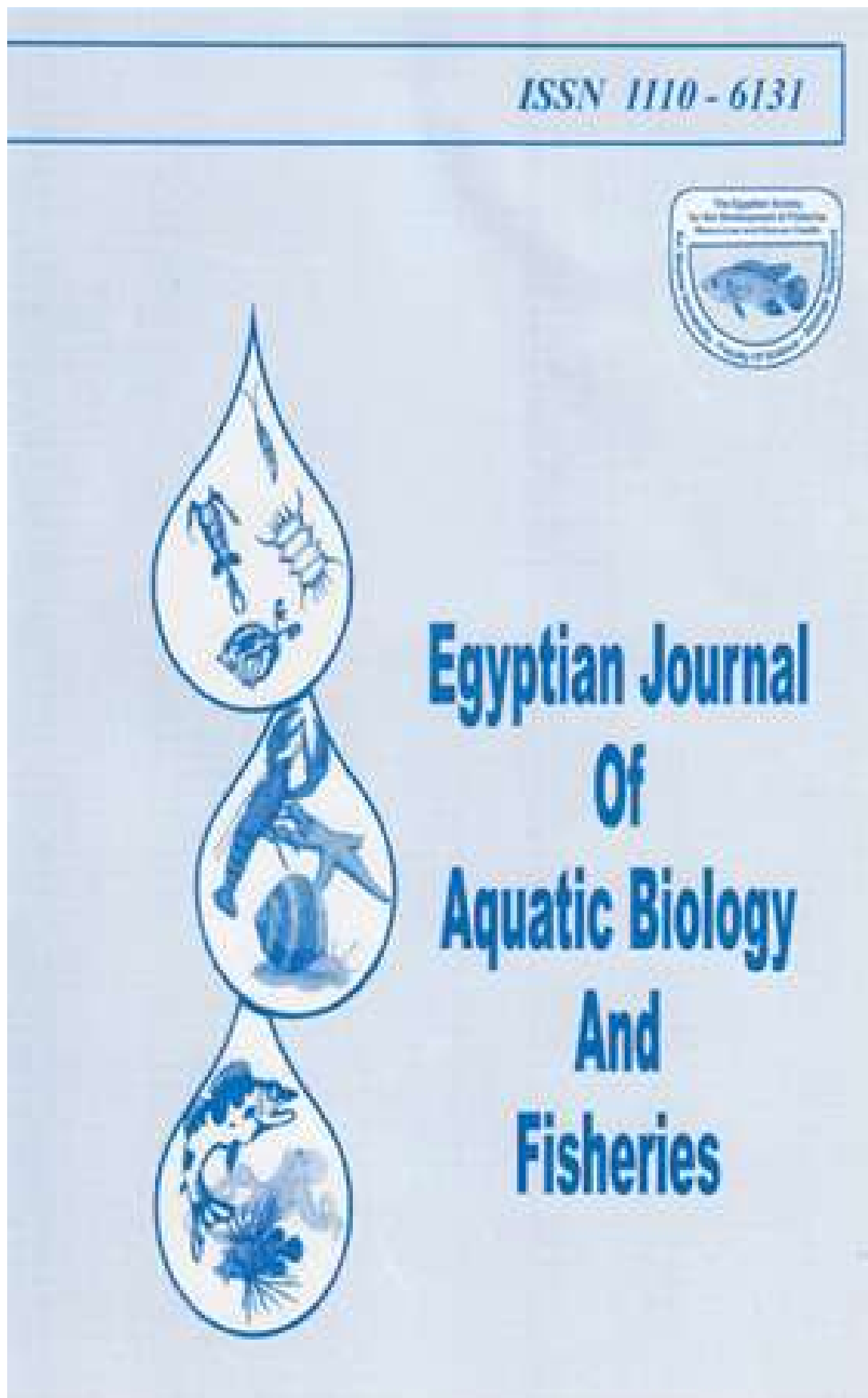




Articles in Press

Current Issue

## Journal Archive

## — Volume 29 (2025)

 Issue 6 Issue 5 Issue 4 Issue 3 Issue 2 Issue 1

## + Volume 28 (2024)

## + Volume 27 (2023)

## + Volume 26 (2022)

## + Volume 25 (2021)

## + Volume 24 (2020)

## + Volume 23 (2019)

## + Volume 22 (2018)

## + Volume 21 (2017)

## + Volume 20 (2016)

## + Volume 19 (2015)

## + Volume 18 (2014)

## + Volume 17 (2013)

## + Volume 16 (2012)

## + Volume 15 (2011)

## + Volume 14 (2010)

## + Volume 13 (2009)

## + Volume 12 (2008)

## + Volume 11 (2007)

## + Volume 10 (2006)

## + Volume 9 (2005)

## + Volume 8 (2004)

## + Volume 7 (2003)

## + Volume 6 (2002)

## + Volume 5 (2001)

## + Volume 4 (2000)

## + Volume 3 (1999)

## + Volume 2 (1998)

## + Volume 1 (1997)

| Facts & Figures          |           |
|--------------------------|-----------|
| Number of Volumes        | 29        |
| Number of Issues         | 108       |
| Number of Articles       | 4,133     |
| Article View             | 1,925,996 |
| PDF Download             | 2,740,615 |
| View Per Article         | 466       |
| PDF Download Per Article | 663.11    |

Egyptian Journal of Aquatic Biology and Fisheries (EJABF) is an International Journal, that covers the full range of Fisheries, Aquatic Management, Wetlands, Lakes, Aquaculture, and other related fields. This is ensured by subjecting each paper to a strict assessment procedure by the International editorial board. This journal publishes original articles reporting fields and advances in theory, methodology, applications, general surveys, reviews, etc.

In order to maintain the highest level of transparency and high standard of review, this journal follows the highly respected and toughest Advanced OPEN peer-review system; especially that of the Committee on Publication Ethics (COPE) Guidelines for Journal Editors (March 2011) and for Peer Reviewers (March 2013). The copyright of the articles will transfer to Journal.

- **Format:** Print & Online
- **ISSN:** 1110-6131 (Print) & 2536-9814 (Online)
- **Available from:** SCOPUS, DOAJ, EIJL, EBSCO, IUCAT, Index Copernicus International.
- **Frequency:** Bimonthly.
- **Publication Dates:** January, March, May, July, September & November.
- **Open Access:** Yes
- **Advance Access:** Yes
- **Article Charges:** 1800 Egyptian Pound For Egyptian Authors & \$160 for non-Egyptian Authors.
- **Language:** English
- **Scope:** Please check
- **Types of Journal:** Biology, Fisheries, aquaculture, aquatic pollution, aquatic management
- **Indexed & Abstracted:** DOAJ, EIJL, EBSCO, IUCAT, Index Copernicus International
- **Policy:** Peer-reviewed
- **Contact e-mails:** mtkhalil52@hotmail.com

 **Current Issue: Volume 29, Issue 6, November and December 2025** 

### Assessment of Noncommercial Catch Caught by the Beach Seine Operating in the Southern Mediterranean Sea off Port Said, Egypt

Pages 1-16

Mohamed El-sayed Ahmed Kassem; Mohamed I. Hassan; Fedekar Fadel Madkour; Manal Moustafa Sabrah

View Article  PDF 653.49 K  View on SCiNiTO

### Green Remediation Strategy Using *Azolla pinnata*: Heavy Metals Removal and Waste Water Ultra-Purification

Pages 17-38

Noha Abdelwahab; Amira Faysal; Marzouka Shaban; Asmaa A. Amin; Seham Moussa Hamed

View Article  PDF 606.61 K  View on SCiNiTO

### **An Overview of the Commercial Catch from Beach Seine Fishing Method in the Southern Mediterranean Sea off Port Said, Egypt**

Pages 39-56

Manal Moustafa Sabrah; Mohamed Hassan; Fedekar Fadel Madkour; Mohamed El-sayed Ahmed Kassem

View Article  PDF 1.09 M  View on SCiNiTO

### **Reef Fishes Community in the Candidate Sites for Lobster Restocking in Pangandaran and Trenggalek Waters, Indonesia**

Pages 57-73

Gussasta Arnenda; Mujiyanto Mujiyanto; Riswanto Riswanto; Danu Wijaya; Yayuk Sugianti; Amran Rony Syam

View Article  PDF 678.19 K  View on SCiNiTO

### **Dietary Supplementation of Peanut Worm (*Siphonosoma australe-australe*) Meal Enhances Digestive Enzyme Activities, Feed Efficiency, and Growth Performance of the Nile tilapia (*Oreochromis niloticus*)**

Pages 75-94

Agus Kurnia; Bahtiar Bahtiar; Wellem Henrik Muskita; Muhaimin Hamzah; La Ode Baytul Abidin; Yusnaini Yusnaini; Muhammad Idris; Rahmad Sofyan Patadjai; La Ode M Aslan; Ruslaini Ruslaini; Irwan Junaidi Effendy; La Ode Aslin; Abdul Muis Balubi; Indriyani Nur; Wa Iba; Abdul Rahman; Affandi Rahman; Rizky Halalan Thoyba; La Ode Tony Kurniawan; Indra Suharman; Noratat Prachom

View Article  PDF 337.79 K  View on SCiNiTO

### **Climate Vulnerability and Water Extent Assessment in Four Salt Lakes in Northwestern Algeria: Suitability for Brine Shrimp *Artemia* Production**

Pages 95-116

RABHI Mohammed; Ghomari Sidi Mohammed; Bougherira Abdeldjalil

View Article  PDF 1.27 M  View on SCiNiTO

### **Application of a Modified Booster System in the Polyculture of the Swamp Eel (*Monopterus albus*) and the Nile Tilapia (*Oreochromis niloticus*) in Brackish Water**

Pages 117-133

Niken Ayu Pamukas; Mulyadi Mulyadi; Iskandar Putra; Dwi Septiani Putri; Rahma Aprianti; Randy Wiradharma

View Article  PDF 604.69 K  View on SCiNiTO

### **Study on the Growth Performance of Indigenous Shrimp from the Batetangnga River, Polewali Mandar, West Sulawesi, Indonesia**

Pages 135-142

Firmansyah Bin Abd Jabbar; Dewi Yuniati; ADIARA FIRDHITA ALAM NASYRAH; Andi Arham Atjo

View Article  PDF 165.59 K  View on SCiNiTO

### **The Potential of Aquatic Eco-Tourism and Agroforestry in the Sustainable Management of the Duma Galela Volcanic Lake Area, North Halmahera**

Pages 143-158

Hamidin Rasulu; Abdul Kadir Kamaluddin; Andy Kurniawan; Juharni - Juharni; Mila Fatmawati; Nurjanna Albaar

View Article  PDF 684.31 K  View on SCiNiTO

**Exploring the Potential of *Garcinia cowa* as a Phytogenic Feed Additive for Fish**

Pages 159-174

Muhamad Dwi Cahya; Yuli Andriani; R Adharyan Islamy; Andi Masriah

View Article  PDF 280.78 K  View on SCiNiTO**Comparative Assessment of Fish Biodiversity in the Coastal Waters of Eretan, Indramayu Using eDNA and Traditional Methods**

Pages 175-190

Jauhar Zainalarifin; Hefni Effendi; Ali Mashar; Mita Aprilia; Rafi Subrata; Khoirul Nur Hidayat; Adelia Rosita; Amelia Amelia; Karin Syahfitri; Brilliant Jelang Ramadhan; Daffa Setoary Hernantoro

View Article  PDF 471.27 K  View on SCiNiTO**Black Soldier Fly Larval Meal as a Cost-Effective Protein Source for Enhancing *Tilapia* (*Oreochromis niloticus*) Growth**

Pages 191-206

TF Safrana; MNM Fouzi; Muneeb M Musthafa; Faiz Marikar

View Article  PDF 308.89 K  View on SCiNiTO**Seasonal Variation of Aquatic Insect Biotic Indices and Their Relationship with Water Quality in the Tropical Mong Sen Stream, Lao Cai Province, Vietnam**

Pages 207-224

Hieu Van Nguyen; Hien Thi Thu Nguyen

View Article  PDF 474.67 K  View on SCiNiTO**Fraudulent Practices in the Fisheries and Aquaculture Sector: A Review of Detection Methods and Policy Approaches**

Pages 225-244

Purwanto Purwanto; Gazali Gazali; Rika Syahadatina

View Article  PDF 273.86 K  View on SCiNiTO**Morphological and Molecular-Genetic Characterization of the Nematode *Oswaldocruzia filiformis* Goeze, 1782 (Nematoda: Molineoidea) in the Amphibians of Southern and Central Uzbekistan**

Pages 245-252

Aliyev et al.

View Article  PDF 300.1 K  View on SCiNiTO**Comparative Impacts of Plant-Derived Functional Diets (Azolla, Duckweed, and Napier Grass) on Growth, Hematology, and Serum Biochemistry of Grass Carp (*Ctenopharyngodon idella*)**

Pages 253-268

Muhammad Shafiq; Basim S. A. Al Sulivany ; Nuha Hameed Albassam; Nidhal Tahseen Taha Al-Tae; Tahseen Taha Al-Tae; Ayesha Shahid; ALI HASSAN; Muhammad Owais; Syed Sibte Hassan

View Article  PDF 291.64 K  View on SCiNiTO**Effect of Treatment with Ultrasonic Pulses on the Functional Properties and Antioxidant Capacity of Dogfish (*Galeorhinus galeus*) Viscera Proteins**

Pages 269-286

Joe Luis Arias Moscoso; Francisco Cadena; Ofelda Peñuelas-Rubio; Leandris Argente-Martinez; UĞUR AZİZOĞLU; Aldo Fraijo-Valenzuela; Ivan de Jesus Tolano-Villaverde; María del Socorro Núñez-Ruiz

[View Article](#)  PDF 475.39 K  [View on SCiNiTO](#)

### **Effects of Weight on Ovarian Maturity and Reproductive Characteristics in Female *Clarias jaensis* (Boulenger 1909)**

Pages 287-304

Chongsi Margaret Mary Momo; Etsabou Tabougue Elise Duchelle; Justin NTSOLI; Meutchieye Felix

[View Article](#)  PDF 909.07 K  [View on SCiNiTO](#)

### **Temporal Pattern in Scads (*Decapterus* spp.) Catches from Java Sea at Bajomulyo Coastal Fishing Port**

Pages 305-315

Siti Oftafia Wijayanti; Hendrik Anggi Setyawan; Bogi Budi Jayanto

[View Article](#)  PDF 310.37 K  [View on SCiNiTO](#)

### **Fortification of Black Soldier Fly Oil and Squid Oil in Diets on the Nutritional Quality, Growth, and Survival of Juvenile Giant Gourami (*Osphronemus gouramy*)**

Pages 317-330

Febry Ferdianto Purba; Netti Aryani; Niken Ayu Pamukas; Indra Suharman; Henni Syawal

[View Article](#)  PDF 319.98 K  [View on SCiNiTO](#)

### **Sustainable New Algicidal Effectiveness of Cycloheximide Against *Phaeocystis globosa***

Pages 331-344

Roqayah Al-Habeeb; Helal Ragab Moussa

[View Article](#)  PDF 487.46 K  [View on SCiNiTO](#)

### **Indian Aquatic Plants: Untapped Resources for Novel Therapeutic Agents**

Pages 345-358

Dubey et al.

[View Article](#)  PDF 691.8 K  [View on SCiNiTO](#)

### **Assessment of Water Quality and Nutrient Dynamics in the Mediterranean Lagoon of El Mellah**

Pages 359-370

Tanca Adem; Amira Aicha Beya; Zaidi Raouf; Bougdah Mounira; Labar Sofiane

[View Article](#)  PDF 426.78 K  [View on SCiNiTO](#)

### **Fisheries and Biological Indicators of Hungarian Carp Fish**

Pages 371-382

Temirova et al.

[View Article](#)  PDF 317.84 K  [View on SCiNiTO](#)

### **Enhancing Growth Performance and Omega-3 Fatty Acid Composition of the Nile Tilapia through Dietary Supplementation of *Andrographis paniculata* Leaves Extract**

Pages 383-394

Juliana et al.

[View Article](#)  PDF 234.41 K  [View on SCiNiTO](#)

**Efficiency of Utilizing the Nile Tilapia and Catfish Aquaculture Wastewater in Enhancing Growth Performance of the Freshwater Prawns (*Macrobrachium lanchesteri*)**

Pages 395-410

Hadiana et al.

[View Article](#)  PDF 528.09 K  [View on SCiNiTO](#)

**Economic Policy and Institutional Arrangements in Local Fisheries: Insights from a Systematic Review**

Pages 411-427

Nurul Alfian; Purwanto Purwanto; Gazali Gazali; Rohmaniyah Rohmaniyah

[View Article](#)  PDF 474.08 K  [View on SCiNiTO](#)

**Physicochemical and Sensory Evaluation of Novel Composite Flour System in *Saurida tumbil* Fishballs: Arrowroot (*Maranta arundinacea*) and Seaweed (*Eucheuma cottonii*) as Sustainable Tapiocal Alternative**

Pages 429-447

Sukoso et al.

[View Article](#)  PDF 335.34 K  [View on SCiNiTO](#)

**Bioaccumulation of Lead (Pb) and Microplastic Contamination in the Estuary of Kombal Bay, North Lombok, Indonesia Using *Padina* sp. as a Bioindicator**

Pages 449-461

Daniar Kusumawati; Reagan Saptory; Moh. Awaludin Adam; Apri Supii; Salnida Yuniarti Lumbessy; Hasriani Ayu Lestari; Raditya Andrean Saputra; Sabilah Fi Ramadhani; Asmanik Asmanik; Lia Hadiawati; Joko Sumarwan

[View Article](#)  PDF 512 K  [View on SCiNiTO](#)

**Morphometric and Reproductive Parameters of the Prussian Carp (*Carassius gibelio*) of Lake Ullishurkul, Uzbekistan**

Pages 463-472

Narboev et al.

[View Article](#)  PDF 598.38 K  [View on SCiNiTO](#)

**Biologically Active Substances and Sorption Capacity of the Diatom *Climaconeis scalaris* (Brebisson) E.J. Cox**

Pages 473-487

Sokolovskaya et al.

[View Article](#)  PDF 433.42 K  [View on SCiNiTO](#)

**Ecological Assessment of Mangrove Community Structure and Habitat Quality in Perupuk Village, North Sumatra, Indonesia**

Pages 503-524

Kishdali Lougarfius Immanuel; Pujiono Wahyu Purnomo; Trisnani Dwi Hapsari

[View Article](#)  PDF 1.18 M  [View on SCiNiTO](#)

**Designing Waqf-Based Fisheries Financing: A Hybrid Model Approach**

Pages 525-540

Trisno Wardy Putra; Abdul Wahid Mongkito; Rahman Rahman; Mukhtar Luthfi; Rahmawati Muin; Rahman Ambo Masse; Muslimin Kara; Amiruddin K; Nasrullah bin Sapa; Andi Syathir Sofyan; La Ode Ali Musa; Moh Nur Qomar

View Article  PDF 384.32 K  View on SCiNiTO

**Age Structure and Growth Modeling of Sander lucioperca (Linnaeus, 1758) from Lake Oubeira (Northeast Algeria)**

Pages 541-556

GUEZI Rabie; Nabila BENSALIA; Khadidja wissal Abdallah; Mounira universitaire Rachedi; Raouf Zaidi; Naouel Ouaili; Fadila universitaire Zeghdoudi; Zehaira Boudjadi; Nadia Bezzazel

View Article  PDF 782.44 K  View on SCiNiTO

**Biological Aspects of the Thicklip Grey Mullet (Chelon labrosus) in Bardawil Lagoon, Egypt**

Pages 557-575

Kariman Ahmed Shawky Shalloof; Attia El- Aiatt; Shima Ali; Mohamed attia Ali Omar

View Article  PDF 776.83 K  View on SCiNiTO

**Effectiveness of Depuration Method on the Elimination of Cadmium (Cd) and Lead (Pb) Heavy Metal Content in Rice Paddy Eel (Monopterus albus, Zuiew 1793)**

Pages 577-588

Candra et al.

View Article  PDF 504.96 K  View on SCiNiTO

**Growth Performance and Feed Conversion Efficiency of the Nile Tilapia (Oreochromis niloticus) in a Greenhouse Aquaponic System coupled with Lettuce (Lactuca sativa) Under Moroccan Conditions**

Pages 589-600

Haytam RHARRHOUR; Hassane Jaziri; Ahmed Yahyaoui; Fatima WARIAGHLI

View Article  PDF 616.08 K  View on SCiNiTO

**Microbiological Quality and Shelf Life of Collagen-Coated Sillago sihama During Frozen Storage**

Pages 601-613

Elham Salim Abdullah; Salah Najim

View Article  PDF 467.17 K  View on SCiNiTO

**Growth Dynamics of Lettuce (Lactuca sativa) Coupled with the Nile tilapia (Oreochromis niloticus) in a Greenhouse Aquaponic System in Morocco**

Pages 615-625

Haytam RHARRHOUR; Hassane Jaziri; Ahmed Yahyaoui; Fatima WARIAGHLI

View Article  PDF 614.83 K  View on SCiNiTO

**Phenotypic Characterization of Intestinal Bacteria Isolated from Coconut Crabs (Birgus latro) on Liwo Island North Maluku**

Pages 627-639

Murhum et al.

View Article  PDF 956.52 K  View on SCiNiTO

**Gastropod Diversity on a Tropical Ecotourism Coastline: A Case from Pantai Tengkuhyung West Kalimantan**

Pages 641-655

Yusuf Arief Nurrahman; Madi Juna Permalem Ginting; Ikha Safitri

View Article  PDF 367.26 K  View on SCiNiTO**Population Genetics Analysis of *M. gulio* in Three Rivers in Pasuruan, East Java Using COI**

Pages 657-671

Endang Yuli Herawati; Akhsan Fikrillah Paricahya; Ekwan Nofa Wiratno; Pratama Diffi Samuel; Chandika Lestariaji; Rahmi Valina; Alfi Nur Rusyidi; Ruly Isfatul Khasanah

View Article  PDF 713.74 K  View on SCiNiTO**Contamination of Microplastics in Surface Waters of Kapuas Kecil Estuary West Kalimantan**

Pages 673-686

Farrel Pahlevi; Mega Sari Juane Sofiana; Ikha Safitri; Apriansyah Apriansyah; Syarif Irwan Nurdiansyah

View Article  PDF 553.76 K  View on SCiNiTO**Capture Fisheries Business Analysis of Boat Seine "Payang" Fishing Fleet at Palabuhanratu Nusantara Fishing Port, Indonesia**

Pages 687-698

Faqih Baihaqi; Shafira Bilqis Annida

View Article  PDF 527.59 K  View on SCiNiTO**Bioactivity of Ultrasound-Assisted Ethanolic Extract of *Ulva lactuca*: Antioxidant, Anti-Inflammatory, and Antibacterial Evaluation**

Pages 699-716

Ririn Suharsanti; Christina Astutiningsih; Victoria Kristina Ananingsih; Florentinus Dika Octa Riswanto; Lia Kusmita

View Article  PDF 453.57 K  View on SCiNiTO**Environmental Impact Assessment of Brine Discharge from Desalination Facilities via Bioindicators**

Pages 717-732

Nassar et al.

View Article  PDF 714.76 K  View on SCiNiTO**Assessment of Growth Performance in *Channa punctata* (Bloch, 1793) Fed Diets Supplemented with Differential Concentrations of Lycopene**

Pages 733-743

Somnath Kundu; Tapan Sarkar

View Article  PDF 440.22 K  View on SCiNiTO**Seasonal Variations of Heavy Metal Distribution and Bioaccumulation Patterns with Health Risk Assessment in Commercial Freshwater Fish from Karanja Reservoir, India**

Pages 745-771

Sabha Sayeed Shaikh; Gautam V. Zodape

View Article  PDF 816.4 K  View on SCiNiTO

**Adsorption of Some Heavy Metals and Dyes in Aquatic Environment by Using Sludge Biochars Obtained at Different Pyrolysis Temperatures**

Pages 773-787

Abid et al.

View Article  PDF 398.46 K  View on SCiNiTO**Evaluation of a Black Soldier Fly (*Hermetia illucens*) Larvae-Based Diet on the Growth Performance of the Nile Tilapia (*Oreochromis niloticus* L., Brazilian Strain) During Grow-Out Period in Côte d'Ivoire**

Pages 789-806

Yacouba BAMBA; Youssouf DIABAGATE; Aboubacar Torna SORO; Dofara SORO; Allassane OUATTARA

View Article  PDF 536.11 K  View on SCiNiTO**Assessment of Chemical Pollution in Water and Suspended Matter in the Gulf of Skikda (Northeastern Algeria)**

Pages 807-834

Naouel Ouaili; Fadila universitaire zeghdoudi; Nabila Bensafia; Mounira Rachedi; Mounia Aouissi; Bourhane Eddine Belabed

View Article  PDF 758.36 K  View on SCiNiTO**Publication Information**** Publisher**

The Egyptian Society for the Development of Fisheries and Human Health (ESDFHH)

** Editor-in-Chief**

Prof. Abdalla M. Ibrahim

** Co-Editor-in-Chief**

Prof. Magdy T. Khalil

** Associate Editor**Prof. Waheed M. Emam  
Prof. Abd El-Halim A. Saad  
Prof. Nassr Allah Abdel-Hameid,  
Prof. Sahar Fahmy Mehanna  
Prof. Alahmady Shafiq Alzahaby  
Prof. Ahmad Mosaad Azab  
Prof. Gamal Shebl Ramadan** Advisory Board**Prof. Roger Flower  
Prof. Safwat H. Shakir  
Prof. Richard Heckmann  
Prof. Irvin W. Osborne-Lee  
Prof. Raouf Kilada** Language Editor**

Mrs. Mona S. Higazy

** Administrative Director**

Mohamed M. Elnaggar

** Frequency**

Bimonthly

** Print ISSN**

1110-6131

 **Online ISSN**

2536-9814

Search



Advanced Search

Indexing and Abstracting



DOAJ



SJR

EJL



...

---



## Bioactivity of Ultrasound-Assisted Ethanolic Extract of *Ulva lactuca*: Antioxidant, Anti-Inflammatory, and Antibacterial Evaluation

Ririn Suharsanti<sup>1</sup>, Christina Astutiningsih<sup>1</sup>, Victoria Kristina Ananingsih<sup>2</sup>, Florentinus Dika Octa Riswanto<sup>3</sup>, Lia Kusmita<sup>1\*</sup>

<sup>1</sup>STIFAR Yayasan Pharmasi, Letjend Sarwo Edie Wibowo KM 1, Semarang, 50193, Indonesia

<sup>2</sup>Soegijapranata Catholic University (SCU), Rm. Hadisoebeno Sosro Wardoyo, Mijen, Semarang, 50218, Indonesia

<sup>3</sup>Sanata Dharma University, Jl Paingan, Maguwoharjo, Depok, Sleman, Yogyakarta, 55281, Indonesia

\*Corresponding Author: [lia\\_kusmita@yahoo.com](mailto:lia_kusmita@yahoo.com)

### ARTICLE INFO

#### Article History:

Received: Aug. 30, 2025

Accepted: Nov. 1<sup>st</sup>, 2025

Online: Nov. 17, 2025

#### Keywords:

*Ulva lactuca*,  
Antioxidant,  
Anti-inflammatory,  
Antibacterial,  
UAE

### ABSTRACT

Green seaweed contains many bioactive compounds, including phenols, saponins, flavonoids, and terpenoids. These compounds are considered to produce strong antioxidant activity, and it is hoped that they can provide health benefits and play a role in disease prevention. The aim of this study is to evaluate the antioxidant, anti-inflammatory, and antibacterial activities of *Ulva lactuca* ethanolic extract obtained using ultrasound-assisted extraction (UAE). *Ulva lactuca* powder was extracted using UAE with 96% ethanol at a 1:5 ratio in a closed container. The extract was then subjected to phytochemical screening for phenolic, flavonoid, alkaloid, saponin, tannin, and terpenoid compounds. Antioxidant activity was assessed using the DPPH, FRAP, and ABTS methods, with ascorbic acid as the standard. Anti-inflammatory activity was evaluated using the BSA method, with diclofenac sodium as the standard. Antibacterial activity was tested using the agar diffusion method against *E. coli* and *S. aureus*. The yield from ethanol extraction using the UAE method was 16.56%. Phytochemical screening showed that the extract contained phenols, flavonoids, alkaloids, saponins, and terpenoids, while tannins were absent. The IC<sub>50</sub> values for antioxidant activity using DPPH, FRAP, and ABTS methods were  $52.65 \pm 0.46$ ,  $47.48 \pm 0.52$ , and  $41.17 \pm 1.09 \mu\text{g/mL}$ , respectively. All extract results were significantly different compared to ascorbic acid as the standard. The anti-inflammatory activity of the extract (IC<sub>50</sub> =  $23.15 \pm 1.61 \mu\text{g/mL}$ ) was not significantly different from diclofenac sodium. Higher antibacterial activity against *S. aureus* indicates that the antibacterial compounds in *Ulva lactuca* are more effective against Gram-positive bacteria. The antibacterial activity against both *S. aureus* and *E. coli* was significantly different from K<sup>+</sup> (amoxicillin), except for the 20% concentration extract, which did not significantly inhibit *E. coli*. In conclusion, extraction of *Ulva lactuca* using UAE can enhance its antioxidant, anti-inflammatory, and antibacterial activities.

## INTRODUCTION

Advances in pharmaceutical science and food technology have driven innovation in functional products based on natural ingredients. Natural products are designed not only as food and beverages but also as delivery vehicles for bioactive compounds with high biological activity, such as antioxidants, anti-inflammatory agents, and antibacterial agents. These three activities are interconnected in maintaining the body's physiological balance. Antioxidants play a role in preventing oxidative stress that can trigger inflammatory responses, while anti-inflammatory activity inhibits the release of inflammatory mediators and suppresses tissue damage caused by excess oxidants (**López-Valverde *et al.*, 2023**). On the other hand, antibacterial activity serves to prevent microbial infections, which often trigger secondary inflammation. Therefore, the development of herbal remedies containing bioactive compounds with these three activities is expected to provide comprehensive protective effects against oxidative stress, inflammation, and microbial infections simultaneously, while increasing the bioavailability and stability of the active compounds in the body (**Liang *et al.*, 2025**).

Most compounds that contain antioxidants are found in plants, one of the plants that contains potential antioxidant activity is green seaweed (**Rompas & Gasah, 2022**). GC-MS analysis of *Ulva lactuca* revealed the fatty acid composition of the samples, showing that palmitic acid, eicosenoic acid, and linoleic acid were the most abundant fatty acids. LC-MS analysis indicated that naringin, rutin, sinapic acid, quercetin, salicylic acid, apigenin, cinnamic acid, flavone, and flavanone were the predominant phenolic compounds. The aqueous extract obtained by maceration showed a total phenolic content of  $379.67 \pm 0.09$  mg GAE/g and a total flavonoid content of  $212.11 \pm 0.11$  mg QE/g (**Ouahabi *et al.*, 2024**). *Ulva lactuca* collected from Kukup Beach, Gunung Kidul regency, Central Java had 5.17% of fat, 17.43% of protein, 62.93% of carbohydrate, 11.53% of water content, and 2.94% of ash content. Antioxidant test using DPPH found that inhibition concentration (IC<sub>50</sub>) of *Ulva lactuca* was 88890.55 ppm (weak category). *Ulva lactuca* contains chlorophyll a, b, and c, neoxanthin, anteraxanthin, dinoxanthin, flavoxanthin, micronone, and vaucheriaxanthin (**Franziska da Costa *et al.*, 2018**). Ethanol extract *Ulva lactuca* obtained by maceration has antioxidant activity with a percentage value of 51.63% at a concentration of 100 mg/L with DPPH method (**Aprilia *et al.*, 2019**). Recent antioxidant research shows that methanolic extract *Ulva lactuca* obtained by maceration also exhibited an impressive ability to scavenge DPPH radicals, as indicated by its IC<sub>50</sub> value of  $0.095 \pm 0.12$  mg/ mL, while the methanolic extract obtained using the soxhlet method demonstrated antioxidant properties by preventing  $\beta$ -carotene discoloration, with an IC<sub>50</sub> of  $0.087 \pm 0.14$  mg/ mL (**Ouahabi *et al.*, 2024**). Hydrocolloid sulfate from *Ulva lactuca*, better known as ulvan, has also been identified as a weak antioxidant with an IC<sub>50</sub> value of 469 ppm (**Jacoeb *et al.*, 2024**). Chlorophyll extraction on *Ulva* sp. was performed using the ultrasound assisted extraction (UAE)

method with acetone solvent and obtained antioxidant inhibition of 45.32% with the DPPH method (Humaidi *et al.*, 2024). The role of ultrasound assisted extraction (UAE) is also proven in optimizing the function of ulvan hydrocolloids for food applications (Istiqlaal *et al.*, 2025).

*Ulva lactuca* has also been reported to have antibacterial activity. Ethanolic 96% extract of *Ulva lactuca* obtained by maceration was able to inhibit the growth of *Staphylococcus aureus* bacteria with strong categories at concentrations of 20, 40, and 60% (Emelda *et al.*, 2021). Furthermore, this extract has antibacterial activity against three different bacteria (*Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*) with an MIC at 12.5% (Panjaitan *et al.*, 2022). Methanol and ethyl acetate extracts also have potential as antibacterial agents for *Pseudomonas aeruginosa* and *Staphylococcus aureus* (Lembang, 2023). Various active compounds in the *Ulva lactuca* extract are thought to have multiple antibacterial and anti-inflammatory properties that can overcome the MRSA antimicrobial resistance and accelerate tissue growth in the wound healing process (Ardita *et al.*, 2021). Methanolic extract also has the power to aid antibiotics in reducing the growth of pathogenic *Klebsiella pneumoniae* (EL-Sayed *et al.*, 2023). However, *Ulva lactuca* ethanolic extract did not show the ability to inhibit *Streptococcus agalactiae* bacteria (Mubayyinah *et al.*, 2024).

*In silico* prediction of ulvan using the protein structure database cyclooxygenase-2 enzyme (4COX) showed a best binding affinity energy of gluconic acid ulvan -7.62 kcal/mol similar to the control drug diclofenac sodium (-7.81 kcal/mol), followed by iduronic acid ulvan -7.57 kcal/mol, fucoidan (-6.11 kcal/mol), alpha carrageenan (-6.93 kcal/mol), and lambda carrageenan (-5.38 kcal/mol) (Utami *et al.*, 2023). The anti-inflammatory activity of each extract/fraction was assessed by the human red blood corpuscles (HRBCs) membrane stabilizing method on methanol extract, light petroleum fraction, dichlormethane, ethyl acetate, butanol, and water, showing hemolysis-prevention (%). The highest hemolysis-prevention was found in the light petroleum fraction (29%) and the lowest was found in the ethyl acetate fraction (12%) (Zaatout *et al.*, 2019). *Ulva lactuca* as a food source and medicinal ingredient has never been subjected to ultrasound assisted extraction (UAE) extraction to test antioxidant activity using methods other than DPPH, antibacterial, and anti-inflammatory with the BSA (Bovine serum albumin) method.

## MATERIALS AND METHODS

### Collection and preparation of samples

*Ulva lactuca* were collected from Krakal sea Gunung Kidul, Yogyakarta, Indonesia, with coordinate points S8°8'43" E110°35'59". The *Ulva lactuca* samples were gathered at sea level and rinsed with sterilized seawater on-site to remove any sand and sediments. The samples were then placed in a cool box and transported to the laboratory for further processing (Nugraheni *et al.*, 2010; Sabdaningsih *et al.*, 2017).

### Extraction with ultrasound-assisted extraction (UAE)

One hundred grams of *Ulva lactuca* powder was carefully weighed. The *Ulva lactuca* powder was extracted using ultrasonic-assisted extraction (UAE) using 96% ethanol solvent (smartlab, Indonesia) at a ratio of 1:5 in a closed container (Pertiwi *et al.*, 2025). The powder was soaked for 60 minutes with occasional stirring in UAE. The extraction process was carried out at 30°C, and the frequency of 20 KHz. Extraction was replicated 5 times. Ethanolic extract was evaporated using a rotary evaporator.

### Phytochemical screening

Phytochemical tests were conducted to identify secondary metabolite compounds in ethanol extracts. Phenolic tests were performed by adding 5% FeCl<sub>3</sub> (Sigma-Aldrich, USA) which produced a blue-black color (Jemal *et al.*, 2022), while flavonoids were detected by adding Mg powder (Supelco, Germany), concentrated HCl (bratachem, Indonesia), and amyl alcohol (Merck, Germany), which produced a red, yellow, or orange color in the amyl alcohol layer (Faramayuda *et al.*, 2021). Alkaloids were tested using Mayer, Bouchardat, and Dragendorff reagents (Nitrakimia, Indonesia), which produced white, yellow, or brick-red precipitates, respectively (Dilshad & Batool, 2022; Jemal *et al.*, 2022). Tannins were identified by adding 10% NaCl (Brtachem, Indonesia) and 0.5% gelatin (Sigma-Aldrich, USA) solution, which formed a white precipitate (Bonetti *et al.*, 2020). Saponins were identified by the formation of a stable foam after shaking and adding 2N HCl (bratachem, Indonesia) (Dilshad & Batool, 2022; Jemal *et al.*, 2022), while terpenoids and steroids were distinguished using the Libermann-Burchard reagent (Nitrakimia, Indonesia), which produced a brown color for triterpenoids and blue or green for steroids (Dilshad & Batool, 2022; Jemal *et al.*, 2022).

### Antioxidant activity test

#### a. DPPH method

Extract samples at various concentrations (3mL each) were mixed with 1mL of 0.1 mM DPPH (Sigma Aldrich, USA) solution. The tube was covered with aluminum foil and homogenized. The mixture was incubated for 30 minutes at 37°C, and the absorbance was measured at 517nm using a UV-Vis spectrophotometer (Shimadzu, Japan) (Wahyuono *et al.*, 2024).

#### b. FRAP method

A total of 10mg of extract was dissolved in 10mL of 96% ethanol. Then, 1mL of the solution was mixed with 1mL of 0.2 M phosphate buffer (pH 6.6) and mL of 1% K<sub>3</sub>Fe(CN)<sub>6</sub> (Sigma Aldrich, USA), followed by incubation at 50°C for 20 minutes. After incubation, 1mL of TCA (Supelco, Germany) was added, and the mixture was centrifuged at 3000 rpm for 10 minutes. One milliliter of the supernatant was pipetted into a test tube, mixed with 1mL of distilled water and 0.5mL of 0.1% FeCl<sub>3</sub> (Sigma Aldrich, USA), and left for 50 minutes. Absorbance was measured at 695nm. A blank

consisting of oxalate solution was used, and a calibration curve was prepared using ascorbic acid solutions at various concentrations (Wahyuono *et al.*, 2024).

#### *c. ABTS method*

A total of 0.1mL of extract was added to 2mL of ABTS (Sigma Aldrich, USA) stock solution and vortexed. The mixture was incubated for 6 minutes, and absorbance was measured at 734nm using a UV-Vis spectrophotometer. Antioxidant activity was expressed as the percentage inhibition of ABTS radicals (Wahyuono *et al.*, 2024).

#### **Anti-inflammatory activity test**

To evaluate anti-inflammatory activity, 500μL of each sample, positive control, and negative control solution was added to 0.2% BSA (Sigma Aldrich, USA) in TBS (Sigma Aldrich, USA) to a final volume of 5mL. The mixtures were incubated at 25°C for 30 minutes, then heated at 70°C for 5 minutes, followed by cooling in water for 10 minutes. After cooling, solutions were vortexed, and absorbance was measured at 660nm using a UV-Vis spectrophotometer (Laksmitawati & Tiffani, 2020).

#### **Antibacterial activity test**

The antibacterial activity was assessed using the agar diffusion method. Mannitol salt agar (MSA, Merck, Germany) was used for *Staphylococcus aureus* and nutrient agar (NA, Merck, Germany) for *Escherichia coli*. Wells were formed using cylinder cups. Bacterial suspensions adjusted to ½ McFarland standard were added at 10μL per 100mL of media. Each plate contained 10, 15, and 20% *Ulva lactuca* extract, 0.005% amoxicillin (positive control, Kimia Farma, Indonesia), and 4% DMSO (negative control, Merck, Germany), with 50μL pipetted into each well. Plates were incubated at 37°C for 24 hours (Binder, Germany), and the diameter of the inhibition zones was measured (Pertiwi *et al.*, 2025).

#### **Data analysis**

All experiments were performed in triplicate. Data are presented as mean ± standard deviation. Statistical analyses were performed using GraphPad Prism (version 9.1.2; GraphPad Inc., San Diego, CA, USA). IC<sub>50</sub> values represent the concentration of the test sample causing 50% inhibition. Significance levels were defined as  $P < 0.05$  (),  $< 0.005$  (),  $< 0.0005$  (), and  $< 0.0001$  (\*\*\*\*) (Suharsanti *et al.*, 2023). Two-way ANOVA was used for antioxidant and antibacterial tests, while t-test was applied for the anti-inflammatory test.

## RESULTS

### 1. Extraction and phytochemical screening

The extraction method used in this study was UAE (Ultrasound-assisted extraction). This method was chosen because it is more efficient than conventional methods and can shorten extraction time, reduce the amount of solvent, and increase the yield (Shen *et al.*, 2023). The yield from ethanol extraction using the UAE method was 12.65%. The 96% ethanol used in this study refers to the results of previous research that 96% ethanolic extract of *Ulva Lactuca* obtained by maceration was able to inhibit the growth of *Staphylococcus aureus* bacteria in the strong category (Emelda *et al.*, 2021). The extraction results were then phytochemically screened to determine the compound content in the extract. The results of the phytochemical screening are shown in Table (1).

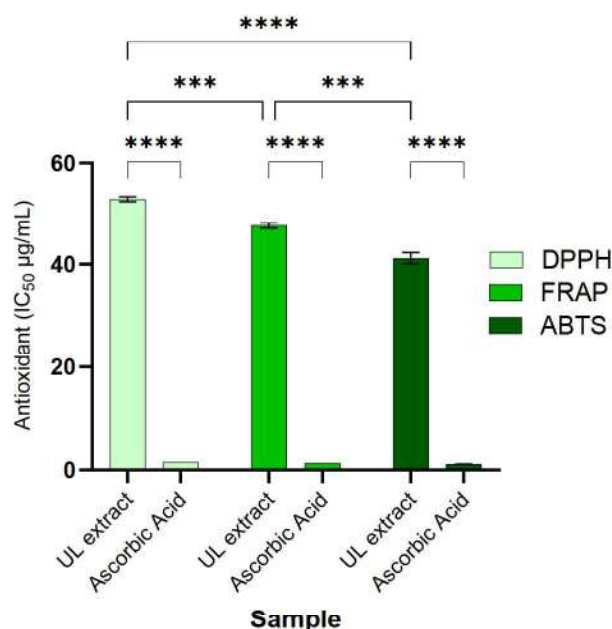
**Table 1.** Phytochemical screening of ethanol extract using UAE method

| Compound   | Literature                                                  | Research                                                    | Result   |
|------------|-------------------------------------------------------------|-------------------------------------------------------------|----------|
| Phenolic   | dark bluish                                                 | dark bluish                                                 | Positive |
| Flavonoids | yellow, red solution in amyl alcohol                        | Red solution in amyl alcohol                                | Positive |
| Tannin     | White precipitate                                           | Green solution                                              | Negative |
| Alkaloid   | Mayer: white precipitate<br>Dragendroff: orange precipitate | Mayer: white precipitate<br>Dragendroff: orange precipitate | Positive |
| Saponin    | The solution forms a stable foam                            | The solution forms a stable foam                            | Positive |
| Terpenoid  | The solution forms a red or purple color                    | The solution forms a red or purple color                    | Positive |

Based on Table (1), the ethanol extract of *Ulva lactuca* is positive for containing phenols, flavonoids, alkaloids, saponins, and terpenoids but negative for tannins. Each compound component contained in the *Ulva lactuca* extract has the potential to produce certain biological activities. The biological activities that can be tested in *Ulva lactuca* extracted using the UAE method are antioxidant, anti-inflammatory, and antibacterial.

## 2. Antioxidant activity

The antioxidant activity of ethanol extract of *Ulva lactuca* using the UAE method was carried out using 3 methods, namely DPPH, FRAP, and ABTS. The results of the antioxidant activity test of ethanol extract of *Ulva lactuca* using the UAE method are illustrated in Fig. (1).



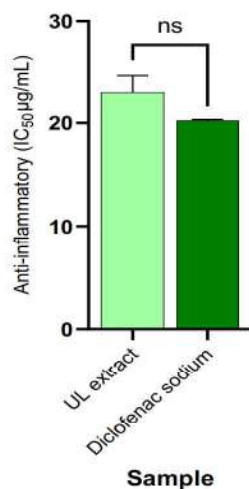
**Fig. 1.** Antioxidant activity of *Ulva Lactuca* (LC) ethanolic extracted using UAE with DPPH, FRAP, and ABTS method

\*\*\*= significant,  $P$  value  $<0.0005$  and \*\*\*\*= significant,  $P$  value  $<0.0001$ ,  $n=3$ , analyzed by two way ANOVA).

Based on the analysis of antioxidant activity test data using three methods, significant differences were found in all groups using the two-way ANOVA. Clearly significant differences were only observed between the *Ulva lactuca* extract group and the ascorbic acid standard for each method (DPPH, FRAP, and ABTS).

## 3. Anti-inflammatory activity

To determine the anti-inflammatory ability of the ethanol extract of *Ulva lactuca*, a protein denaturation method was used to observe the IC<sub>50</sub> value. The anti-inflammatory effect was tested by adding BSA (Bovine serum albumin), which causes denaturation when heated. The results of the ethanol extract test of *Ulva lactuca* are shown in Fig. (2).



**Fig. 2.** Anti-inflammatory activity of *Ulva Lactuca* (UL) extract and diclofenac sodium as positive control

ns=no significant,  $p$  value  $>0.05$ ,  $n=3$ , analyzed by oneway ANOVA.

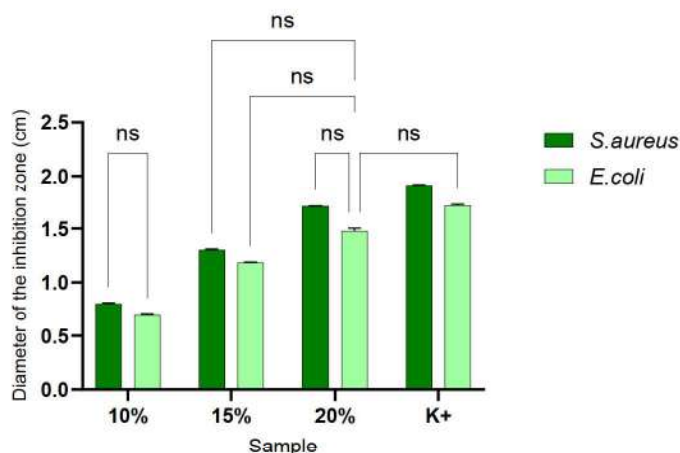
Based on the analysis of anti-inflammatory activity test data using t-test, there was no difference between the *Ulva lactuca* extract group and the diclofenac sodium standard. This indicates that the extract's effectiveness is equivalent to that of the diclofenac sodium standard.

#### 4. Antibactery activity

Ethanol extract of *Ulva lactuca* using UAE method showed antibacterial activity against *E. coli* (Gram-negative) and *S. aureus* (Gram-positive) bacteria with inhibition zones formed at various extract concentrations (Figs. 3, 4).



**Fig. 3.** Antibacterial activity of *Ulva lactuca* against ethanolic extract of (a) *E. coli* and (b) *S. aureus*



**Fig. 4.** Diameter of the inhibition zone (cm) against *S.aureus* and *E.coli* compared with K+ (Amoxicillin)

ns = no significant, *P*- value <0.05, n=3, analyzed by two- way ANOVA.

Based on the analysis of antibacterial activity test data processed with two-way ANOVA, all groups showed significant differences except the group marked with ns in Fig. (2). In Fig. (2), ns means that there is no significant difference between the groups. *Ulva lactuca* extract tested on *E. coli* bacteria has no significant difference at a concentration of 20% when compared to the positive control amoxicillin, while the extract when tested on *S. aureus* bacteria has better activity compared to *E. coli*.

## DISCUSSION

The yield from ethanol extraction using the UAE method was 12.65%. The yield obtained was remarkably greater than extraction using the maceration method. In terms of maceration extraction, the aqueous extract demonstrated the highest extraction yield at  $9.45 \pm 0.05\%$ , followed by the methanolic extract at  $1.18 \pm 0.09\%$ . Furthermore, the methanolic extract obtained through Soxhlet extraction had the highest polyphenolic yield with  $4.21 \pm 0.04\%$ , followed by the hexanic extract with  $2.23 \pm 0.07\%$ . The ethyl acetate extract had the lowest yield at  $1.34 \pm 0.06\%$  (Ouahabi *et al.*, 2024). The UAE method is more optimal in extracting compounds because it is assisted by electromagnetic waves (Carreira-Casais *et al.*, 2021). Screening results showed that the ethanol extract of *Ulva lactuca* using the UAE method contained flavonoids, alkaloids, saponins, and terpenoids. The results of the extract identification are the same as in previous research which were positive for tannin (Mubayyinah *et al.*, 2024), phenolic, flavonoids and terpenoids (Ouahabi *et al.*, 2024; Pertiwi *et al.*, 2025), and alkaloid (Lailaturramadhini *et al.*, 2025). These results are consistent with the study of Rompas

**and Gasah (2022)**, which showed that the ethanol extract of *Ulva Lactuca* contained all four compounds. Similarly, **Lailaturramadhini *et al.* (2025)** studied the comparative phytochemical composition of flavonoids, alkaloids, and tannins from Sukabumi and Lombok. The compounds contained in *Ulva lactuca* have the potential to possess bioactivity, such as antioxidant, anti-inflammatory, and antibacterial properties.

The antioxidant activity of ethanol extract of *Ulva Lactuca* using the UAE method was carried out using 3 methods, namely DPPH, FRAP, and ABTS. All three methods used spectrophotometry to measure antioxidant activity based on the principle of radical or reduction reactions. The difference lies in the mechanism of action of the antioxidant. The DPPH method has a hydrogen donor mechanism that will pair with the DPPH radical, causing the loss of purple color and producing a bright yellow color. FRAP has a mechanism where the antioxidant compound will donate electrons to the ferri-tripyrindyltriazine ion, thus converting it into a blue ferri-tripyrindyltriazine. Meanwhile, the ABTS mechanism is to transfer electrons or hydrogen to the ABTS<sup>•+</sup> radical, resulting in color fading (**Irianti *et al.*, 2021**).

The ability of antioxidant activity is seen from the IC<sub>50</sub> value (the ability of a compound to inhibit by 50%). The IC<sub>50</sub> value indicates the strength or weakness of antioxidant activity. A compound is said to have a very strong antioxidant if the IC<sub>50</sub> value is >50 ppm, strong antioxidant activity with an IC<sub>50</sub> value of around 50-100 ppm, moderate antioxidant activity if the IC<sub>50</sub> is 100-150 ppm and weak antioxidant activity if the IC<sub>50</sub> is 151-200 ppm (**Molyneux, 2004; Kedare & Singh, 2011**). To obtain a comprehensive picture of the antioxidant capacity of a sample, it is recommended to use more than one method because each method measures different aspects of the mechanism of antioxidant activity. Of the three methods, the antioxidant activity of *Ulva Lactuca* ethanol extract has quite high activity in the DPPH IC<sub>50</sub> method obtained at 52.66±0.47 µg/mL in the strong category, FRAP at 47.49±0.52 µg/mL in the very strong category, and ABTS 41.17±1.09 µg/mL in the very strong category. The DPPH method will produce higher IC<sub>50</sub> values (low activity) if the compound is not completely soluble or the reaction does not proceed optimally in the organic solvent (**Csepregi *et al.*, 2016**). When compared with previous research, *Ulva lactuca* extracted with 70% ethanol using the maceration method had an IC<sub>50</sub> of 46.68 ppm, which was better in activity when compared to the extract produced in this study using the UAE method (**Rompas & Gasah, 2022**). Whereas in other research, *Ulva lactuca* Algae had antioxidant activity with a percentage value of 51.63% at a concentration of 100 mg/L which showed that the UAE method was better (**Aprilia *et al.*, 2019**) The antioxidant test using DPPH obtained an inhibitory concentration (IC<sub>50</sub>) of wet *Ulva lactuca* L. extract macerated with methanol of 88890.55 ppm. (**Franzisca da Costa *et al.*, 2018**). The ABTS method often provides higher antioxidant activity values than DPPH or FRAP, especially for complex extracts or polar-nonpolar mixtures, due to its broader mechanism (**Thaipong *et al.*, 2006; Shah & Modi, 2015**). Meanwhile, FRAP provides high activity values for compounds with strong

reducing ability, but does not consider the ability of compounds that only react through radical scavenging mechanisms (**Kotha et al., 2022**). In an optimization study of *Ulva lactuca* L. extract using two optimization methods: the response surface method (RSM) and the artificial neural network-genetic algorithm (ANN-GA), the antioxidant activity obtained using the FRAP method was  $95.36 \pm 1.55$  mg Trolox Equi/g and  $106.14 \pm 0.82$  mg Trolox Equi/g, respectively (**Korkmaz, 2025**).

The antioxidant activity of a sample is also influenced by the extraction method. **Arbi et al. (2016)** tested the antioxidant activity with DPPH from the ethanol extract of *Ulva lactuca* using the maceration extraction method. The results of the activity test showed that the  $IC_{50}$  value obtained was  $60.97 \mu\text{g/mL}$ , a result obtained that was greater. **Ghasemzadeh et al. (2015)** found that ultrasound extraction with ethanol-water solvents produced the highest phenolic content and antioxidant activity compared to the maceration method or extraction with a single solvent. On the other hand, the testing method (assay) can also affect the results due to differences in reactivity to the radicals tested.

To determine the anti-inflammatory ability of the ethanol extract of *Ulva lactuca*, a protein denaturation method was used to observe the  $IC_{50}$  value. The anti-inflammatory effect was tested by adding BSA (Bovine serum albumin), which causes denaturation when heated. Secondary metabolites that are able to maintain protein stability from denaturation have potential as anti-inflammatory agents. The interaction of BSA with secondary metabolites such as tyrosine, lysine, and threonine can increase the bond between active substances, thus preventing protein denaturation.

Based on the measurement results, the  $IC_{50}$  value of the ethanol extract of *Ulva lactuca* was  $23.15 \pm 1.61 \mu\text{g/mL}$  and as a control diclofenac sodium had an  $IC_{50}$  value of  $20.22 \pm 0.11 \mu\text{g/mL}$ . Based on these results, it can be said that the ethanol extract of *Ulva lactuca* with the UAE method has anti-inflammatory activity that is comparable *in vitro*. The anti-inflammatory activity of the ethanol extract is influenced by the secondary metabolite compounds present in the extract. Secondary metabolites have the potential as anti-inflammatories by inhibiting denatured proteins in the body, which can occur because the formation of free radicals causes inflammation by stimulating inflammatory mediators (**Purba et al., 2019**). Flavonoid compounds can inhibit protein denaturation because the structure of the hydroxyl group and aromatic ring interact with albumin through hydrogen bonds, resulting in a more stable protein structure and less prone to denaturation (**Panche et al., 2016**). Alkaloids inhibit targets (COX-2 and prostaglandins) and also act on endothelial cells, neutrophils, and leukocytes, reducing inflammation in these cells (**Nurjanah et al., 2020**). Terpenoids inhibit the production of inflammatory factors nitric oxide and IL-6 induced by lipopolysaccharide (**Yang et al., 2020**). Meanwhile, diclofenac sodium, a comparator, acts as a COX inhibitor for anti-inflammatory effects, demonstrating its ability to inhibit the formation of prostaglandins, which act as inflammatory mediators. *Ulva lactuca* ethanol extract enhances wound

healing properties *in vivo*. These results suggest that bioactive compounds derived from *Ulva lactuca* extract are beneficial for wound healing and anti-inflammatory therapies (Wang *et al.*, 2025).

Ulvan sulfate polysaccharide isolated from *Ulva lactuca* has been widely reported to possess physiologically interrelated antidiabetic and anti-inflammatory activities. Ulvan isolated from *Ulva lactuca* is able to lower blood glucose levels by increasing insulin sensitivity, improving pancreatic  $\beta$ -cell function, and inhibiting intestinal glucose absorption through the regulation of the  $\alpha$ -glucosidase enzyme. This antidiabetic activity is inseparable from ulvan's ability as a natural anti-inflammatory agent, which works by suppressing the expression of pro-inflammatory cytokines such as TNF- $\alpha$ , IL-6, and IL-1 $\beta$  through inhibition of the NF- $\kappa$ B and MAPK transduction pathways. This anti-inflammatory role is important because in type 2 diabetes mellitus, low-grade inflammation occurs that contributes to insulin resistance and metabolic dysfunction. Furthermore, ulvan's antioxidant properties help reduce oxidative stress that triggers chronic inflammation, thereby enhancing its antidiabetic effects. Thus, ulvan has the potential to be developed as a candidate for multifunctional phytotherapeutic agents that simultaneously target the inflammatory-oxidative-metabolic pathways in diabetes mellitus (Flórez-Fernández *et al.*, 2023).

Based on the results above, the antibacterial activity of ethanol extract of *Ulva lactuca* using the UAE method was higher against *S. aureus* bacteria. The difference in sensitivity between *E. coli* and *S. aureus* is generally caused by differences in the structure of their cell walls. *E. coli* is a Gram-negative bacterium that has a lipopolysaccharide (LPS) layer on the outer membrane that functions as a barrier against hydrophobic compounds. Meanwhile, *S. aureus* as a Gram-positive bacterium has a thicker cell wall consisting of peptidoglycan, but does not have an outer layer of LPS, so antibacterial compounds can more easily penetrate and work on target cells (Ardita *et al.*, 2021; Panjaitan *et al.*, 2022).

The antibacterial activity of the ethanol extract of *Ulva lactuca* is thought to be due to the presence of secondary metabolites such as phenolics, flavonoids, alkaloids, saponins, and terpenoids reported in this species. These compounds work through several mechanisms, including damaging cell membrane integrity, inhibiting protein and nucleic acid synthesis, and causing leakage of intracellular components (Ardita *et al.*, 2021). Flavonoids and phenolics, in particular, play an important role as inhibitors of bacterial growth by forming complexes with extracellular proteins and cell walls, thereby disrupting membrane permeability (Evans & Cowan, 2016).

Furthermore, the use of ethanol as a solvent in the extraction process significantly impacts the extract's ability to dissolve polar and semi-polar compounds such as phenols and flavonoids. This explains why ethanol extracts often yield higher antibacterial activity compared to non-polar solvents such as n-hexane (Liswandari *et al.*, 2018). Previous research supports these findings. According to Hamed *et al.* (2015), ethanol

extract of *Ulva lactuca* showed inhibition zones of 14–18mm against *S. aureus* and 10–15mm against *E. coli* at a concentration of 100mg/ mL. Higher activity against *S. aureus* indicates that the antibacterial compounds in *Ulva lactuca* are more effective against Gram-positive bacteria. The results of other the study showed that the methanol extract from maceration was active against *S. aureus* with a clear zone of 8.20mm so that extraction with UAE in this study is better with a larger clear zone diameter (**Lembang, 2023**).

The UAE extraction method used in this study also affected the resulting antibacterial activity. **Panjaitan *et al.* (2022)** studied the antibacterial activity of ethanol extract of *Ulva lactuca* against *E. coli* and *S. aureus* bacteria, resulting in lower activity than the UAE method. The UAE method increases the efficiency of active compound extraction through ultrasonic cavitation, which damages cell walls and accelerates the release of secondary metabolites, so the resulting ethanol extract has the potential to have a higher antibacterial content than conventional extraction with the same time. Although the results of this study show promising potential, further research is needed to address limitations such as the lack of *in vivo* testing and more in-depth isolation of active compounds.

## CONCLUSION

Ultrasonic-assisted ethanol extracts of *Ulva lactuca* exhibited potent antioxidant and anti-inflammatory activities, as well as moderate antibacterial potential, particularly against *Staphylococcus aureus*. These findings support the potential use of *Ulva lactuca* as a source of marine bioactives for future functional product development.

## ACKNOWLEDGMENTS

The author would like to thank the 2025 Ministry of Education and Culture's Impactful Consortium Research Program (RIKUB) Indonesia for the funding support under contract number 034/C3/DT.05.00/RIKUB/2025 provided so that this research can be carried out properly.

## REFERENCES

- Aprilia, G.; Ulaan, K.; Yudistira, A. and Rotinsulu, H.** (2019). Antioxidant Activity Test of Ethanolic Extract of *Ulva Lactuca* Algae Using The DPPH (1,1 Diphenyl-2-Picrylhydrazyl) Method. *PHARMACON*, 8(3), 535–541.
- Arbi, B.; Ma'ruf, W. F. and Romadhon.** (2016). The Activity of Bioactive Compounds from Sea Lettuce (*Ulva lactuca*) as Antioxidant in Fish Oil. *Indonesian Journal of Fisheries Science and Technology (IJFST)*, 12(1), 12–18.
- Ardita, N. F.; Mithasari, L.; Untoro, D. and Salasia, S. I. O.** (2021). Potential

Antimicrobial Properties of the *Ulva lactuca* Extract Against Methicillin-Resistant *Staphylococcus aureus*-infected wounds: A review. *Veterinary World*, 14(5), 1116.

**Bonetti, C. I.; Dalmagro, M.; Friedrich, J. C.; Jesus, D. R.; Pinc, M. M.; Alberton, O. and Lourenço, E. L. B.** (2020). Phytochemical Profile and Evaluation of the Antimicrobial Activity of *Echinodorus grandiflorus* Crude Extract of the Leaves. *Journal of Agricultural Studies*, 8(4), 176.

**Carreira-Casais, A.; Otero, P.; Garcia-Perez, P.; Garcia-Oliveira, P.; Pereira, A. G.; Carpena, M.; Soria-Lopez, A.; Simal-Gandara, J. and Prieto, M. A.** (2021). Benefits and Drawbacks of Ultrasound-Assisted Extraction for The Recovery of Bioactive Compounds From Marine Algae. *International Journal of Environmental Research and Public Health*, 18(17), 1–25.

**Csepregi, K.; Neugart, S.; Schreiner, M. and Hideg, É.** (2016). Comparative Evaluation of Total Antioxidant Capacities of Plant Polyphenols. *Molecules*, 21(2), 1–17.

**Dilshad, R. and Batool, R.** (2022). Phytochemical Analysis, Antibacterial Activity, Thin Layer Chromatography, Bacterial Efflux Pump Inhibition Activity, Gas Chromatography Mass Spectrometry. *Jordan Journal of Pharmaceutical Sciences*, 15(3), 1–9.

**EL-Sayed, A. I. M.; El-Sheekh, M. M. and Makhlof, M. E. M.** (2023). Synergistic Antibacterial Effects of *Ulva lactuca* Methanolic Extract Alone and in Combination With Different Antibiotics on Multidrug-Resistant *Klebsiella pneumoniae* Isolate. *BMC Microbiology*, 23(1), 1–10.

**Emelda; Safitri, E. A. and Fatmawati, A.** (2021). Inhibition Activity of Ethanolic Extract of *Ulva lactuca* Against *Staphylococcus aureus*. *Pharmaceutical Journal of Indonesia*, 7(1), 43–48.

**Evans, S. M. and Cowan, M. M.** (2016). Plant Products As Antimicrobial Agents. *Cosmetic and Drug Microbiology*, 12(4), 205–231.

**Flórez-Fernández, N.; Rodríguez-Coello, A.; Latire, T.; Bourgougnon, N.; Torres, M. D.; Buján, M.; Muñón, A.; Muñón, A.; Meijide-Failde, R.; Blanco, F. J.; Vaamonde-García, C. and Domínguez, H.** (2023). Anti-Inflammatory Potential of Ulvan. *International Journal of Biological Macromolecules*, 253, 126936.

**Franziska da Costa, J.; Merdekawati, W.; Rambu Otu Program Studi Gizi, F.; Kedokteran dan Ilmu Kesehatan, F.; Kristen Satya Wacana Program Studi Teknologi Pangan, U.; Kristen Satya Wacana, U. and korespondensi, P.** (2018). Proximate Analysis, Antioxidant Activity, and Pigment Composition of *Ulva*

*lactuca* L. from Kukup Coastal Waters. *Jurnal Teknologi Pangan Dan Gizi*, 17(1), 1–17.

**Ghasemzadeh, A.; Jaafar, H. Z. E.; Juraimi, A. S. and Tayebi-Meigooni, A. (2015).** Comparative Evaluation of Different Extraction Techniques and Solvents for The Assay of Phytochemicals and Antioxidant Activity of Hashemi Rice Bran. *Molecules*, 20(6), 10822–10838.

**Hamed, I.; Özogul, F.; Özogul, Y. and Regenstein, J. M. (2015).** Marine Bioactive Compounds and Their Health Benefits: A Review. *Comprehensive Reviews in Food Science and Food Safety*, 14(4), 446–465.

**Humaidi, F. A.; Fachri, B. A.; Palupi, B.; Mumtazah, Z.; Rizkiana, F.; Amini, H. W. and Rahmawati, I. (2024).** Optimization of Chlorophyll Extraction from *Ulva* sp. with Ultrasound-Assisted Liquid Biphasic Systems Method. *Indonesian Journal of Science and Education*, 08(01), 26–41.

**Irianti, T. T.; Kuswandi, Nuranto, S. and Purwanto. (2021).** Antioksidan dan Kesehatan. *UGM Press*.

**Istiqlaal, S.; Sitanggang, A. B. and Wijaya, C. H. (2025).** Impact of Ultrasonic-Assisted Extraction Period on Physical Properties of Ulvan. *BIO Web of Conferences*, 01005(169).

**Jacoeb, A. M.; Abdullah, A. and Hakimah, S. N. (2024).** Potential of Ulvan from *Ulva lactuca* as an Antioxidant Source. *Jurnal Pengolahan Hasil Perikanan Indonesia*, 27(3), 242–251.

**Jemal, K.; Sandeep, B. V. and Pola, S. (2022).** Phytochemical Screening and *in Vitro* Antioxidant Activity Analysis of Leaf and Callus Extracts of *Allophylus serratus* (Roxb) Kurz. *Jordan Journal of Pharmaceutical Sciences*, 15(1), 51–69.

**Kedare, S. B. and Singh, R. P. (2011).** Genesis and Development of DPPH Method of Antioxidant Assay. *Journal of Food Science and Technology*, 48(4), 412–422.

**Korkmaz, N. (2025).** Extract Optimization of *Ulva lactuca* L. and Biological Activities of Optimized Extracts. *BMC Biotechnology*, 25(21), 1–10.

**Kotha, R. R.; Tareq, F. S.; Yildiz, E. and Luthria, D. L. (2022).** Oxidative Stress and Antioxidants—A Critical Review on In Vitro Antioxidant Assays. *Antioxidants*, 11(12), 1–30.

**Lailaturramadhini, N.; Yuniarti, A.; Maimunah, Y.; Eka Supriatin, F.; Suryanto, D. and Ridwanudin, A. (2025).** Comparison of Phytochemical Composition, Total Polysaccharides, and Highest Nutrient Content in Seaweed (*Ulva lactuca*) From

- Two Different Locations. *Journal of Aquaculture and Fish Health*, 14(2), 284–296.
- Laksmiawati, D. R. and Tiffani, C.** (2020). Albumin Denaturation Inhibitory Activity and Anti-Inflammatory Effect of a Mixture of *Phyllanthus Niruri*, *Moringa* Leaves, and Bay Leaves Extracts. *Majalah Farmasetika*, 4(Suppl 1), 233–239.
- Lembang, S. K.** (2023). Antibacterial Activity and Identification of Active Compound Groups of the Extract of Green Seaweed *Ulva lactuca*. *Thesis. Hasamuddin University Indonesia*.
- Liang, Y.; Liu, T.; Wang, D. and Liu, Q.** (2025). Exploring The Antimicrobial, Anti-Inflammatory, Antioxidant, and Immunomodulatory Properties of *Chrysanthemum morifolium* and *Chrysanthemum indicum*: a Narrow Review. *Frontiers in Pharmacology*, 16(March), 1–21.
- Liswandari, M. S.; Lantang, D. and Dirgantara, S.** (2018). Antibacterial Activity Test of Green Algae (*Ulva* sp.) from Sorido Beach Against *Escherichia coli* and *Staphylococcus aureus* Bacteria . *Jurnal Farmasi Medica/Pharmacy Medical Journal (PMJ)*, 1(1), 9–15.
- López-Valverde, N.; López-Valverde, A.; Montero, J.; Rodríguez, C.; Macedo de Sousa, B. and Aragonese, J. M.** (2023). Antioxidant, Anti-Inflammatory and Antimicrobial Activity of Natural Products in Periodontal Disease: a Comprehensive Review. *Frontiers in Bioengineering and Biotechnology*, 11(8), 1–14.
- Molyneux, P.** (2004). The Use of the Stable Free Radical Diphenylpicryl-hydrazyl (DPPH) for Estimating Antioxidant Activity. *Songklanakarin Journal of Science and Technology*, 26, 211–219.
- Mubayyinah, L.; Tara Mudita, L.; Rizqi Rahmadia, A.; Ayu Sekar Pawening, D.; Ciptadi Kodja, S. and Nova Wiratno, E.** (2024). Comparative Analysis of Flavonoid and Tannin Extraction From *Ulva lactuca* Using Maceration and Ultrasonic-Assisted (UAE) Techniques For Antibacterial Activity. *Jurnal Perikanan Unram*, 14(4), 2015–2025.
- Nugraheni, S. A.; Khoeri, M. M.; Sabdono, A. and Radjasa, O. K.** (2010). Antibacterial Activity of Bacterial Symbionts of Softcoral *Simularia* sp. Against Pathogenic Resistant Bacteria. *Journal of Coastal Development*, 13(2), 113–118.
- Nurjanah, S.; Marlina, E. and Astuti, W.** (2020). Amylase Activity Test on Melicope Plants Which Have The Potential as Antidiabetic. *Jurnal Atomic*, 5(2), 94–98.
- Ouahabi, S.; Daoudi, N. E.; Loukili, E. H.; Asmae, H.; Merzouki, M.; Bnouham, M.; Challioui, A.; Hammouti, B.; Fauconnier, M. L.; Rhazi, L.; Ayerdi Gotor, A.;**

- Depeint, F. and Ramdani, M.** (2024). Investigation into the Phytochemical Composition, Antioxidant Properties, and *In-Vitro* Anti-Diabetic Efficacy of *Ulva lactuca* Extracts. *Marine Drugs*, 22(6), 240.
- Panche, A. N.; Diwan, A. D. and Chandra, S. R.** (2016). Flavonoids: An overview. *Journal of Nutritional Science*, 5(47), 1–15.
- Panjaitan, R. S.; Thalib, N. and Sumantri, S.** (2022). Antibacterial Activity of 96% Ethanolic Extract of *Ulva reticulata* Against *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. *Indonesian Journal of Pharmaceutical Research*, 2(1), 13–19.
- Pertiwi, Y. P.; Wulansari, E. D. and Kusmita, L.** (2025). Antibacterial Activity of the Active Compound of *Ulva lactuca* Against MRSA Bacteria. *Egyptian Journal of Aquatic Biology and Fisheries*, 29(1), 681–694.
- Purba, N. E.; Suhendra, L.; Wartini, N. M.; Pertanian, F. T.; Udayana, U. and Bukit, K.** (2019). The Effect of Temperature and Extraction Time by Maceration on the Coloring Characteristics of Red Algae Extract (*Gracilaria* sp.). *Jurnal Rekayasa Dan Manajemen Agroindustri*, 7(4), 488–498.
- Rompas, I. F. X. and Gasah, O.** (2022). Effectiveness of Green Seaweed Extract (*Ulva lactuca*) on Antioxidant Activity as a Sustainable Food Source. *BIO-EDU: Jurnal Pendidikan Biologi*, 7(3), 172–189.
- Sabdaningsih, A.; Cristianawati, O.; Sibero, M. T.; Nuryadi, H.; Radjasa, O. K.; Sabdono, A. and Trianto, A.** (2017). Screening Antibacterial Agent from Crude Extract of Marine-Derived Fungi Associated with Soft Corals against MDR-*Staphylococcus haemolyticus*. *IOP Conference Series: Earth and Environmental Science*, 55(1), 012026.
- Shah, P. and Modi, H. A.** (2015). Comparative Study of DPPH, ABTS and FRAP Assays for Determination of Antioxidant Activity. *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, 3(vi), 636–641.
- Shen, L.; Pang, S.; Zhong, M.; Sun, Y.; Qayum, A.; Liu, Y.; Rashid, A.; Xu, B.; Liang, Q.; Ma, H. and Ren, X.** (2023). A Comprehensive Review of Ultrasonic Assisted Extraction (UAE) for Bioactive Components: Principles, Advantages, Equipment, and Combined Technologies. *Ultrasonics Sonochemistry*, 101(8), 1–23.
- Suharsanti, R.; Wahyuono, S.; Astuti, P. and Yuniarti, N.** (2023). Isolation and Characterization of Curcumenotone, a Sesquiterpene from *Curcuma aeruginosa* Roxb as Antioxidant. *Indonesian Journal of Pharmacy*, 34(4), 593–602.

- Thaipong, K.; Boonprakob, U.; Crosby, K.; Cisneros-Zevallos, L. and Hawkins Byrne, D.** (2006). Comparison of ABTS, DPPH, FRAP, and ORAC assays for estimating antioxidant activity from guava fruit extracts. *Journal of Food Composition and Analysis*, 19(6–7), 669–675.
- Utami, D.; Wahyudi, R. and Widyaningsih, W.** (2023). The Sulphated Polysaccharide Compounds from Green Algae (*Ulva lactuca* L) as a potential natural anti-inflammatory agent based on molecular docking study targeting cyclooxygenase-2 receptor. *Pharmaciana*, 13(2), 146–158.
- Wahyuono, S.; Yuniarti, N. and Astuti, P.** (2024). Antioxidant Activity and Pancreatic Lipase Inhibition of *Curcuma aeruginosa* Roxb Rhizome Fractions. *Jurnal Biodjati*, 9(November), 228–243.
- Wang, C. H.; Huang, Z. T. and Tai, K. F.** (2025). *In Vitro* and *in Vivo* Evaluation of *Ulva lactuca* for Wound Healing. *PloS One*, 20(1). <https://doi.org/10.1371/JOURNAL.PONE.0311037>
- Yang, W.; Chen, X.; Li, Y.; Guo, S.; Wang, Z. and Yu, X.** (2020). Advances in Pharmacological Activities of Terpenoids. *Natural Product Communications*, 15(3), 1–13.
- Zaatout, H.; Ghareeb, D.; Abd-Elgwad, A. and Ismael, A.** (2019). Phytochemical, Antioxidant, and Anti-Inflammatory Screening of the Egyptian *Ulva lactuca* Methanolic Extract. *Records of Pharmaceutical and Biomedical Sciences*, 3(2), 33–38.