Bioactive compounds evaluation of the mudskippers (Periophthalmus chrysospilos, Boleopthalmus boddarti, Boleopthalmus dussumieri and Periophthalmodon schlosseri) in the estuarine area of Musi River, S

JEE Journal of Ecological Engineering
ISSN 2299-8993

Bioactive compounds evaluation of the mudskippers (Periophthalmus chrysospilos, Boleopthalmus boddarti, Boleopthalmus dussumieri and Periophthalmodon schlosseri) in the estuarine area of Musi River, South Sumatera, Indonesia.

Type

Research paper

Keywords

mudskippers, musi river, bioactive compounds

Abstract

This research was conducted to asses the various bioactive compounds in the meat of some mudskippers founding in the Sungsang 2 Village, Banyuasin regency, South Sumatra. The research had been synthesized using n-hexane from February to May 2018 at Agricultural Technology Production Laboratory, Sriwijaya University. Subsequently, the mudskippers (Periopthalmus chrysospilos, Boleopthalmus boddarti, and Periophthalmodon schlosseri) extract was synthesized and further analysed by using GC-MS analysis. The study of bioactive compounds in mudskippers was carried out by evaporating in vacuum evaporation at 30°C. The results showed that Periopthalmus chrysospilos has five classes of bioactive compounds such as steroids, terpenoids, carotenoids, canabinoids, and alkaloids and Boleopthalmus boddarti has five classes of bioactive compounds such as steroids, carotenoids, terpenoids, bufadienolides, and carotatoxins. Furthermore, Boleopthalmus dussumieri has four classes of bioactive compounds such as steroids, carotenoids, terpenoids, and carotatoxins and Periophthalmodon schlosseri has three classes of bioactive compounds such as steroids, carotenoids and terpenoids. This research discuss the potential benefit of all bioactive compounds in mudskippers for alleviate and treating people with enuresis in child through the literature review of the most cited bioactive compounds.

Manuscript body
Download source file (215.76 kB)

JEE Journal of Ecological Engineering
ISSN 2299-8993

Bioactive compounds evaluation of the mudskippers (*Periophthalmus chrysospilos*, *Boleopthalmus boddarti*, *Boleopthalmus dussumieri* and *Periophthalmodon schlosseri*) in the estuarine area of Musi River, South Sumatera, Indonesia

Mohammad Rasyid Ridho[1*], Arum Setiawan[1], Sarno[1], Arwinsyah[1], Enggar Patriono[1], and Sulistiono[1]

[1] *Department of Biology, Faculty of Mathematic and Natural Sciences, Sriwijaya University, Palembang 30139, Indonesia*

*Corresponding author Ph: +62-821-7958-6528; Email: moh.rasyidridho@mipa.unsri.ac.id

Abstract. This research was conducted to asses the various bioactive compounds in the meat of some mudskippers founding in the Sungsang 2 Village, Banyuasin regency, South Sumatra. The research had been synthesized using n-hexane from February to May 2018 at Agricultural Technology Production Laboratory, Sriwijaya University. Subsequently, the mudskippers (*Periopthalmus chrysospilos*, *Boleopthalmus boddarti*, and *Periophthalmodon schlosseri*) extract was synthesized and further analysed by using GC-MS analysis. The study of bioactive compounds in mudskippers was carried out by evaporating in vacuum evaporation at 30°C. The results showed that *Periopthalmus chrysospilos* has five classes of bioactive compounds such as steroids, terpenoids, carotenoids, canabinoids, and alkaloids and *Boleopthalmus boddarti* has five classes of bioactive compounds such as steroids, carotenoids, terpenoids, ufadienolides, and carotatoxins. Furthermore, *Boleopthalmus dussumieri* has four classes of bioactive compounds such as steroids carotenoids, terpenoids, and carotatoxins and *Periophthalmodon schlosseri* has three classes of bioactive compounds such as steroids, carotenoids and terpenoids. This research discuss the potential benefit of all bioactive compounds in mudskippers for alleviate and treating people with enuresis in child through the literature review of the most cited bioactive compounds.

Keywords: Mudskippers, Musi river, Bioactive compounds

1. Introduction

Mudskipper is a genus from the family of Gobiidae and subfamily Oxudercinae that is habitually known as ikan gelodok at Musi river, South Sumatera (Shukla et al., 2014; Polgar et al., 2017; Lauriano et al., 2018; Ridho et al., 2019). Mudskippers are commonly found in brackish river water, and beaches with certain salinity concentration, and mangrove areas of the Indo-Pacific region (Tytler and Vaughan, 1983). Mudskippers are amphibious fish that are able to tolerate in both freshwater and marine on muddy and sandy bottom habitat and spawn in estuarine areas (Hu et al., 2016; Hong et al., 2017). Mudskippers are also capable to spend extended periods

out of water (Martin et al., 2013; Konstantinidis et al., 2016; Martinez et al., 2018). They appear during low tide, forage on tropical mudflats, seek mate and preserve territories for some portion of their daily cycle (Dabruzzi et al., 2019). According to the classification of amphibious gobies, 40 species mudskippers in the world have been currently identified which are divided into four genera of Oxudercinae, namely *Boleophthalmus*, *Periophthalmus*, *Periophthalmodon* and *Scartelaos* (Clayton 1993; Graham 1997; Graham and Wegner 2010; Ishimatsu and Gonzales 2011; Takeda et al., 2012; Murdy 2011a, You et al., 2018).

Juveniles of this Gobiidae are herbivores that eat more diatoms and filamentous algae, while the major food of adult Gobiidae are crustaceans (95.5%), polichaetas (86.4%) and land insects (85%) (Bob-Manuel, 2011). The burrows of these habitats are categorically suitable for the mudskippers for feeding grounds, spawning areas and nursery grounds (Masuda et al., 1984; Bob-Manuel, 2011; Satapoomin and Poovachiranon, 1997; Redjeki, 2013). Mudskippers are commonly consumed and employed specifically traditional medicine in many countries such as China, Malaysia and Japan (Feulner 2013; Gadhavi et al., 2017; Ikram et al., 2010; looi et al., 2016 and Yang, X. X., 2017). Medicinal mudskippers were often prepared from the natural products which contain of different bioactive compounds (Mahadevan et al., 2019; Wu et al., 2009). On the other hand, many fisherman and general public around Musi river ignore the existence and benefits of mudskippers.

Corticosteroids, one of bioactive compound in mudskippers, are steroid hormone class for overcoming inflammatory (Panda and Mabalirajan, 2018; Heughten et al., 2018). These hormones is one contributing factor to alleviate enuresis (bedwetting) in child. Enuresis is most common for a child or young person's behaviour that is denoted by repeated voiding of urine into the bed or clothing (Apos et al., 2017 and shafi et al., 2019). the study area represents bioactive compound like corticosteroid compounds in mudskippers that can reduce enuresis problem in children (Jain et al., 2016). Based on these things, the authors intend to evaluate the bioactive compounds in the four species mudskippers including *Periophthalmus chrysospilos*, *Boleopthalmus boddarti*, *Boleopthalmus dussumieri* and *Periophthalmodon schlosseri*.

2. Materials and Methods

2.1 Fishes and Experimental Design

Mudskippers were obtained from estuarine area around the Sungsang 2 village, Banyuasin regency, South Sumatera. Mudskippers, apparently healthy, were randomly caught using fishing equipment and transported to the Agricultural Technology Production Laboratory, Sriwijaya University for cleaning and removing the bones from the fish. After the fillet process, the mudskippers were divided into four groups with *Periophthalmus chrysosphilos* (8 grams), *Boleopthalmus boddarti* (100 grams), *Boleopthalmus dussumieri* (13.8 grams) and *Periophthalmodon schlosseri* (100 grams) which were each homogenized.

Crushed fish flesh dissolved in n-hexane solvent with a sample ratio of 1: 4 and macerated for 24 hours. The next step is filtering with calico cloth and filter paper and evaporating with vacuum evaporator at at 30°C with a speed of 200 rpm. Each extract sample was reconstituted using n-hexane solvent, then each 1 µL was taken to be injected and analyzed in GC-MS alternately.

2.2 Analysis Technique

The data in this research were expressed in the form of chromatograms that contain graphs

JEE Journal of Ecological Engineering
ISSN 2299-8993

and were equipped with a list of detected chemical compounds, along with the structure of compounds, retention times, areas, and probability of compound types. Data analysis was performed by identifying the chemical compounds detected to find out the natural name (nature of compound name), synonym, and the class of compounds of these chemical compounds. Identification is done by comparing the compound name detected with a data base on the literature in the form of books and journals. We included studies reported as full-text articles, those published as abstracts only and unpublished data.

2.3 Gas Chromatography and Mass Spectroscopy (GC-MS) Analysis

Qualitative analyses of mudskipper extract were expressed as a GCMS-QP 2010 Plus (Shimadzu, Japan) system equipped under computer control at 70 eV (Mohammed and Imad, 2013). The 1 µl of the methanol extract was entered into the GC-MS with a micro injector and followed by scanning for 45 min. The temperature was maintained in the oven at 100°C and Helium gas was utilized as a carrier as well as an eluent. The helium flow was arranged to 1 ml per min and electron energy was fired by a mass detector about 70 eV. The compound of elite 5 was used as separation coloumn (100% dimethyl poly siloxane) (Hameed et al., 2016; Kareem et al., 2015). The identity of the compounds in the extracts was assigned by the comparison of their retention indices and mass spectra fragmentation patterns with those stored on the computer library and also with published literatures. Compounds were identified by comparing their spectra to those of the Wiley and NIST/EPA/NIH mass spectral libraries.

3. Results and Discussions

3.1 GC-MS Results of Periopthalmus chrysospilos extract

Gas chromatography and mass spectroscopy analysis of bioactive compounds was carried out in *Periopthalmus chrysospilos* extract that was 6 resented in **Fig. 1**. It can be seen that the vertical lines in the chromatogram pattern point out the short periods of time when the ion beam is deflected-off the plate (and thus off the beam monitor) which is necessary when changing the position of the photographic plate, a process that takes about 2-3 seconds with our present arrangement. This pen deflection affords a useful signal of the exact quantities of the chromatogram being noted with the mass spectrometer and facilitates in the reconnection of the spectra on the plate with the chromatogram.

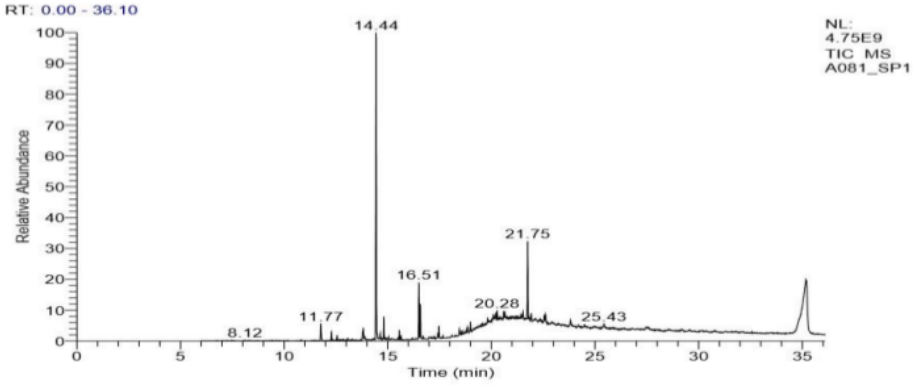


Figure 1. Chromatogram result of peak chemical compounds in *Periopthalmus chrysospilos*. (Source: LHP, 2018)

JEE Journal of Ecological Engineering
ISSN 2299-8993

The GC-MS chromatogram showed that the presence of five major peaks of bioactive compounds was detected and the components corresponding to the peaks were determined as follows. The highest peak in chromatogram pattern could be seen that the extract of *Periopthalmus chrysospilos* has retention time 14.44 minutes. Based on the GC-MS signal, the sample has many bioactive compounds which was shown by some signals detected. It shows that GC-MS analysis successfully proves *Periopthalmus chrysospilos* extract for treating people with inflammatory disease especially enurosis.

3.2 Bioactive compounds in the Periopthalmus chrysospilos extract

The results of *Periopthalmus chrysospilos* extract revealed the amounts of bioactive compounds such as terpenoids, alkaloids, steroids, carotenoids and canabinoids. Terpenoid compounds were detected as many as 4 types of compounds with a total of 4 compounds. Carotenoid compounds were detected as many as 1 type of compound with a total of 4 compounds. Canabinoid compounds were detected as many as 1 type of compound with a total of 2 compounds; and alkaloid compounds detected as many as 1 type with a total of 1 compound. Cannabinoid bioactive compounds were also detected in this sample with a total of 1 compound. Cannabinoid compounds include secondary metabolites which are usually found in cannabis plants. According to Maggyvin and Sinuraya (2017), cannabinoids are classified by source and origin. Phytocannabinoids are derivative compounds from cannabis and other plants, including delta-9-tetrahydrocannabinol (THC), cannabidiol (CBD), and cannabinol (CBN). The details of *Boleopthalmus boddarti* extract elucidated in following **Table 1**.

Table 1. The amount of bioactive compounds in the *Periopthalmus chrysospilos* extract.

No.	Compound Names	Compound Classes	Total Numbers
1.	*D-Limonene*	Terponoids	1
2.	*Limonene*	Terponoids	1
3.	*Aspidospermidin-17-ol, 1-acetyl-19,21-epoxy-15, 16-dimethoxy-*	Alkaloids (*Aspidospermidin*)	1
4.	*Choltesan-3-ol, 2-methylene-*	Steroids	6
5.	*Azulene, 1,4-dimethyl-7-(1-methylethyl)-*	Terpenoids	1
6.	*17.alfa.,21á-28, 30-Bisnorhopane*	Steroids	1
7.	*4-Androsten-6á-ol-3,17-dione*	Steroids	3
8.	*3,9-Epoxypregn-16-ene-14,20-diol, 7,11,18-triacetoxy-3-methoxy-*	Steroids	1
9.	*Cholestan-26-oic acid, 3,7,12-trihydroxy-*	Steroids	1
10.	*Rhodopin*	Carotenoids	1
11.	*Cannabinol, trifluoroacetate*	Cannabinoids	4
12.	*Cholestan-3,5-diol, 5-acetate*	Steroids	2
13.	*Milbemycin B, 5-demethoxy-5-one-6,28-anhydro-25-ethyl-4-methyl-13-chloro-oxime*	Steroids	1
14.	*9,19-Cyclolanostan-3-ol, 24,24-epoxymethano-acetate*	Terpenoids	1
15.	*8,14-Seco-3,19-epoxyandrostane-8,14-dione,17-acetoxy-3 á-methoxy-4,4-dimethyl-*	Steroids	11

16.	*Androst-7-ene-6,17-dione, 2,3,14-trihydroxy-*	Steroids	10
17.	*2-Phenanthrenecarboxylic acid, 1-(1,3-dithian-2-ylmethyl)-7-hydroxy-2,4b-dimethyl-1,2,3,4,4a,4b,5,6,7,8,10,10a-dodecahydro-,methyl ester*	Steroids	1

The highest bioactive compounds in *Periopthalmus chrysospilos* extract were steroid compounds which were detected as many as 10 type of compounds with a total of 24 compounds. The total number of compounds detected are named Androst-7-ene-6,17-dione, 2,3,14-trihydroxy-, where the total amount of compounds is 10 compounds. According to Moss (1989) androstane is an anabolic steroid group that belongs to the basic carbon cycle, which is unsaturated and is an alkyl substitute in the 17th carbon chain.

3.3 GC-MS Results of Boleopthalmus boddarti extract

The result of GC-MS analysis of *Boleopthalmus boddarti* extract describes as the chromatogram form for all chemical compounds that was read by the detector (**Fig.2**). The vertical lines were found in this chromatogram pattern. Those indicate more than one bioactive compounds in *Boleopthalmus boddarti* extract. The presence of five major peaks of bioactive compounds was detected and the most compound are from steroids. The highest peak in chromatogram pattern could be seen that *Boleopthalmus boddarti* extract has retention time 14.44. Based on the GC-MS signal, the sample has many bioactive compounds which was shown by some signals detected. It shows that GC-MS analysis successfully proves *Boleopthalmus boddarti* extract for treating people with inflammatory disease especially enuresis.

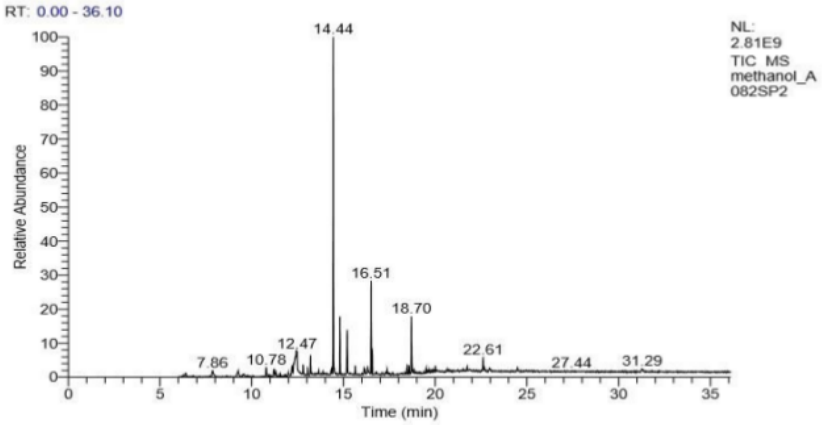


Figure 2. Chromatogram result of peak chemical compounds in *Boleopthalmus boddarti*. (Source: LHP, 2018)

3.4 Bioactive compounds in the Boleopthalmus boddarti extract

The results of *Boleopthalmus boddarti* extract revealed the amounts of bioactive compounds such as steroids, carotenoids, terpenoids, bufadienolide, carotatoxin, cholesterol, and corticosteroid shown in **Table 2**. Compounds of steroid groups were detected as many as 24 types

of compounds with a total of 44 compounds. Specific steroid compounds namely corticosteroids are detected with 2 types of compounds and a total of 3 compounds. The details of *Boleopthalmus boddarti* extract elucidated in following **Table 2**.

Table 2. The amount of bioactive compounds in the *Boleopthalmus boddarti* extract

No.	Compound Names	Compound Classes	Total Numbers
1.	*Curan-17-oic acid, 19,20-dihydroxy-, methyl ester*	Steroids	2
2.	*Cholestan-3-ol, 2-methylene-*	Steroids	12
3.	*Citronellol epoxide*	Terpenoids	1
4.	*Falcarinol*	Carotatoxin (secondary cancer anti metabolites)	1
5.	*Cholestan-3-one, cyclic 1,2-ethanediyl aetal*	Steroids	1
6.	*..psi.,.psi.-Carotene, 1,1',2,2'-tetrahydro-1'-dimethoxy*	Carotenoids	8
7.	*Androsten-4-en-11-ol-3,17-dione, 9-thiocyanato-*	Steroids	2
8.	*Androsten-5-en-17-one-3,11-bis[(trimethylsilyl)oxy]-, O-(phenylmethyl)oxime*	Steroids	1
9.	*Prosta-5,13-dien-1-oic acid, 9,11,15-tris[(trimethylsilyl)oxy]-, trimethylsilyl ester*	Steroids	6
10.	*Rhodoxanthin*	Carotenoids	2
11.	*Rhodopin*	Carotenoids	2
12.	*5á-Ergost-24-en-26-oic acid, 5,6á-epoxy-4á, 18,22-trihydroxy-3-methoxy-1-ox o-, ë-lactone, diacetate,*	Steroids	1
13.	*Ethyl iso-allocholate*	Steroids	1
14.	*Gamabufotalin*	Bufadienolide (stereoid aglycones in frogs)	1
15.	*Betamethasone acetate*	Corticosteroid	2
16.	*Cholestan-26-oic acid, 3,7,12-trihydroxy-*	Steroids	2
17.	*..psi.,.psi.-Carotene, 3,4-didehydro-1,2,7',8'-tetrahydro-1- methoxy-2-ox o*	Carotenoids	1
18.	*..psi.,.psi.-Carotene, 3,3',4,4'-tetrahydro-7',2'-dihydro-1-hydroxy-1'methoxy*	Carotenoids	1
19.	*Prosta-5,13-dien-1-oic acid, 9,11,15-tris[(trimethylsilyl)oxy]-, trimethylsilyl ester*	Steroids	2
20.	*17á-Acetoxy-1',1 carboethoxy-1á,2á-dihydrocy cloprop[1,2]-5á-androst-1-en-3-one*	Steroids	2
21.	*Cholesterol*	Cholesterol	1
22.	*26-Nor-5-cholesten-3á-ol-25-one*	Steroids	1
23.	*17-(1,5-Dimethylhexyl)-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17-*	Steroids	1

	tetradecahydro-1Hcyclopenta[a]phenanthren-3-ol		
24.	*Androst-4-en-9-thiocyanomethyl-11-ol-3,17-dione*	Steroids	1
25.	*Androst-5-en-3-one, 19-acetoxy-4,4-dimethyl-,oxime*	Steroids	1
26.	*3-Isopropyl-6a,7,10b-trimethyl-8-(2-oxo-2-phenylethyl)dodecahydrobenzo[f]chromene-7-carboxylic acid, methyl ester*	Corticosteroid	1
27.	*Androst-8-en-3-ol, 4,4,14á-trimethyl-17-(2-bromo-1-methylethyl)*	Steroids	1
28.	*1',1'-Dicarboethoxy-1á,2á-dihydro-3'H-cycloprop[1,2]cholesta-1,4,6-trien-3-one*	Steroids	1
29.	*Prosta-5,13-dien-1-oic acid, 9,11,15,19-tetrakis[(trimethylsilyl)oxy]-, methyl ester*	Steroids	1

Corticosteroids are drugs that contain steroid hormones that are useful to increase the steroid hormones in the body that are needed, and relieve inflammation and help the body's excessive working system including asthma, allergy and multiple sclerosis (Cidlowski, 2013; Panda and Mabalirajan, 2018; Rozaliyani, 2011). According to the analysis of Prasad *et al* (2018), corticosteroids also reduce the mortality risk from tuberculosis effect at least in the short term. A quite unique compound was detected from this *Boleopthalmus boddarti* extract, the compound named Gamabufotalin which is a bioactive compound of the bufadienolide types. According to Dmitrieva et al. (2000), Bufadienolides are biosynthetic steroid that is independent of the side chain of cholesterol division. Bufadienolides (BDs) also include corticic steroid groups, which are usually obtained from amphibian poison extracts, these compounds are often used as traditional medicine in Asia.

3.5 GC-MS Results of Boleopthalmus dussumieri extract

The result of GC-MS analysis of *Boleopthalmus dussumieri* extract describes as the chromatogram form for all chemical compounds that was read by the detector (**Fig.3**). The vertical lines were found in this chromatogram pattern. Those indicate more than one bioactive compounds in *Boleopthalmus dussumieri* extract. The presence of four major peaks of bioactive compounds was detected by GC-MS like steroids, terpenoids, carotenoids and carotatoxins. The highest peak in chromatogram pattern could be seen that *Boleopthalmus dussumieri* extract has retention time 22.61. Based on the GC-MS signal, the sample has significant bioactive compounds which was shown in the **Table 3**.

JEE Journal of Ecological Engineering
ISSN 2299-8993

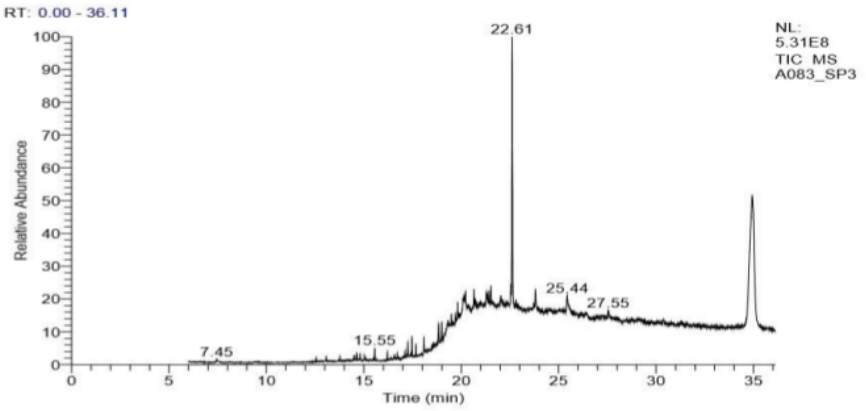


Figure 3. Chromatogram result of peak chemical compounds in *Boleopthalmus dussumieri*. (Source: LHP, 2018)

3.6 Bioactive compounds in the Boleopthalmus dussumieri extract

Bioactive compounds detected from *Boleopthalmus dussumieri* extract include steroids, terpenoids, carotenoids and carotatoxins. The compounds of steroid classes are as many as 11 types of compounds, with a total of 26 compounds. The group of carotenoid compounds was detected as many as 6 types of compounds, with a total of 13 compounds. The group of terpenoid compounds was detected by 2 types of compounds, with a total of 2 compounds. Carotatoxin compounds were also detected in this *Boleopthalmus dussumieri* extract, with a total of 1 compound. The details of *Boleopthalmus dussumieri* extract elucidated in following **Table 3**.

Table 3. The amount of bioactive compounds in the *Boleopthalmus boddarti* extract

No.	Compound Names	Compound Classes	Total Numbers
1.	*Limonene*	Terpenoids	1
2.	*D-Limonene*	Terpenoids	1
3.	*Corynan-17-ol, 18,19-didehydro-10-methoxy-,acetate (ester)*	Steroids	2
4.	*Rhodopin*	Carotenoids	5
5.	*Ç-Sitosterol*	Steroids	1
6.	*Spirost-8-en-11-one, 3-hydroxy*	Steroids	13
7.	*Cholest-5-en-3-ol, 24-propylidene-*	Steroids	2
8.	*Stigmasta-5,24(28)-dien-3-ol*	Steroids	1
9.	*..psi.,.psi.-Carotene, 1,1',2,2'-tetrahydro-1,1'-dimethoxy*	Carotenoids	4
10.	*5á-Ergost-24-en-26-oic acid, 5,6á-epoxy-4á, 18,22-trihydroxy-3-methoxy-1-ox o-, ë-lactone, diacetate,*	Steroids	1
11.	*..psi.,.psi.-Carotene, 3,4-didehydro-1,2,7',8'-tetrahydro-1-methoxy-2-ox o*	Carotenoids	1

12.	*5-Chloro-6beta-nitro-5alpha-cholestan-3-one*	Steroids	1
13.	*Prosta-5,13-dien-1-oic acid, 9,11,15-tris[(trimethylsilyl)oxy]-, trimethylsilyl ester*	Steroids	1
14.	*Cholest-4-ene, 3á-(methoxymethoxy)-*	Steroids	1
15.	*Rhodoxanthin*	Carotenoids	1
16.	*4'-Apo-á,.psi.—carotenoic acid*	Carotenoids	1
17.	*Astaxanthin*	Carotenoids	1
18.	*Androst-7-ene-6,17-dione, 2,3,14-trihydroxy*	Steroids	2
19.	*Prosta-5-en-1-oic acid, 9,11,15-tris[(trimethylsilyl)oxy]-, methylsilyl ester*	Steroids	1
20.	*Falcarinol*	Carotatoxin	1

The name of steroid compounds with the highest total number of compounds is Spirost-8-en-11-one, 3-hydroxy. According to Rajendran et al. (2017), Spirost-8-en-11-one, 3-hydroxy including steroid compounds which have anti-cancer bioactivity. Spirost-8-en-11-one, 3-hydroxy has the chemical formula C27H40O4. The group of carotenoid compounds detected with the highest amount is Rhodopin, where the total amount of these compounds is 5 compounds. According to Komori et al. (1998), Rhodopin is a carotenoid compound which is usually produced by Rhodosiprillum rubrum bacteria which has the chemical formula C40H58O.

Bioactive carotatoxin alkaloids are also detected from *Boleopthalmus dussumieri extract*. The name of the carotatoxin group is falcarinol and the total of compound is only 1 compound. According to Zaini et al. (2012), falcarinol (FaOH) is one of the compounds found in carrots, this compound has shown bioactive action in several types of cell cultures. Falcarinol has been shown to be cytotoxic to the culture of acute lymphoblastic leukemia cells.

3.7 GC-MS Results of Periopthalmodon schlosseri extract

The result of GC-MS analysis of *Periopthalmodon schlosseri* extract describes as the chromatogram form for all chemical compounds that was read by the detector (**Fig. 4**). The vertical lines were found in this chromatogram pattern. Those indicate more than one bioactive compounds in *Boleopthalmus boddarti* extract. The presence of five major peaks of bioactive compounds was detected and the most compound are from steroids. The highest peak in chromatogram pattern could be seen that *Boleopthalmus boddarti* extract has retention time 14.44. Based on the GC-MS signal, the sample has many bioactive compounds which was shown by some signals detected. It shows that GC-MS analysis successfully proves *Boleopthalmus boddarti* extract for treating people with inflammatory disease especially enurosis.

JEE Journal of Ecological Engineering
ISSN 2299-8993

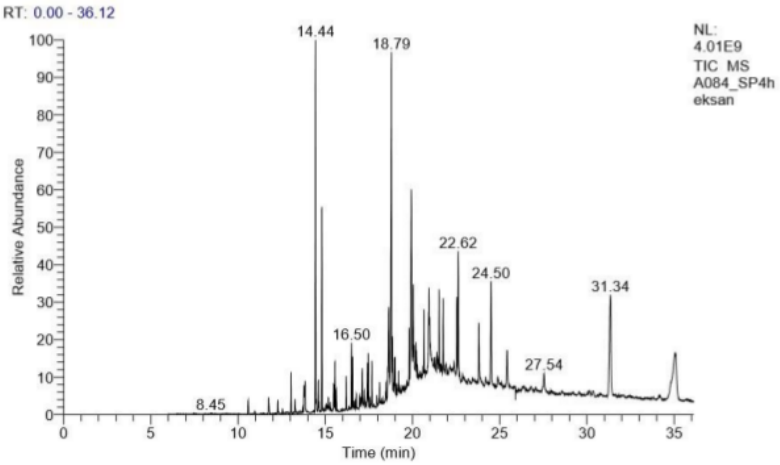


Figure 4. Chromatogram result of peak chemical compounds in *Periopthalmodon schlosseri*. (Source: LHP, 2018)

3.8 Bioactive compounds in the Periopthalmodon Schlosseri extract

Bioactive compounds detected from *Periopthalmodon schlosseri* extract including steroids, carotenoids and terpenoids. Bioactive steroid compounds were detected as many as 11 types of compounds with a total of 21 compounds; carotenoid group compounds detected as many as 3 types of compounds with a total of 6 compounds; while terpenoid group compounds were detected only 1 type of compound with a total of 1 compound. The details of *Periopthalmodon schlosseri* extract elucidated in **Table 4**.

Table 4. The amount of bioactive compounds in the *Periopthalmodon schlosseri* extract

No.	Compound Names	Compound Classes	Total Numbers
1.	*D-Limonene*	Terpenoids	1
2.	*Cholestan-4-ol, 2-methylene-*	Steroids	4
3.	*Cholest-5-en-3-ol (3á)-, tetradecanoate*	Steroids	1
4.	*Cholesta-3,5-diene*	Steroids	1
5.	*Cholesteryl benzoate*	Steroids	1
6.	*Rhodopin*	Carotenoids	3
7.	*Azafrin*	Carotenoids	1
8.	*17.alfa.,21á-28,30-Bisnorhopane*	Steroids	2
9.	*Cholesterol*	Steroids	2
10.	*26-Nor-5-cholesten-3á-ol-25-one*	Steroids	1
11.	*Cholestane-3,5-diol, 5-acetate*	Steroids	1
12.	*Campesterol*	Steroids	1
13.	*Ergost-5-en-3--ol*	Steroids	1
14.	*Astaxanthin*	Carotenoids	2
15.	*Androst-7-ene-6,17-dione, 2,3,14-trihydroxy-*	Steroids	6

The steroid compounds in *Periopthalmodon schlosseri* extract are named Cholestan-3-ol, 2-methylene-, Cholest-5-en-3-ol (3á) -, tetradecanoate, Cholesta-3,5-diene, Cholesteryl benzoate, 17.alfa., 21á-28 , 30-Bisnorhopane, Cholesterol, 26-Nor-5-cholesten-3á-ol-25-one, Cholestane-3,5-diol, 5-acetate, Campesterol, Ergost-5-en-3-ol, and Androst- 7-ene-6,17-dione, 2,3,14-trihydroxy-. According to Salempa and Muharram (2016), steroids are natural compounds which consist of a carbon skeleton and consist of three circles of six perdidro phenanthrene and fused into one circle of five. Saturated-click hydrocarbons, which have a circumference system consisting of 17 carbon atoms.

D-Limonene is the only the group of terpenoid compounds which detected from *Periopthalmodon schlosseri* extract. This compound was also detected in samples of *Periopthalmus chrysospilos extract* and *Boleopthalmus dussumieri extract*. According to Sun (2007), D-Limonene is a monocyclic terpenoids with a lemon-like odor and is a major constituent of several essential oils of Citrus sp. (orange, lemon, mandarin, lime and grapefruit). D-Limonene is widely used as an additive (additive) there is perfume, soap, food, gum and drinks. This compound is also listed in the Code of Federal Regulation as a material that is known to be safe or generally recognized as safe (GRAS) as a flavoring agent.

The group of carotenoid compounds detected include rhodopin, azafrin and astaxanthin. Rhodopin compounds were detected in all samples with a sufficient number of total compounds in each sample. Astaxanthin compounds were also detected from the flesh extracts of *Boleopthalmus boddarti* and *Boleopthalmus dussumieri* with a total of 1 compound each in each sample. While azafrin compounds were only detected in *Periopthalmodon schlosseri* extract. According to Gopalakrishnan and Kalaiarasi (2012), azafrin is a compound of the carotenoid ester group with the molecular formula C28H40O4. Azafrin compounds include bioactive compounds that have the potential as antioxidants, anti-inflammatory, anticancer, anti-criticism, natural dyes, eye pain medications, and as compounds that can reduce hypertension.

3.9 Physical and Chemical Properties of the Environment at Sampling Locations

The main point of sampling mudskippers based on the GPS is in the coordinates S 02° 21'57.5 "E 104° 54'00.1". The environment measurements of the physical and chemical properties were carried out at the main point of sampling and obtained as presented in Table 5.

Table 5. Physical and chemical properties of the environment at the sampling location

Parameter	Measurement Time		
	March	April Morning	April Afternoon
Soil moisture (%)	100	100	100
Soil pH	6.5	6.5	6.5
Water pH	6.82	7.32	6.7
Waters salinity (%)	0.1	0	0

The measurement of physical and chemical properties of the environment was carried out at 3 different times. The first measurements were made in late March precisely in the afternoon and obtained soil moisture data of 100%, soil pH of 6.5, water pH of 6.82, and water salinity of 0.1 ‰. The second measurement was carried out in April morning and 100% of soil moisture was obtained, soil pH was 6.5, water pH was 7.32, and water salinity was 0 ‰. The third measurement was carried out in the afternoon of April and obtained 100% soil moisture data, a soil pH of 6.5, a water pH of 6.7, and water salinity of 0 ‰.

Based on the data of the physical and chemical properties of the environment, it can be seen that the soil moisture at the main sampling point shows 100% at 3 times measurements with different times. This shows that the sampling location has a substrate in the form of mud which is always wet. According to Kurnia et al. (2006), soil moisture is one of the key variables in the hydrological process that plays an important role in determining the availability of water as a very fundamental element in the life of living things. 100% soil moisture indicates that the soil is saturated with water.

Water salinities at 3 measurements with different times showed the numbers 0.1 ‰, 0 ‰ and 0 ‰. This shows that the waters around the sampling location tend to be tasteless. According to Masuda et al. (1984) and Redjeki (2013), the gudder is an amphidromous demersal fish that is able to tolerate freshwater and sea and live on muddy and sandy bottom and spawn in estuarine areas.

4. Conclusions

The bioactive compound analysis of *Periopthalmus chrysospilos* extract consist of compounds the natural names of steroids, terpenoids, carotenoids, canabinoids, and alkaloids. All these hormones which was found as many as 10 types with a total of 24 compounds in *Periopthalmus chrysospilos* extract. *Boleopthalmus boddarti* extract was natural names of steroids, carotenoids, terpenoids, bufadilenoid, and carotatoksin. There are 24 types of compounds which were detected with a total of 44 compounds in *Boleopthalmus boddarti* extract. *Boleopthalmus dussumieri* extract has bioactive compounds from the groups of steroids, carotenoids, terpenoids, and carotatoksin. *Boleopthalmus dussumieri extract has* as many as 11 types of compounds with a total of 26 compounds. *Periopthalmodon schlosseri* detected bioactive compounds from groups and or with the natural names of steroids, carotenoids and terpenoids. All hormones which was detected as many as 11 types of compounds with a total of 21 compounds. The higher concentrations of bioactive compounds were found in mudskippers that those are possibly consumed for inflammatory disease, enuresis in children and allergy.

Acknowledgments

The authors would like to thank Dr. Arum Setiawan and Sulistiono, Dr. Sarno, Dr. Arwinsyah[1], Enggar Patriono, M.Si., College of Agricultural Technology Production Laboratory, Sriwijaya University for his help in specimen preparation. We also thank anonymous referees for constructive criticism on the manuscript. This work was supported by the projects of Kemenristekdikti.

References

Bob-Manuel, F.G., 2011. Food and feeding ecology of the mudskipper *Periophthamus koelreuteri* (Pallas) Gobiidae at Rumuolumeni Creek Niger Delta, Nigeria. *Agriculture and Biology Journal of North America*. 2, 897–901.

Clayton DA. 1993. Mudskippers. *Oceanogr Mar Biol Annu*. Rev 31:507–77.

Dabruzzi, T. F., Fangue, N. A., Kadir, N. N, and Bennett, W. A., 2019. Thermal Niche Adaptations of Common Mudskipper (Periophthalmus kalolo) and Barred Mudskipper (Periophthalmus argentilineatus) in Air and Water. *Journal of Thermal Biology*. 81, 170-177.

DKP Provinsi Sumatera Selatan, 2017. Sumberdaya: *Pengelolaan Pesisir Provinsi Sumatera Selatan 1*. [*online*] Tersedia: dislutkan.sumselprov.go.id/page/38/sumberdaya#. [11 November 2017].

Dmitrieva, R. I. Bagrov, A. Y., Lalli, E., Sassone-Corsi, P., Stocco, D., dan Doris, P. A., 2000. *Mamalian Bufadienolide is Synthesized from Cholesterol in the Adrenal Cortex by Pathway that is Independent of Cholesterol Side-chain Cleavage Hypertention*. 36, 3, 442-8.

Feulner, G. R., and Binish R, 2013. Re-discovery of the mudskipper Periophthalmus waltoni Koumans, 1941 in the United Arab Emirates. *Tribulus*, vol. 21, 2013, p. 42+. Gale Academic Onefile, Accessed 13 Oct. 2019

Gadhavi, M.K., Kukadia, D., Dar, S., Gokulakannan, N., Talukdar, G., Sivakumar, K., and Gopi, G. V., 2017. Indigenous techniques of catching mudskipper in Bhavnagar and Bharuch districts, Gujarat. *Indian Journal of Traditional Knowledge*. 16(3), pp. 533-538.

Gopalakrishnan, S., and Kalaiarasi, T., 2012. I*dentification of Chemical Compound from the Fruits of Cucumis trigonus* Roxb. *By GC-MS Analysis*. *International Journal of Phytopharmacy*. 2 (5) 122-128.

Graham, J. B., 1997. Air-breathing fishes: evolution, diversity, and adaptation. *San Diego: Academic Press*. p. 299.

Graham, J. B., and Wegner, N. C., 2010. Breathing air in water and in air: the air-breathing fishes. In: Nilsson GE, editor. Respiratory physiology of vertebrates: life with and without oxygen. *Cambridge: Cambridge University Press*. p. 174–221.

Hameed, I. H., Jebor, M. A., and Ommer, A. J., 2016. Haplotype data of mitochondrial DNA coding region encompassing nucleotide positions 11,719–12,184 and evaluate the importance of these positions for forensic genetic purposes in Iraq. *Mitochondrial DNA Part A*. 27(2), 1324-1327.

Huang, M. C., and Lee C. L., 2019. Thermostability of tropomyosins from the fast skeletal muscles of tropical fish species. *Fish Physiology and Biochemistry*. 45, 1189-1202.

Hu, W., Zhang. J., Kang, B., 2016. Structure and function of corneal surface of mudskipper fishes. *Fish Physiology and Biochemistry*. 42, 1481-1489.

Ikram, M. M., Ismail, A., Yap, C. K., and Azwady, A. A. N., 2013. Levels of heavy metals (Zn, Cu, Cd, and Pb) in mudskippers (Periophthalmodon schlosseri) and sediments collected from intertidal areas at Morib and Remis, Peninsular Malaysia. *Toxicology & Environmental Chemistry*. 92(8), 1471-1486.

Ishimatsu, A., andGraham, J. B., TT. 2011. Mudskippers: front runners in the modern invasion of land. In: Patzner R, Van Tassell JL, Kovac M, Kapoor BG, editors. The biology of gobies. *Enfield: Science Publishers*. p. 603–32.

13
Kareem, M. A., Abdulzahra, A. I., Hameed, I. H., and Jebor, M. A., 2015. A New Polymorphic Positions Discovered in Mitochondrial DNA Hypervariable Region HVIII From Central and North-Central of Iraq. *Mitochondrial DNA Part A*. 27(5), 3250-3254.

17
Komori, M. R., Ghosh, S., Takachi, S., Hu, Y., Mizoguchi, T., Koyama, Y., and Kuki, 1998. *A Null Lesion in the Rhodopin 3,4-desaturase of Rhodospirillum rubrum Unmask a Cryptic Branch of the Carotenoid Biosynthetic Pathway. Biochemistry*. 37: 8987-8994.

Kurnia, U., Agus, F., Adimihardja, A., dan Dariah, A. 2006. *Sifat Fisik Tanah dan Metode Analisisnya*. BBSDLP: Banjarmasin.

Lauriano, E. R., Faggio, C., Capillo, G., Spanò, N., Kuciel, M., Aragona, M., Pergolizzi, S., 2018. Immunohistochemical characterization of epidermal dendritic-like cells in giant mudskipper, *Periophthalmodon schlosseri*. *Fish & Shellfish Immunology*. 74, 380-385

Looi, L. J., Aris, A. Z., Haris, H., Yusoff, F. Md., and Hasim, Z., 2016. The levels of mercury, methylmercury and selenium and the selenium health benefit value in grey-eel catfish (Plotosus canius) and giant mudskipper (Periophthalmodon schlosseri) from the Strait of Malacca. *Journal of Chemospere*.152, 265-273

Maggyvin, E. dan Sinuraya, R. K. 2017. Marijuana dan Autisme: *Sebuah Literatur Review*. *Jurnal Farmaka*. 15 (1): 70-92.

Mahadevan, G., Mohan, K., Vinoth, J., and Ravi, V., 2019. Biotic potential of mucus extracts of giant mudskipper Periophthalmodon schlosseri (Pallas, 1770) from Pichavaram, southeast coast of India. *The journal of basic and applied zoology*. 80(13).

Martin, K. L., 2013. Theme and variations: amphibious air-breathing intertidal fishes

Martínez, H. L., Agorreta, A., Sánchez, M. T., and Mauro, D, S., 2018. Evidence of positive selection suggests possible role of aquaporins in the water to land transition of mudskippers. *Organisms Diversity and Evolution*. 18(4), 499-414.

Moss, S.M. 1989. *Effect of Exogenous Androgens on Growth, Biochemical Composition and Reproduction of the Coot Calm Mulinia literalis*. *Pac SCI.*

Mohammed, A., and Imad, H., 2013. Autosomal STR: From locus information to next generation sequencing technology. *Res. J. Biotechnol.* 8(10):92-105.

Murdy, E.O., 1989. A taxonomic revision and cladistic analysis of the Oxudercine gobies (Gobiidae: Oxudercinae). *Rec Aust Mus Suppl* 11: 1–93.

Panda, L., and Mabalirajan, U., 2018. Recent updates on corticosteroid resistance in asthma.

European Medical Journal. 3(3), 49-57.

Polgar, G., Ghanbarifardi, M., Milli, S., Agorreta, A., Aliabadia, M., Esmaeili, H. R., and Khang, T. F., 2017. Ecomorphological adaptation in three mudskippers (Teleostei: Gobioidei: Gobiidae) from the Persian Gulf and the Gulf of Oman. *Hydrobiologia*. 795(1), 91-111.

Prasad, K., Singh, M. B., and Ryan, H., 2016. Corticosteroids for managing tuberculous meningitis (Review). *European Medical Journal*. 3(3), 49-57.

Rajendran, P., Bharatidhasan, R., dan Sureshkumar, K. 2017. *GC-MS Analysis of Phyto-Components in Raw and Treated Sugarcane Juice. Int J,Curr.Microbiol.App.Sci.* 6 (7): 51-61.

Rozaliyani, A., Susanto, A. D., Swidarmoko, B., dan Yunus, F. 2011. Mekanisme Resistens Kartikosteroid pada Asma. *Jurnal Respir Indo*. 31 (4): 210-223.

Ridho, M. R., Patriono, E., Sholikah, M., 2019. Food habits of three species of mudskippers in the Musi River Estuary, South Sumatra, Indonesia. *Biodiversitas*. 20(8), 2368-2374.

Salempa, P. dan Muharram, H. 2016. *Senyawa Steroid dalam Tumbuhan Bayur*. Badan penerbit UNM: Makasar.

Sari, M., 2012. *Jenis Fauna Hutan Mangrove di Areal PT. Bina Ovivipari Semesta dan Sekitarnya*. Penerbit PT. Bina Ovivipari Semesta: Pontianak.

Sun, J. 2007. *D-Limonene: Safety and Clinical Aplication*. *Alternative Medicine Review*. 12 (3): 259-264.

Takeda, T., Hayashi, M., Toba, A., Soyano, K., and Ishimatsu, A., 2012. Ecology of the Australian mudskipper *Periophthalmus minutus*, an amphibious fish inhabiting a mudflat in the highest intertidal zone. *Australian Journal of Zoology*. 57: 312-320.

Wu, R. X., Hong, W. S., Zhang, Q. Y., Chen, S. X., 2009. Comparative enzyme activities of the intestinal brush border membranes of the herbivorous mudskipper Boleophthalmus pectinirostris and the carnivorous Chinese black sleeper Bostrichthys sinensis. *Journal of Applied Ichthyology*. 25, 571-575.

Yang, X., Gu, W., Liang, L., Yan, H, L., Wang, Y. F., Bi, Q., Zhang, T., Yu, J., and Rao, G. X., 2017. Screening for the bioactive constituents of traditional Chinese medicines-progress and chalenges. *Royal society of chemistry*. 7, 3089-3100.

You, X, X., Sun, M., Li, J., Bian, C., Chen, J., Yi, Y., Yu, H., and Shi, Q., 2018. Mudskippers and Their Genetic Adaptations to an Amphibious Lifestyle.

Zaini, R. G., Brandt, K., Clench, M. R., dan Maitre, C. L. L. 2012. *Effect of Bioactive Compounds from Carrots (Daucus carota L.), Polyacetylenes, Beta-carotene and Lutein on Human Lymphoid Leukimia Cells*. *Medical Chemistry Journal*. 12 (0): 2-13.

Manuscript body

Download source file (215.76 kB)

JEE Journal of Ecological Engineering
ISSN 2299-8993

JEE Journal of Ecological Engineering
ISSN 2299-8993

Figure 1

Download source file (58.39 kB)

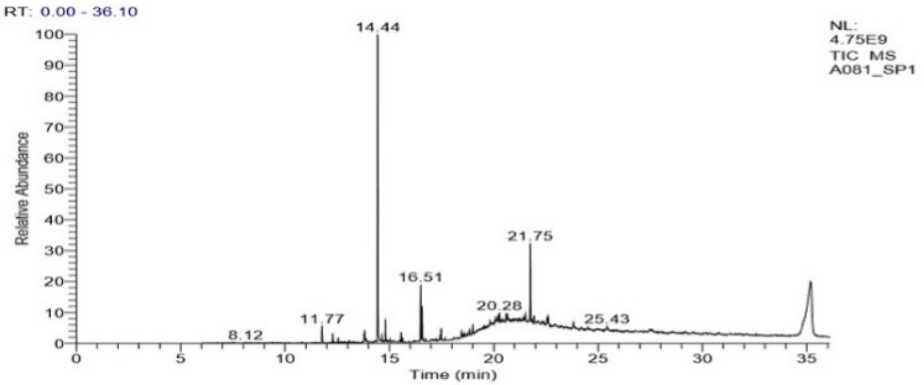


Figure 2

Download source file (64.62 kB)

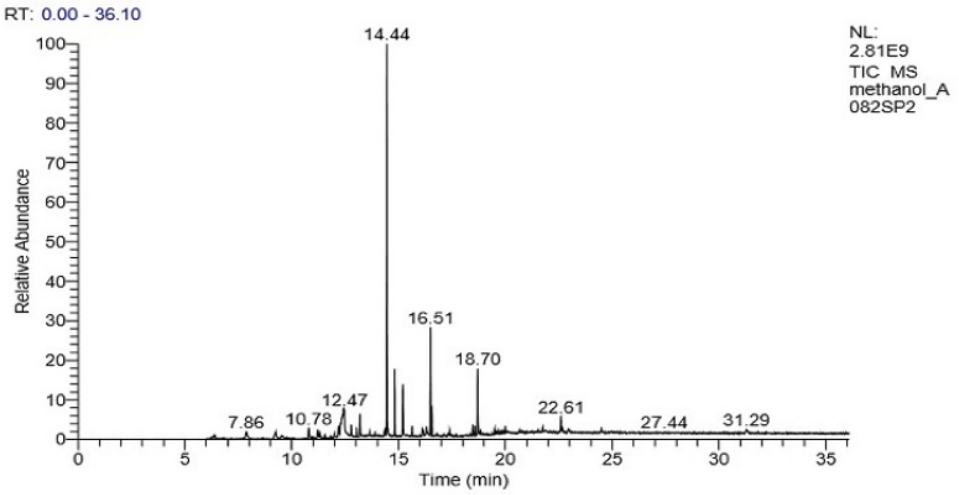
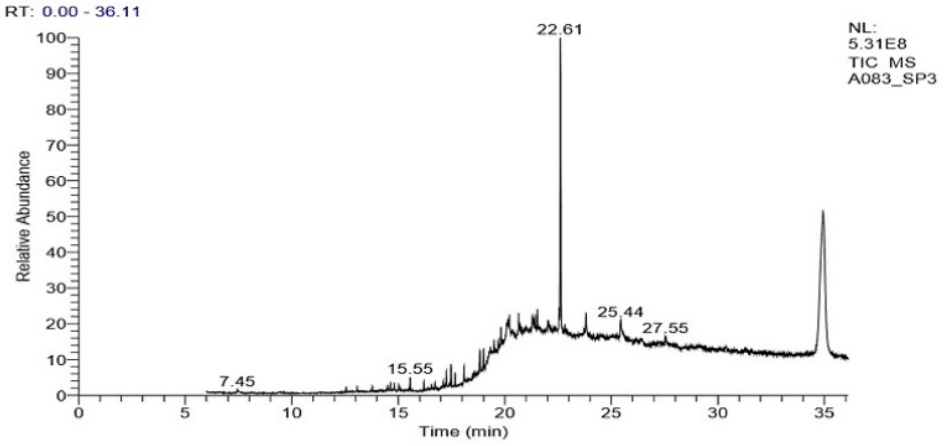


Figure 3

Download source file (59.85 kB)



JEE Journal of Ecological Engineering
ISSN 2299-8993

Figure 4

Download source file (73.59 kB)

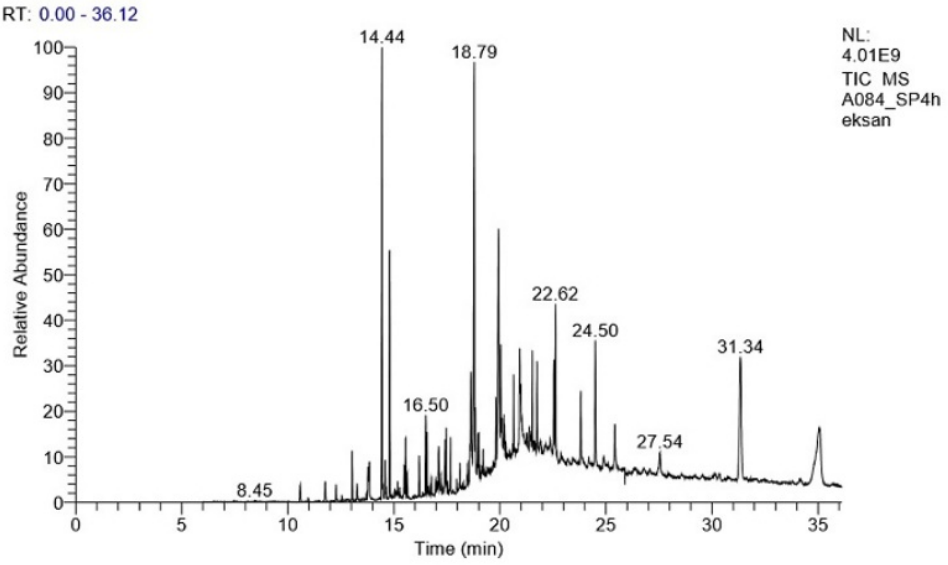


Figure 5
Download source file (1.31 MB)

No.	Compound Names	Compound Classes	Total Numbers
1.	*D-Limonene*	Terponoids	1
2.	*Limonene*	Terponoids	1
3.	*Aspidospermidin-17-ol, 1-acetyl-19,21-epoxy-15, 16-dimethoxy-*	Alkaloids (*Aspidospermidin*)	1
4.	*Choltesan-3-ol, 2-methylene-*	Steroids	6
5.	*Azulene, 1,4-dimethyl-7-(1-methylethyl)-*	Terpenoids	1
6.	*17.alfa.,21á-28, 30-Bisnorhopane*	Steroids	1
7.	*4-Androsten-6á-ol-3,17-dione*	Steroids	3
8.	*3,9-Epoxypregn-16-ene-14,20-diol, 7,11,18-triacetoxy-3-methoxy-*	Steroids	1
9.	*Cholestan-26-oic acid, 3,7,12-trihydroxy-*	Steroids	1
10.	*Rhodopin*	Carotenoids	1
11.	*Cannabinol, trifluoroacetate*	Cannabinoids	4
12.	*Cholestan-3,5-diol, 5-acetate*	Steroids	2
13.	*Milbemycin B, 5-demethoxy-5-one-6,28-anhydro-25-ethyl-4-methyl-13-chloro-oxime*	Steroids	1
14.	*9,19-Cyclolanostan-3-ol, 24,24-epoxymethano-acetate*	Terpenoids	1
15.	*8,14-Seco-3,19-epoxyandrostane-8,14-dione,17-acetoxy-3 â-methoxy-4,4-dimethyl-*	Steroids	11
16.	*Androst-7-ene-6,17-dione, 2,3,14-trihydroxy-*	Steroids	10
17.	*2-Phenanthrenecarboxylic acid, 1-(1,3-dithian-2-ylmethyl)-7-hydroxy-2,4b-dimethyl-1,2,3,4,4a,4b,5,6,7,8,10,10a-dodecahydro-,methyl ester*	Steroids	1

Figure 6

Download source file (1.68 MB)

No.	Compound Names	Compound Classes	Total Numbers
1.	*Curan-17-oic acid, 19,20-dihydroxy-, methyl ester*	Steroids	2
2.	*Cholestan-3-ol, 2-methylene-*	Steroids	12
3.	*Citronellol epoxide*	Terpenoids	1
4.	*Falcarinol*	Carotatoxin (secondary cancer anti metabolites)	1
5.	*Cholestan-3-one, cyclic 1,2-ethanediyl aetal*	Steroids	1
6.	*..psi.,.psi.-Carotene, 1,1',2,2'-tetrahydro-1,1'-dimethoxy*	Carotenoids	8
7.	*Androsten-4-en-11-ol-3,17-dione, 9-thiocyanato-*	Steroids	2
8.	*Androsten-5-en-17-one-3,11-bis[(trimethylsilyl)oxy]-, O-(phenylmethyl)oxime*	Steroids	1
9.	*Prosta-5,13-dien-1-oic acid, 9,11,15-tris[(trimethylsilyl)oxy]-, trimethylsilyl ester*	Steroids	6
10.	*Rhodoxanthin*	Carotenoids	2
11.	*Rhodopin*	Carotenoids	2
12.	*5á-Ergost-24-en-26-oic acid, 5,6á-epoxy-4å, 18,22-trihydroxy-3-methoxy-1-ox o-, ë-lactone, diacetate,*	Steroids	1
13.	*Ethyl iso-allocholate*	Steroids	1
14.	*Gamabufotalin*	Bufadienolide (stereoid aglycones in frogs)	1
15.	*Betamethasone acetate*	Corticosteroid	2
16.	*Cholestan-26-oic acid, 3,7,12-trihydroxy-*	Steroids	2
17.	*..psi.,.psi.-Carotene, 3,4-didehydro-1,2,7',8'-tetrahydro-1- methoxy-2-ox o*	Carotenoids	1
18.	*..psi.,.psi.-Carotene, 3,3',4,4'-tetrahydro-1',2'-dihydro-1-hydroxy-1'methoxy*	Carotenoids	1
19.	*Prosta-5,13-dien-1-oic acid, 9,11,15-tris[(trimethylsilyl)oxy]-, trimethylsilyl ester*	Steroids	2
20.	*17á-Acetoxy-1',1'-dicarboethoxy-1á,2á-dihydrocy cloprop[1,2]-5á-androst-1-en-3-one*	Steroids	2
21.	*Cholesterol*	Cholesterol	1
22.	*26-Nor-5-cholesten-3á-ol-25-one*	Steroids	1
23.	*17-(1,5-Dimethylhexyl)-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1Hcyclopenta[a]phenanthren-3-ol*	Steroids	1
24.	*Androst-4-en-9-thiocyanomethyl-11-ol-3,17-dione*	Steroids	1

Figure 7
Download source file (1.36 MB)

No.	Compound Names	Compound Classes	Total Numbers
1.	*Limonene*	Terpenoids	1
2.	*D-Limonene*	Terpenoids	1
3.	*Corynan-17-ol, 18,19-didehydro-10-methoxy-,acetate (ester)*	Steroids	2
4.	*Rhodopin*	Carotenoids	5
5.	*Ç-Sitosterol*	Steroids	1
6.	*Spirost-8-en-11-one, 3-hydroxy*	Steroids	13
7.	*Cholest-5-en-3-ol, 24-propylidene-*	Steroids	2
8.	*Stigmasta-5,24(28)-dien-3-ol*	Steroids	1
9.	*..psi.,.psi.-Carotene, 1,1',2,2'-tetrahydro-1,1'-dimethoxy*	Carotenoids	4
10.	*5á-Ergost-24-en-26-oic acid, 5,6á-epoxy-4á, 18,22-trihydroxy-3-methoxy-1-ox o-, ë-lactone, diacetate,*	Steroids	1
11.	*..psi.,.psi.-Carotene, 3,4-didehydro-1,2,7',8'-tetrahydro-1-methoxy-2-ox o*	Carotenoids	1
12.	*5-Chloro-6beta-nitro-5alpha-cholestan-3-one*	Steroids	1
13.	*Prosta-5,13-dien-1-oic acid, 9,11,15-tris[(trimethylsilyl)oxy]-, trimethylsilyl ester*	Steroids	1
14.	*Cholest-4-ene, 3á-(methoxymethoxy)-*	Steroids	1
15.	*Rhodoxanthin*	Carotenoids	1
16.	*4'-Apo-á,.psi.—carotenoic acid*	Carotenoids	1
17.	*Astaxanthin*	Carotenoids	1
18.	*Androst-7-ene-6,17-dione, 2,3,14-trihydroxy*	Steroids	2
19.	*Prosta-5-en-1-oic acid, 9,11,15-tris[(trimethylsilyl)oxy]-, methylsilyl ester*	Steroids	1
20.	*Falcarinol*	Carotatoxin	1

Figure 8

Download source file (1.02 MB)

No.	Compound Names	Compound Classes	Total Numbers
1.	*D-Limonene*	Terpenoids	1
2.	*Cholestan-4-ol, 2-methylene-*	Steroids	4
3.	*Cholest-5-en-3-ol (3á)-, tetradecanoate*	Steroids	1
4.	*Cholesta-3,5-diene*	Steroids	1
5.	*Cholesteryl benzoate*	Steroids	1
6.	*Rhodopin*	Carotenoids	3
7.	*Azafrin*	Carotenoids	1
8.	*17.alfa.,21á-28,30-Bisnorhopane*	Steroids	2
9.	*Cholesterol*	Steroids	2
10.	*26-Nor-5-cholesten-3á-ol-25-one*	Steroids	1
11.	*Cholestane-3,5-diol, 5-acetate*	Steroids	1
12.	*Campesterol*	Steroids	1
13.	*Ergost-5-en-3--ol*	Steroids	1
14.	*Astaxanthin*	Carotenoids	2
15.	*Androst-7-ene-6,17-dione, 2,3,14-trihydroxy-*	Steroids	6

JEE Journal of Ecological Engineering
ISSN 2299-8993

Manuscript body

Download source file (215.76 kB)

Figures

Figure 1 - Download source file (58.39 kB)

Figure 2 - Download source file (64.62 kB)

Figure 3 - Download source file (59.85 kB)

Figure 4 - Download source file (73.59 kB)

Figure 5 - Download source file (1.31 MB)

Figure 6 - Download source file (1.68 MB)

Figure 7 - Download source file (1.36 MB)

Figure 8 - Download source file (1.02 MB)

Bioactive compounds evaluation of the mudskippers (Periophthalmus chrysospilos, Boleopthalmus boddarti, Boleopthalmus dussumieri and Periophthalmodon schlosseri) in the estuarine area of Musi River, S

ORIGINALITY REPORT

14%	11%	10%	13%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universiti Teknologi MARA Student Paper	2%
2	ijrcs.org Internet Source	2%
3	c.ymcdn.com Internet Source	1%
4	Submitted to Higher Education Commission Pakistan Student Paper	1%
5	Submitted to University of Babylon Student Paper	1%
6	J. T. Watson, Klaus. Biemann. "Direct Recording of High Resolution Mass Spectra of Gas Chromatographic Effluents.", Analytical Chemistry, 1965 Publication	1%

7	ir.canterbury.ac.nz Internet Source	1%
8	www.21chemnet.com Internet Source	1%
9	link.springer.com Internet Source	1%
10	Submitted to BENEMERITA UNIVERSIDAD AUTONOMA DE PUEBLA BIBLIOTECA Student Paper	1%
11	uthealth.influuent.utsystem.edu Internet Source	1%
12	www.myjurnal.my Internet Source	1%
13	Submitted to Chester College of Higher Education Student Paper	1%
14	journals.plos.org Internet Source	1%
15	www.phylo.org Internet Source	1%
16	Submitted to CSU, San Marcos Student Paper	1%
17	thesis.library.caltech.edu Internet Source	1%

18	www.frontiersin.org Internet Source	1%

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	Off		