the structure of communities can be studied

Research done by j.L.Carbarallo et al at Algericas Bay on marine sponges reveal that the heterogenicity has conditioned the number of species present.

Among 81 species they have studied marine sponge *Clionaviridis* showed greater adaptive elasticity by substrate,depth and relationships to environmental variables.C.viridis is numerous in the interior ares of the Bay.They are showed a great adaptive plasticity to selection

Taxa	Relative abundance at Stn:												No.	Bathymetric distribution and substrate orientation			
	A	B	C	D	E	F	I	L	N	O	Q	R		0–5 m	5–10 m	10–20 m	20–30 m
1 *Acanthella acuta*	0	0	0	0	0	0	0	0	0	0	0	2	1			O	
2 *Ciocalapata almae*	0	0	0	1	0	0	0	0	0	0	0	0	1			U	
3 *Antho involvens*	1	2	0	0	0	0	1	0	0	0	1	1	5		CC		H,E
4 *Aplysilla rosea*	1	1	2	3	0	0	0	0	0	2	1	1	7	V,U,O	O		
5 *Aplysilla sulphurea*	0	0	0	0	0	0	0	1	0	1	1	1	4	V	U		U
6 *Axinella damicornis*	1	1	0	0	0	0	0	0	0	0	1	1	4				H
7 *Batzella inops*	0	0	0	0	0	0	0	0	0	0	1	0	1			U	
8 *Cacospongia mollior*	0	1	0	0	0	0	0	0	0	0	0	0	1		CC		
9 *Cacospongis scalaris*	1	1	1	1	2	2	0	0	0	1	1	1	9	O,V	CC,O,H	H,CC,O	
10 *Chalinula fertilis*	0	0	0	1	0	0	0	0	0	0	0	0	1	U			
11 *Chalunula nigra*	0	0	0	0	0	0	0	0	0	0	1	0	1			H	
12 *Chondrosia reniformis*	2	1	0	3	0	1	0	0	0	0	1	1	6	H,CC	V,H	O	
13 *Clathria coralloides*	0	0	0	1	0	0	0	0	0	0	0	0	1	U			
14 *Cliona celata*	1	1	1	1	2	1	1	1	1	2	1	1	12	H,V,O	H,V,O	H,V,O	
15 *Cliona rhodensis*	1	1	0	0	0	0	0	0	0	0	0	0	2			H	
16 *Cliona vastifica*	2	2	2	2	2	0	0	0	0	0	2	2	7	V	V,H	V,H,O	
17 *Cliona viridis*	3	3	3	3	3	3	3	3	3	3	3	3	12	H,V,O	H,V,O	H,V,O	H,V,O
18 *Crambe crambe*	3	3	3	3	3	1	1	1	1	2	2	3	12	V,E,O	V,E,O	V,E,O	V,H,O
19 *Crella elegans*	1	1	3	3	2	3	2	3	2	1	2	1	12		V,H	V,H	H
20 *Darwinella corneostellata*	0	0	0	0	0	0	0	0	0	0	1	0	1	V,O			
21 *Dendroxea lenis*	0	0	0	0	0	0	0	0	0	0	2	0	1		U	O,H,U	
22 *Dictyonella incisa*	2	0	0	0	0	0	0	0	0	0	0	0	1			O	
23 *Dysidea avara*	1	0	0	2	2	0	1	1	0	0	0	3	6		V,E	H,V,O	H,V,O
24 *Dysidea fragilis*	2	1	1	1	2	0	1	2	1	2	0	2	10	H,I,E	H,E,C	H,V,E	H,V,E
25 *Dysidea tupha*	0	0	0	0	0	0	0	1	1	0	0	0	2			H	H
26 *Erylus discophorus*	0	0	0	1	0	0	0	0	0	0	0	0	1	U			
27 *Esperiopsis fucorum*	0	0	0	1	0	0	0	0	0	0	0	0	1		O		
28 *Gellius angulatus*	0	0	1	0	0	0	0	0	0	0	0	0	1		U		
29 *Halichondria bowerbanki*	1	1	0	0	0	0	0	0	0	0	0	0	2		H	H	
30 *Haliclona cinerea*	0	0	0	2	1	0	2	2	0	0	0	0	4	U	CC,C,V	O,V	
31 *Haliclona fulva*	1	0	0	0	0	0	0	0	0	0	0	0	1		C		
32 *Haliclona indistincta*	0	0	0	1	0	0	0	0	0	0	0	0	1		U	U	
33 *Haliclona mediterranea*	0	0	0	0	0	0	1	0	1	0	0	2	3		O	O	
34 *Haliclona mucosa*	0	0	0	0	0	0	0	0	0	0	0	2	1				C,O
35 *Haliclona neens*	0	0	0	0	0	0	1	0	0	0	0	0	1	O,E			
36 *Haliclona palmonensis*	0	0	0	0	0	0	0	0	0	0	1	0	1		U		
37 *Hemimycale columella*	0	0	0	2	0	0	0	0	0	0	0	0	1			V,H	
38 *Hymedesmia pansa*	1	1	1	0	0	0	0	0	0	0	1	1	5	U	U	V	
39 *Hymedesmia peachi*	0	0	0	0	0	0	0	0	0	1	0	0	1	E			
40 *Hymedesmia senegalensis*	0	0	0	0	0	0	2	1	0	1	0	0	3	E	E	E	
41 *Hymedesmia versicolor*	0	0	0	0	1	1	0	0	1	0	0	0	3		O	O	
42 *Hymeniacidon sanguinea*	2	0	0	1	0	0	0	0	0	2	0	0	3	H,V,U	H		
43 *Ircinia faciculata*	1	1	1	3	2	2	0	1	1	0	0	0	8	H,V	H,V		
44 *Ircinia oros*	2	0	0	0	0	0	0	0	0	0	0	0	1		C,CC		
45 *Ircinia variablis*	1	1	0	0	0	0	0	0	1	0	0	2	4	C	O		
46 *Leptolabis brunnea*	0	0	0	0	0	0	0	0	1	0	0	0	1		V		
47 *Microciona strepxitosa*	0	0	0	0	0	0	0	1	0	2	0	1	3	E		E	
48 *Mycale macilenta*	0	0	0	0	1	0	0	0	1	0	0	0	2	U		U	
49 *Mycale massa*	0	0	0	0	0	0	0	1	0	0	3	0	2		U	U,CC	
50 *Mycale micracanthoxea*	0	0	0	0	0	0	2	3	0	0	0	0	2		V	V,E	
51 *Mycale rotalis*	0	0	0	0	0	0	0	0	1	1	1	0	3			H	
52 *Myxilla iotrochotina*	0	0	0	1	0	0	0	0	0	0	0	0	1				
53 *Myxilla rosacea*	2	0	0	0	0	0	0	1	0	0	0	0	2		H	V	
54 *Oscarella lobularis*	1	1	1	1	1	2	1	2	1	3	1	1	12	V	V,O		
55 *Pellina semitubulosa*	0	0	0	0	1	0	0	0	0	0	2	0	2		U		
56 *Petrosia ficiformis*	1	0	0	0	0	0	0	0	0	0	0	0	1		O		

Table 1 (continued)

Taxa	Relative abundance at Stn:												No.	Bathymetric distribution and substrate orientation			
	A	B	C	D	E	F	I	L	N	O	Q	R		0–5 m	5–10 m	10–20 m	20–30 m
57 *Phorbas fictitus*	2	2	2	2	2	1	2	2	1	3	2	1	12	H,V,O	H,V,E	H,V,O	H,V
58 *Phorbas paupertas*	0	0	0	1	0	0	0	0	0	0	0	0	1	U			
59 *Phorbas tenacior*	1	1	0	0	0	0	0	0	0	0	1	2	4		O		
60 *Plakina monolopha*	0	0	1	0	0	0	0	0	0	0	0	0	1	U	U		
61 *Pleraplysilla spinifera*	1	1	1	1	2	1	1	2	0	0	0	2	9	C,V,O	H,O	O,C	
62 *Polymastia mamillaris*	0	0	1	0	0	0	0	0	0	0	0	0	1		U,H		
63 *Pronax dives*	0	0	0	0	0	0	0	0	0	0	0	1	1				CC
64 *Pronax lieberkühni*	0	0	0	0	0	1	0	0	0	0	0	0	1			H	
65 *Pronax plumosum*	0	0	0	0	1	0	0	0	0	2	0	0	2	H,E	H,E		
66 *Phyteras fusifera*	1	0	0	1	0	0	0	0	0	0	0	0	2		O		
67 *Raspaciona aculeata*	1	0	0	0	0	0	0	0	0	0	0	1	2		O	O	
68 *Sarcotragus muscarum*	1	1	1	3	2	0	0	0	0	0	1	0	6	O	O,V	O,V	H
69 *Sarcotragus spinosula*	0	1	0	1	0	0	0	0	0	0	0	1	3		O	O	
70 *Scopalina lophiropoda*	1	2	2	1	3	1	0	0	0	0	1	2	8		V	V,O	H,CC
71 *Scopalina madeirensis*	0	1	0	0	0	0	0	0	0	0	0	0	1			H	
72 *Spongia agaricana*	1	2	0	1	2	0	0	0	0	0	1	2	6		O	O	H
73 *Spongia officinalis*	1	1	0	1	1	0	0	0	0	0	0	1	5	V	O,H,V	E	
74 *Spongia vilgurtosa*	1	1	0	0	0	0	0	0	0	0	0	1	3		E		
75 *Stylopus dujardini*	0	0	0	2	3	1	3	2	2	1	1	0	8	H,V,U	H,V,U	E,V,O	H,V
76 *Suberitis domuncula*	1	1	2	0	0	1	1	1	1	1	1	1	10	E	E	E,O	
77 *Tedania anhelans*	0	0	0	1	0	0	0	0	0	0	1	0	2		CC,H		
78 *Terpios fugax*	0	1	1	0	1	1	1	1	1	1	0	1	9	U	V,E	V,H	
79 *Tethya aurantium*	1	1	0	0	1	1	0	0	0	0	0	1	5	C,CC	O	O	
80 *Timea unistellata*	1	1	1	1	0	0	0	0	0	0	0	1	5		U	O	O
81 *Ulosa stuposa*	0	0	0	1	0	0	0	0	0	0	0	0	1		E		
Total species	37	31	21	36	24	18	16	21	18	19	30	32	$\bar{\alpha}$ = 22.66				

C.viridis is abundant in the interior areas of the Bay;where it is always present on vertical and horizontal walls in port construction.It tolerated strong hydrodynamism as well as moderate currents.The beta form of *C.viridis* frequently appears when sedimentation and muddiness are high.The alpha form is found on calcareous algaein areas of high hydrodynamism and good water renewal and is rarer in the interior of the Bay.

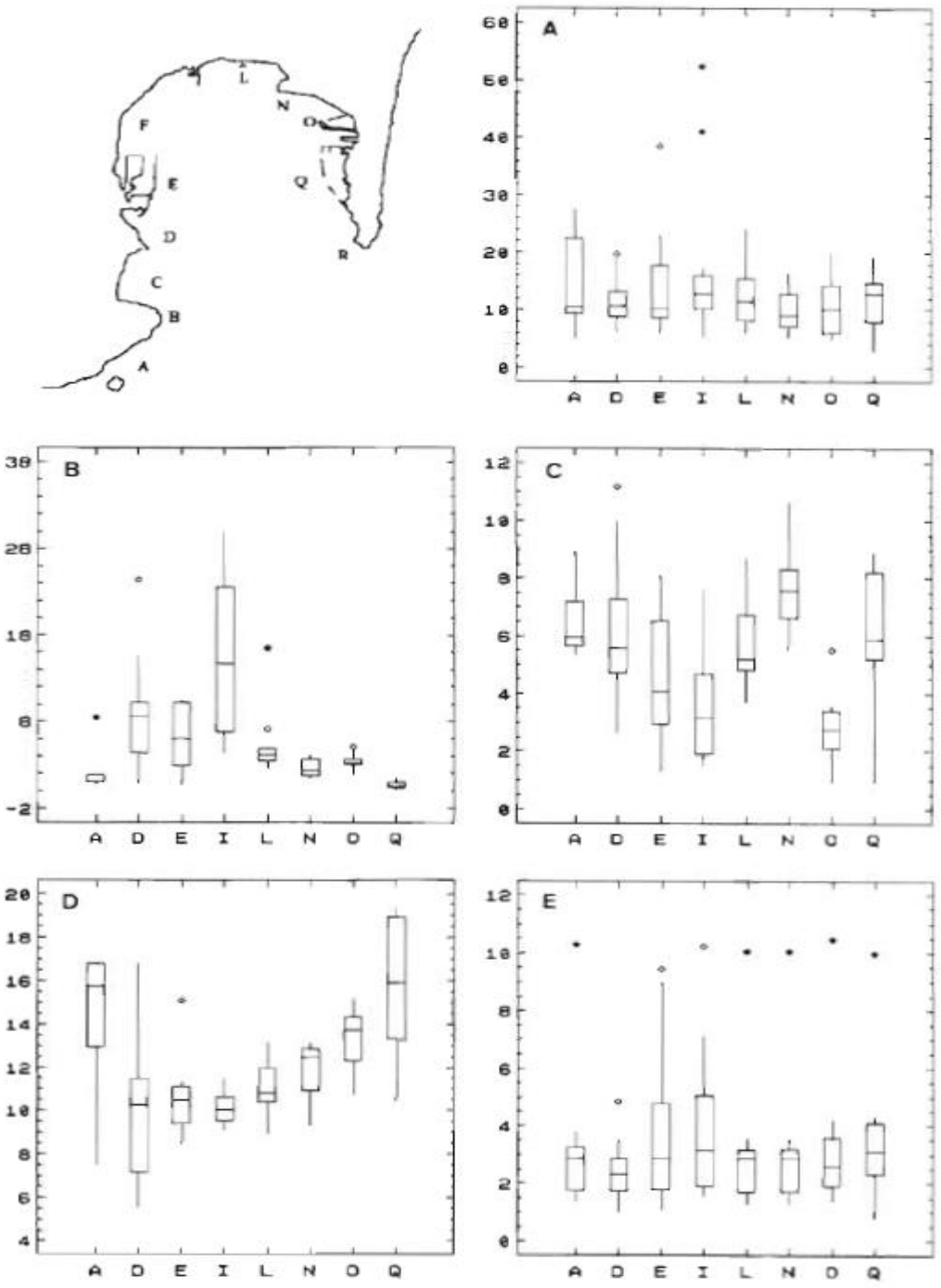


Fig. 5. Multiple 'box-and-whisker' plot for each abiotic variable at 8 sampling stations. (A) Suspended solids, mg l^{-1}; (B) silting, g m^{-2} mo^{-1}; (C) hydrodynamism, V; (D) % organic matter (SOM), %; (E) dissolved organic matter, mg l^{-1} The small black or open diamonds indicate outliers

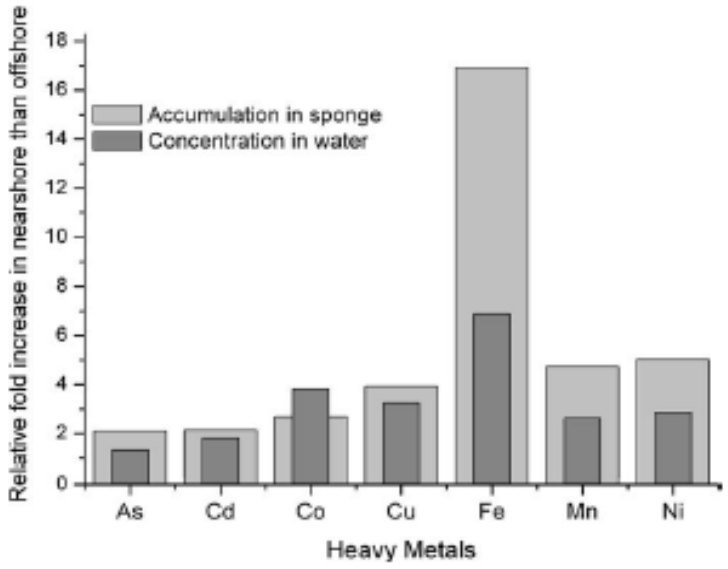
III. SPONGES AS BIOINDICATORS FOR METAL CONTAMINATION IN ECOSYSTEM

Sponges communities can live same locality and are capable of accumulating metals for a long period.High concentrations of pollutants have been reported in several sponge species like hydrocarbons and metals.Study of marine sponge,*Haliclonatenuiramosa*,asbioindicator by J VenkateswaraRaoet al(2008) revealed that heavy metal accumulation Fe>Mn>Ni>Cu>As>Co>Cd was higher in near shore region,at Gulf Of Mannar,due to anthropogenic input.

Table 1 Heavy metal concentrations (μg/l) in bottom water samples and metal accumulation in the tissues of *H. tenuitramosa* at nearshore and offshore locations

Location	As	Cd	Co	Cu	Fe	Mn	Ni
Water samples collected at nearshore areas							
CMCRI	0.24	0.09	0.48	0.97	79.42	2.67	4.33
M' Camp	0.27	0.07	0.27	0.73	42.35	2.35	2.17
Mandapam	0.36	0.12	0.29	0.77	74.53	2.46	1.99
Near bridge	0.25	0.1	0.36	0.86	49.52	2.97	2.67
Pamban	0.34	0.09	0.69	1.08	57.33	1.71	2.45
Mean±SE	0.29 ± 0.02	0.09 ± 0.01	0.42 ± 0.08	0.88 ± 0.06	60.63 ± 7.12	2.43 ± 0.21	2.72 ± 0.42
Water samples collected at near islands (offshore) areas							
Musal	0.26	0.07**	0.15**	0.34***	6.95***	0.98***	0.73**
Manoli	0.19	0.04**	0.09**	0.27***	7.68***	0.83***	1.21**
Pumarichan	0.27	0.04**	0.08**	0.27***	11.64***	1.02***	0.86**
Pullivasal	0.12	0.05**	0.13**	0.36***	9.08***	0.65***	0.94**
Shingle	0.28	0.05**	0.11**	0.13***	8.64***	1.16***	0.99**
Mean±SE	0.22 ± 0.03	0.05 ± 0.01	0.11 ± 0.01	0.27 ± 0.04	8.8 ± 0.8	0.93 ± 0.09	0.95 ± 0.08
H. tenuitramosa collected at nearshore areas							
CMCRI	1.03	0.13	0.35	1.85	1104.32	9.62	6.59
M' Camp	0.95	0.14	0.56	1.65	905.14	7.65	7.68
Mandapam	0.94	0.11	0.62	1.38	895.55	11.26	8.69
Near bridge	0.73	0.19	0.43	2.34	768.68	10.74	9.13
Pamban	1.09	0.15	0.19	2.42	965.64	9.68	8.63
Mean±SE	0.95 ± 0.06	0.15 ± 0.01	0.43 ± 0.08	1.93 ± 0.2	927.87 ± 54.5	9.79 ± 0.62	8.14 ± 0.46
H. tenuitramosa collected at offshore areas							
Musal	0.39**	0.07***	0.15*	0.53***	65.23***	1.85***	1.84**
Manoli	0.59**	0.04***	0.11*	0.35***	56.23***	1.74***	1.97**
Pumarichan	0.43**	0.08***	0.15*	0.41***	47.57***	1.35***	1.26**
Pullivasal	0.32**	0.07***	0.24*	0.62***	56.35***	2.56***	1.49**
Shingle	0.53**	0.07***	0.17*	0.56***	48.52***	2.77***	1.56**
Mean±SE	0.45 ± 0.05	0.07 ± 0.01	0.16 ± 0.02	0.49 ± 0.05	54.78 ± 3.2	2.06 ± 0.27	1.62 ± 0.13

The heavy metal concentration was high in near shore-region than off shore region.



The heavy metal concentration in sponge tissues were twice that the concentration in near shore water.The marine sponge *Haliclonatenuiramosa*fulfilled many of the requirements of a useful monitoring organism in that they are abundant in the intertidal zone,sessile,long lived and exhibited high accumulation of metals in their tissue.These findings may also be considered as an important warning signal for the health of existing coral reefs in these locations.A good bioindicator accumulates contaminants from the environment and accurately reflects environmental levels.Selection of a proper bioindicatorspecies as atool for assessing the environmental damage,which is essential in monitoring any biosphere Reserve Areas.

IV. HEAVY METALS AND CYTOTOXICITY

Heavy metals are naturally occurring elements that have a high atomic and a density at least 5 times greater than that of water. Their toxicity depends on several factors including the dose,route of exposure and chemical species,as well as the age,gender,genetics and nutritional status of exposed individuals.The essential heavy metals exert biochemical and physiological functions in plants and animals.They are important constituents of several key enzymes and play important roles in various oxidationreductionreactions.Copper for example,serves as an essential cofactor for several oxidative stress –related enzymes including catalase,superoxidedismutase,peroxidase,cytochrome C oxidases,fenoxidases,monoamine oxidase and dopamine –β- monooxygenase.In biological systems,heavy metals have been reported to affect cellular organelles and components such as cell membrane,mitochondrial,lysosome,endoplasmicreticulum,nuclei and some enzymes involved in metabolism,detoxification and damage repair.Metal ions have been found to interact with cell components such as DNA,and nuclear proteins causing DNA damage and conformational changes that may lead to cell cycle modulation

Several pieces of evidence indicate that iron deprivation could be an excellent therapeutic approach

1. Dietary iron restriction markedly decreases tumor growth in rodents
2. Antibodies which block transferrin-binding to cellular receptors inhibit cancer cell growth in vitro and in vivo
3. Antitumor effect of bleomycin,as anticancer drug ,is mediated by chelation of iron or copper to form a complex which degrades DNA

Among iron containing enzymes,ribonucleotidereductase is one of the most sensitive to iron depletion.This enzymes catalyses the conversion of ribonucleotides to deoxyribonucleotides for DNA synthesis.Among key enzymes ribonucleotidereductases shows the greatest increase in activity in neoplastic tissues

[6]Arsenic trioxide has been used for ten years in patients with acute promyelocyticleukemia(APL)There are several possible explanations for the mechanism of action of Arsenic trioxide.It induces a p53 dependent G1 or G2/M cell cycle arrest, through an activation of Caspase8 or Caspase9 .Others have reported that arsenic trioxide induces cell cycle arrest or apoptosis.The induction of apotosis could also be related to an increase in the production of ROS and a decrease in antioxidation property. Arsenic trioxide induces an increase in GSH content as a response to oxidative stress

Organic xenobiotic metabolism often results in oxidative stress,involving GSH depletion,alteration of thiol/disulphide balance and peroxidation of membrane lipids.These events can lead to the disruption of Ca^{2+}homeostasis,through impairment of the Ca^{2+}translocases present in cellular membranes.Inhibition of the activity of Ca,Mg ATP ases due to oxidation of their SH groups would lead to uncontrolled rises in cytosolic Ca^{2+} levels resulting in loss of cell viability .The cations such as Hg^{2+},Cu^{2+},Cd^{2+} and Zn have an extremely high affinity for SH group,they may affect the function of SH containing proteins,such as the Ca,Mg-ATP ase,as in the case of oxidative stress.Results are reported indicating that Hg^{2+}may stimulate Ca^{2+} influx through voltage-dependent channels in different experimental system.Moreover, evidencespresented that heavy metals can inhibit Ca,Mg ATPase activity and affect the mitochondria functions in the cells of different organism

[7] FengxiaTan,Min Wang et al (2008) studied cytotoxicity for four metals Cadmium(Cd) ,Chromium (Cr),Zinc (Zn) and Copper (Cu) metals using cell lines from a green sea turtle.Experimental results indicated that all the four metal salts were cytotoxic to the turtle cell lines at varied concentration.Calculated 10% and 50% inhibitory concentration (IC_{10} and IC_{50}) values revealed that the cytotoxicities of Cd and Cr were significantly more potent than the other two metal salts.Marinepollutants,including trace elements such as Cd,Cr,Zn and Cu,are known to enter the oceans and accumulate within the tissues of green sea turtles and other marine invertebrates

V. CONCLUSION

From the above findings,it is understood that heavy metalshas a major role in cytotoxicity.Sponges,the benthic dominant aquaticspecies,accumulate heavy metals and pollutants in sea and oceans due to filter feeding mechanism.It can be used as a bioindicator in heavy metal poisioning. Discovery of marine cytotoxic drugs,antibiotics,antiiflammatory,cardiovascular drugs are being increased drastically for the past decade

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Rani.S,V.Padmaja. "Sponges As Heavy Metal Accumalators And As Cytotoxic Agents" IOSR Journal of Pharmacy (IOSRPHR), vol. 8, no. 09, 2018, pp. 49-56