International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(6): 84-87

Received: 01-09-2021
Accepted: 11-10-2021

Poonam Gupta
Department of Chemistry,
M.M.H. College, Ghaziabad,
Uttar Pradesh, India

Corresponding Author:
Poonam Gupta
Department of Chemistry,
M.M.H. College, Ghaziabad,
Uttar Pradesh, India

Chemistry and biology of *Cinachyrella* a marine sponge

Poonam Gupta

Abstract
Sponges are known to produce a wide range of secondary metabolites which have been reported to show different biological activities including cytotoxic activities, antibacterial, anticoagulant, anti-viral, anti-fungal, anti-inflammatory, anti-tuberculosis, anti-malarial, anti-platelet, haemolytic and anti-cancer activities. They also provide a vast range of chemical compounds of different classes with unique structures. Considering such large bioactivities and versatile chemical classes of compounds, the sponges have a wide scope in a quest to find new chemical entities in drug discovery process. Many different classes of compounds have been isolated from the sponge *Cinachyrella* which have also been reported to show biological activities. This review article compiles the chemical constituents isolated from *Cinachyrella* and their bioactivities.

Keywords: Sponges, *Cinachyrella*, biological activities, chemical constituents

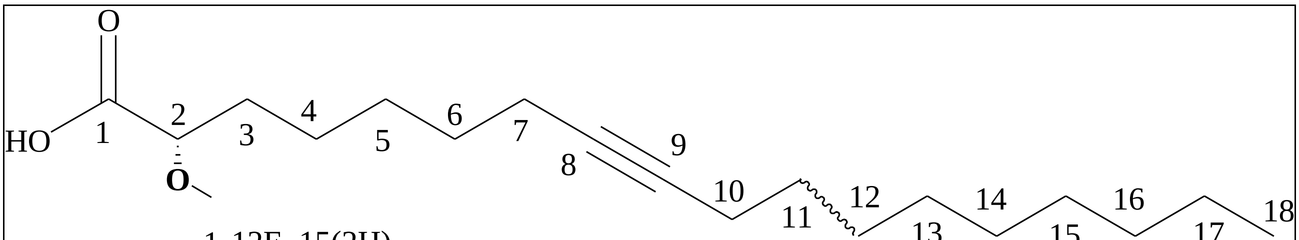
1. Introduction
Cinachyrella is a genus of sponges belonging to the family Tetillidae. There are many species recognized in the genus *viz Cinachyrella australiensis* (Carter 1886), *Cinachyrella australis* (Carter 1888) *Cinachyrella albabidens* (Lendenfeld 1907), *Cinachyrella albaobtusa* (Lendenfeld 1907), *Cinachyrella albatridens* (Lendenfeld 1907), *Cinachyrella alloclada* (Uliczka 1929), *Cinachyrella anatriaenilla* (Fernandez, Kelly & Bell, 2017), *Cinachyrella anomala* (Dendy, 1905), *Cinachyrella apion* (Uliczka 1929), *Cinachyrella arabica* (Carter 1869), *Cinachyrella arenosa* van (Soest & Stentoft, 1988), *Cinachyrella cavernosa* (Lamarck 1815), *Cinachyrella cavernosa* sensu (Burton 1959) etc. It is also known as Golf ball sponge or moon sponge. *Cinachyrella* belongs to the phylum- Porifera, Class-Demospongiae, order-Tetractinellida, Family-Tetillidae. Other species investigated are *C. tarentina, C. schulzei, C. apion, C. kuekenthali*. They are commonly found in both deep and shallow sea. As described by S.Wahidullah *et al* morphology of sponges are so variable that it is difficult to use these for taxonomic purposes [1]. *Cinachyra australiensis* (Carter 1886) recorded preciously by Burton (1936) was later identified as *Chrotella cavernosa* (Lamarck 1815) by (Tsurnamal, 1969). But *Cinachyra australiensis*, *Chrotella cavernosa* and *C. tarentina* all the three species are now accepted as *C. tarentina* (Pulitzer-Finali 1983). The influence of environmental variability on body form and tissue structure of *Cinachyrella australiensis* is reported [2] for populations from three sites within Darwin Harbour, Northern Territory, Australia, that varied considerably in hydrological conditions. Shape of these sponge have been shown to vary from round to flattened depending on the biotic and abiotic factors of their habitat. One of the most common sponge species is *Cinachyrella australiensis* (Carter 1886) is an important structural component of intertidal reef systems, providing a microhabitat for many epiphytic/epizootic organisms[2]. It has a distinctly radial form with a pronounced radial orientation of megascleres, a small basal attachment and an almost solid spicule core at the centre. It has evolved many morphological adaptations to survive even harsh environments. M. Campos *et al*. [3] have described some of the sponges including *C. antarctica* (Carter 1872) and *C. barbatas* (Sollas, 1886) in detail. *C. antarctica* had oval and globular shape with protruding spicules in long bundles, no observed oscules and with abundant pores. *C. barbata* was globular with hispid surface, oscules regularly distributed, surrounded with spicule brush and no observed pores.

2. Chemical constituents
Sponges produce so many different kinds of secondary metabolites with pharmacological potential depending on their habitat and environmental conditions they inhabit.

There is not much research work published on the chemical constituents from *Cinachyrella*. The classes of compounds reported from this genus include lipids, sterols, nucleosides, phthalates, ceramides, pyrone and cytotoxic macrolides.

2.1 Fatty acids and Lipids

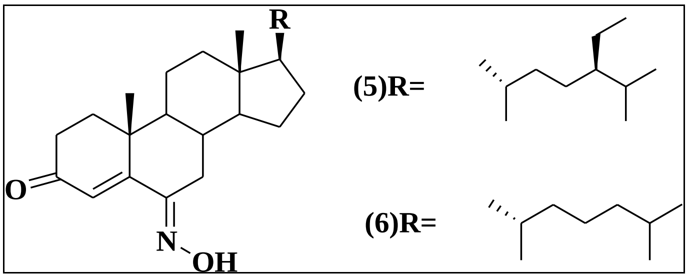
New 2-Methoxy Acetylenic Acids - Cinachylenic Acid A (1), B (2), C (3) and D (4) were reported [4] by A. Mokhleishi *et al*, 2017. J.H. Cardellina *et al* have described lipids [5] from *Cinachyrella alloclada*. The 1-glycerol ether of 17-Z-tetracosenol was identified as a major constituent of CH_2Cl_2-soluble extract of *Cinachyrella alloclada*. Spectral analysis and chemical degradations led to the assigned structure. Six new fatty acids, including 6-bromo-Δ5,9-nonacosadienoic acid, with other fatty acids were reported [6] from Saudi Red Sea collection of a *Cinachyrella* sponge extract. Two new fatty acids not hitherto found in nature, 10,13-octadecadienoic acid and 16-tricosenoic acid [7] were identified. 8-hexadecanoic, 13-nonadecanoic and 5, 3, 13-trimethyl tetradecanoic fatty acids were also reported [6] for the first time from sponges. The major long chain fatty acids encountered were the known 17-tetracosanoic, 19-hexacosenoic, 25-methyl-5, 9-hexacosanoic, 26-methyl-5, 9-heptacosadienoic and 25-methyl-5, 9-hexacosadienoic, 26-methyl-5, 9-heptacosadienoic and 5, 9, 23-tricontatrienoic acids. Some fatty acids were identified as Methyl-esters and N-acyl pyrolilides by gas chromatography and gas chromatographic mass spectrometry. Two isoprenoid fatty acids, 4,8,12-trimethyl-tridecanoic and 5,9,13-trimethyltetradecanoic [8] were reported in all specimens studied of the Senegalese sponges *Cinachyrella alloclada* and *Cinachyrella kukenthali*. Some fatty acids such as 4, 8, 12-trimethyltridecanoic acids may have implications for chemotaxonomy and biosynthetic pathways. More than 50 fatty acids including six fatty acids not hitherto found in nature were reported [9], namely 17-methyltetracosanoic in *C. kükenthali* and 18-methyltetracosanoic, 18-methylpentacosanoic, 18-methylhexacosanoic, 18,24-dimethyl-hexacosanoic and 6-bromo-5,9-nonacosadienoic acids in *C. alloclada*. Approximately 20 Delta 5,9 unsaturated fatty acids were found, including three 6-brominated acids. A series of n-7 monoenoic long chain fatty acids [10] (C_{23} to C_{28}) were also reported from *Cinachyrella schulzei*, including the rare 16-tricosenoic, 18-pentacosenoic, 21-octacosanoic acids. 2-methyoxy-6,12,15-trien-8-yne-octadecanoic acid, 2-benzenedicarboxylic acid dibutyl ester, 1,2-benzenedicarboxylic acid bis(2-ethylhexyl)ester and (-) (3S)-1,2,3,4-tetrahydro-beta-carboline-3-carboxylic acid were isolated [11] from *Cinachyrella australiensis* for the first time by Li *et al*., 2004.



1. 12E, 15(2H)
2. 12(2H), 15(2H)
3. 12(2H), 15E
4. 12Z, 15E

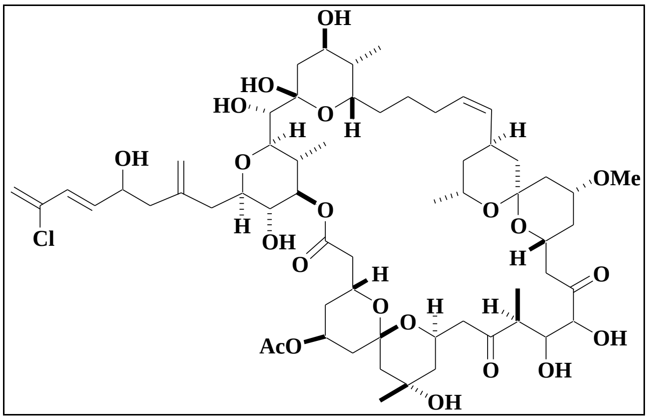
2.2 Sterols

Sterols have been useful in the classification of sponges. 18 steroids including cholesterol, clionasterol, brassicasterol, 22-dihydrobrassicasterol, cholesta- 5,22(E)-diene -3α-ol with minor amount of the corresponding (22Z) isomer was reported [7, 9, 12] previously for sponges of genus *Cinachyrella*. 16-dehydropregnenolone acetate (DPA) was described [1] for the first time in this genus as well marine source. Other interesting sterols found in *C. cavernosa* are gorgosterol (9**)** and 4α-methyl gorgostanol (7). Gorgosterol and clerosterol with other 3beta-hydroxysterols were found by GC/MS was previously reported from *Cinachyrella* sponges of Saudi Arabian Red Sea [9]. Steroid fractions of the demospongia *Cinachyra tarentina* have been studied by Aiello [13] *et al* in 1991. They have reported the identification of three common 3β-hydroxysterols [cholesterol, 24-methylcholesta-5-22-dien-3β-ol, and 24-methylcholesta-5-24(28)-dien-3β-ol], three cholest-4-en-3-ones [cholest-4-en-3-one, 24-methylcholesta-4, 24(28)-dien-3-one, and 24-methyl-cholesta-4, 22-dien-3-one], and two cholest-4-ene-3,6-diones, (5) and (6). In another instance two new 6-hydroximino-4-en-3-one steroids: (24R, 6E)-24-ethylcholes-6-hydroximino-4-en-3-one (5) and (6E) cholest-6-hydroximino-4-en-3-one (2) were isolated[14] from a mixture of two morphospecies of the sponge *Cinachyrella* (*C.alloclada* and *C.apion*). The 3-oxime derivative was reported [15] from *C. australiensis*. Fourteen free sterols have been identified by GC and GC/MS studies, including the 23,24ξ-dimethylcholesta-5,22-dien-3β-ol and the rare 24-norcholesta-5,22-dien-3β-ol from three marine sponge species belonging to the genus *Cinachyrella* were reported [12]: *C. allo*clada and *C. kukenthali* from the Senegalese coast, at two different depths, and *C. aff. schulzei*.



2.3 Macrolides

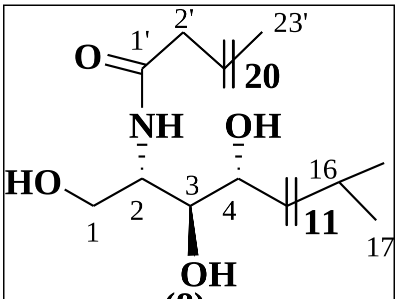
Bioassay guided isolation from *Cinachyra* afforded a new cytotoxic macrolide, cinachyrolide A [16] **(7)**, which apparently is identical to spongistatin-4. The structural elucidation of macrolides included mainly extensive 2D-NMR experiments. *Cinachyrella enigmata* from Papau New Guinea yielded an unusual 18-membered phosphomacrolide-Enigmazole A [17], which exhibited significant cytotoxicity.



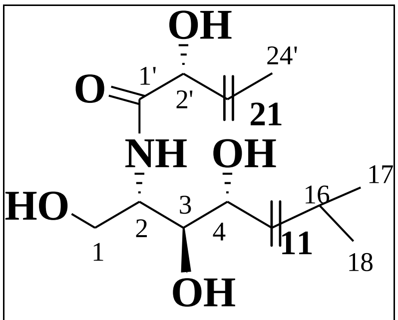
(7)

2.4 Ceramides

Two new ceramides were isolated [18] from the sponge *C. cavernosa* by V.Lakshmi *et al* and identified as (2S, 3S, 4R)-2[(2'R)-hydroxytetracosanoyl amino]- 16-methyl-heptadecane 1,3,4-triol (8) and N- tricosanoyl-(2S,3S,4R)-1,3,4-trihydroxy-2-amino-16-methyl heptadecane or (2S,3S,4R)-16-methyl-2-(tricosanoyl amino)heptadecane-1, 3, 4-triol (9).



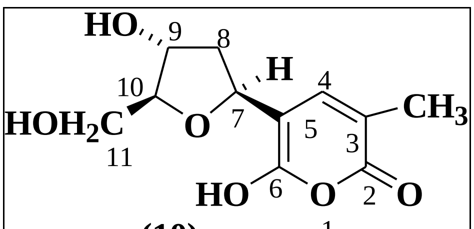
(8)



(9)

2.5 Pyrones

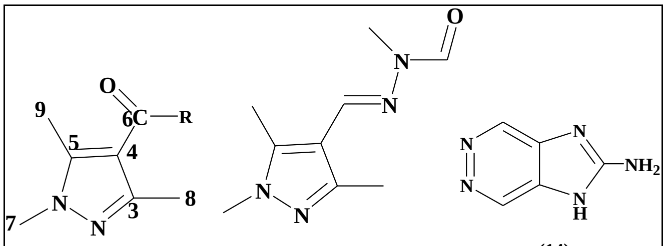
Tetillapyrone (10) earlier reported from *Tetilla* was reported [18] for the first time from the genus *C. cavernosa* by V. Lakshmi *et al*.



(10)

2.5 Alkaloids

Three new natural pyrazole alkaloids (11–13) were isolated [4] from an Indonesian marine sponge of the genus *Cinachyrella* by Mokhlesi A *et al*. 2017 and their structures were established one- and two-dimensional NMR spectroscopy as well as by mass spectrometric data. Another alkaloid zarzissine (14) was reported [15] in Chinese marine Sponge *Cinachyrella australiensis* by Li *et al* 2005. A Novel Alkaloid Cinachyramine was reported[19]from *Cinachyrella sp*.



(11) R=H (12) R=OH (13) (14)

2.6 Amino acids and nucleic acid derivatives

An amino acid derivative 2-N-Acetylglucosamine-O-threonine was reported [20] from the Marine Sponge *Cinachyrella kuekenthali*. 2-methyl-6-amino-9-(2-deoxy-beta-D- ribofuranosyl-purine, 2'-Deoxyadenosine, 6-amino-9-beta-D-ribofuranosyl-9H-purine, uracil, thymine, thymidine, 1-(2-deoxy-beta-D-Ribofuranosyl) uracil, 1-ethyl-alpha-(2-deoxy)-beta-D-ribofuranos, isolumichrome and L-Tryptophan were reported from *C. australiensis* by Li *et al*. 9β-D-ribofuranosyl adenine was reported for the first time from *C. cavernosa* by Wahidullah *et al* from the n-butanol fraction.

2.7 Other miscellaneous compounds

Various benzene derivatives have been reported from *Cinachyrella.* p-hydroxylbenzaldehyde, p-hydroxyl-benzylethanol, p-hydroxyl-benzyl-propanol have also been isolated [11] from marine sponge *C.australiensis*. Phthalate esters 1,2-benzenedicarboxylic acid bis (2-methyl propyl) ester, dibutyl phthalate and 1,2 benzene dicarboxylic acid bis 2-ethyl hexyl ester have also been identified[1] in *C. cavernosa* of which dibutyl phthalate and 1,2 benzene dicarboxylic acid bis 2-ethyl hexyl ester are known constituents of sponges, *C. australiensis* [11].

3. Biological Activities

In this context, this review highlights the metabolic potential of marine sponges of the genus *Cinachyrella* as a rich source of novel bioactive secondary metabolites. The acetylenic acid derivatives Cinachylenic Acid A, B, C and D showed strong inhibitory effect on the growth of L5178Y mouse lymphoma cell line with an IC50 value of 0.3µM. Water-soluble extracts of *C. alloclada* displayed antitumour activity [5]. Cytotoxic activities have also been reported in some compounds including the macrolide cinachyrolide A [16], isolated form a Japanese *Cinachyra sp* while Enigmazole A from *C. enigmata* from Papau New Guinea also exhibited significant cytotoxicity [17]. Cytotoxic Activity of Ethanolic Extract and Fractions of the Marine Sponge *Cinachyrella sp* were investigated by Nurhayati *et al*. [21]. The crude extract from the sponge *Cinachyrella apion* showed cross-reactivity with the polyclonal antibody IgG anti-CvL (Cliona varians lectin) and also a strong haemagglutinating activity [22] towards human erythrocytes of all ABO groups. A lectin isolated from the sponge *Cinachyrella apion* (CaL) showed preferential binding activity [23] and indicated the potential of CaL in studies of medicine for treating cancer.

4. Conclusion

A wide range of fatty acids and sterols have been isolated as a major constituent from *Cinachyrella* including the unusual ones. In addition to these other classes included pyrones, nucleosides, alkaloids, ceramides and macrolides, it has revealed interesting varied classes of chemical compounds isolated from them. Biological activities reported so far in this sponge majorly showed cytotoxic and antitumour activities. Some findings indicated potential of lectin isolated from this in treating cancer. *Cinachyrella* therefore possess a potential for further research as source for new leads in drug discovery process.

5. References

1. *Biochem. Syst. Ecol.*, 2015;58:91-96 Chemotaxonomic Study of the Demosponge *Cinachyrella cavernosa* (Lamarck). Wahidullah S, Naik B G, Al-Fadhli AA, Biochem. Syst. Ecol. 2015;58:91-96.
2. Mcdonald J, Hooper J, McGuinness K. Environmentally influenced variability in the morphology of *Cinachyra australiensis* (Carter, 1886) (Porifera: Spirophorida: Tetillidae).. Marine and Freshwater Research. 2002;53:79-84.
3. Campos M, Beatriz M, Inga L, Veitenheimer M. “Antarctic sponges (Porifera, Demospongiae) of the South Shetland Islands and vicinity: part II. Poecilosclerida.” Revista Brasileira De Zoologia. 2007;24:742-770.
4. Mokhlesi A, Hartmann R, Kurtán T, Weber H, Lin W, Chaidir C, *et al*. New 2-Methoxy Acetylenic Acids and Pyrazole Alkaloids from the Marine Sponge *Cinachyrella sp*. Mar Drugs. 2017;15(11):356.
5. Cardellina JH, Clinton JG, Bradley JG, John RK. "17Z-Tetracosenyl 1-glycerol ether from the sponges *Cinachyra alloclada* and *Ulosa ruetzleri*." Lipids. 1983;18(2):107-110.
6. Velosaotsy N, Genin E, Nongonierma R, Al-Lihaibi S, Kornprobst JM, Vacelet J *et al*. Phospholipid Distribution and Phospholipid Fatty Acids in four Saudi Red Sea Sponges. Bollettino dei Musei e degli Istituti Biologici dell ’Universita di Genova. 2004;68:639-645.
7. Barnathan G, Miralles J, Gaudou EM *et al.*, New Phospholipid Fatty Acids from the Marine Sponge *Cinachyrella alloclada uliczka*, Lipids, 1992;27(10):779-784.
8. Barnathan G, Miralles J, Kornprobst JM. Sponge Fatty Acids. 4. Cooccurrence of Two Isoprenoid Fatty Acids (4,8,12-trimethyltridecanoic and 5,9,13-trimethyltetradecanoic) in Phospholipids of Marine Sponges from the Genus *Cinachyrella*, *Nat. Prod. Lett.*, 1993;27:113-118.
9. Barnathan G, Genin E, Velosaotsy NE, Kornprobst JM, Al-Lihaibi S, Al-Sofyani A *et al*. Phospholipid fatty acids and sterols of two *Cinachyrella* sponges from the Saudi Arabian Red Sea: comparison with *Cinachyrella* species from other origins. Comp Biochem Physiol B Biochem Mol Biol. 2003;135(2):297-308.
10. Barnathan G, Doumenq P, Njinkoue JM *et al.*, Sponge Fatty Acids. 3. Occurrence of Series of n-7 Monoenic and Iso-5,9 Dienoic Long-chain Fatty Acids in Phospholipids of the Marine Sponges *Cinachyrella* aff. *Schulzei* Eeller, Lipids. 1994;29(4):297-303.
11. Li LY, Deng ZW, Li J, Fu HZ, Lin WH. Chemical constituents from Chinese marine sponge *Cinachyrella australiensis*. Beijing Da Xue Xue Bao Yi Xue Ban. 2004;36(1):12-7. Chinese.
12. Barnathan, Gilles J, Rodríguez Miralles, Jean-Michel Njinkoué, Alfonso Mangoni, Ernesto Fattorusso *et al*. “Sterol composition of three marine sponge species from the genus *Cinachyrella*.” Comparative Biochemistry and Physiology B. 1992;103:1043-1047.
13. Steroids of the Marine Sponge *Cinachyra tarentina*: Isolation of Cholest-4-ene-3,6-dione and (24R)-24-Ethylcholest-4-ene-3,6-dione Aiello A, Fattorusso E, Magno S, Menna M, and Pansini M. Journal of Natural Products. 1991;54(1):281-285.
14. Rodríguez J, Nuñez L, Peixinho S, Jiménez C. Isolation and Synthesis of the First Natural 6-Hydroximino-4-en-3-one Steroids from the Sponge *Cinachyrella* spp. Tetrahedron Lett. 1997;38:1833-1836.
15. Xiao DJ, Peng XD, Deng SZ, Ma WJ, Wu HM. Structure elucidation of (3E)-Cholest-4-en-3,6-dione-3-oxime in marine sponge *Cinachyrella australiensis* from the South China Sea. Chinese J. Org. Chem. 2005;25:1606-1609.
16. Bioactive marine metabolites. 48. Cinachyrolide A: a potent cytotoxic macrolide possessing two spiro ketals from marine sponge *Cinachyra sp*. Fusetani N., Shinoda K., and Matsunaga S. J. Am. Chem. Soc. 1993;115(10):3977-3981.
17. Oku N, Takada K, Fuller RW, Wilson JA, Peach ML, Pannell LK *et al*. Isolation, Structural Elucidation, and Absolute Stereochemistry of Enigmazole A, a Cytotoxic Phosphomacrolide from the Papua New Guinea Marine Sponge *Cinachyrella enigmatica*. Journal of the American Chemical Society. 2010;132:10278-10285.
18. New ceramides from the sponge *Cinachyra cavernosa* Lakshmi V, Raghubir R, Gupta P, Journal of Asian Natural Products Research 2008;10(8):747-751.
19. Shimogawa H, Kuribayashi S, Teruya T, Suenaga K, Kigoshi H. Cinachyramine, the Novel Alkaloid Possessing a Hydrazone and Two Aminals from Cinachyrella sp. Tetrahedron Letters. 2006;47:1409-1411.
20. Henriquez W, Sevcik C, D’Sue G, Visbal G, Christophersen C. 2-N-Acetylglucosamine-O-threonine, an Amino Acid Derivative from the Marine Sponge *Cinachyrella kuekenthali*. Ciencia. 2013;21:103-107.
21. Cytotoxic Activity of Ethanolic Extract and Fractions of the Marine Sponge *Cinachyrella sp* Nurhayati APD, Pratiwi R, Wahyuono S, Istriyati, Abdillah S, J. Pharm. Sci. & Res. 2014;6(12):404-410.
22. Medeiros DS, Medeiros TL, Ribeiro JK, Monteiro NK, Migliolo L, Uchoa AF *et al*. A lactose specific lectin from the sponge *Cinachyrella apion*: purification, characterization, N-terminal sequences alignment and agglutinating activity on *Leishmania* promastigotes. Comp Biochem Physiol B Biochem Mol Biol. 2010;155(3):211-216.
23. Rabelo L, Monteiro N, Serquiz R, Santos P, Oliveira R, Oliveira A *et al*. A lactose-binding lectin from the marine sponge *Cinachyrella apion* (Cal) induces cell death in human cervical adenocarcinoma cells. Mar Drugs. 2012;10(4):727-43.