ISSN 2664-4142 (Print) & ISSN 2664-6749 (Online)
South Asian Research Journal of Pharmaceutical Sciences
Abbreviated Key Title: South Asian Res J Pharm Sci

| Volume-7 | Issue-4 | Jul-Aug 2025 | **DOI: https://doi.org/10.36346/sarjps.2025.v07i04.003**

Review Article

Antioxdent, Antifungal Activities of n-Hexadecanoic Acid Extracted from Algae

Zaman Abdul Hussein Ali Ghfil[1*], Faheema Jabbar Aboalhur[1], Mervet Abdulhasan Mshachal[1], Abdullah Abdulkareem Ahmed Alobaidi[1]

[1]Tropical Biological Researches Unit, College of Science, Baghdad University, Iraq

***Corresponding Author:** Zaman Abdul Hussein Ali Ghfil
Tropical Biological Researches Unit, College of Science, Baghdad University, Iraq

Article History
Received: 02.06.2025
Accepted: 06.08.2025
Published: 11.08.2025

Abstract: The importance of algae as a natural source of various bioactive compounds continues to grow due to their diverse biological activities. One of such compounds is n-hexadecanoic acid, more commonly known as palmitic acid; it is more lipidous than many algal species. It is one of the most common saturated fatty acids in nature. One can find it in algal, animal, and plant oils and is extracted from numerous natural sources. Its chemical and biological attributes enable its widespread use in the pharmaceutical, food, and cosmetic industries. Numerous studies have found that palmitic acid is effective for fungal activities and does have pharmaceutical and environmental promising antioxidant capabilities.

Keywords: Algae, Palmitic Acid, Lipid Component, Pharmaceutical, Antifungal.

INTRODUCTION

Palmitic acid, or n-hexadecanoic acid, is a common saturated fatty acid found in nature. It has a molecular structure of C16H32O2, meaning it has a 16-carbon chain. It can be found in a variety of vegetable oils, animal fats, and even certain algae. Moreover, it is a significant constituent of triglycerides and phospholipids that form cell membranes. In biological systems, n-hexadecanoic acid is vital in the metabolism process which, in addition to providing energy, helps in the metabolic pathways of complex lipids like sphingolipids and glycolipids. With greater availability from animal and plant sources, n-hexadecanoic acid (palmitic acid) has extensive uses in industrial and pharmaceutical sectors. Palmitic acid constitutes fats as a constituent of several vegetable oils, which is most notably palm oil. It serves as a fat stabilizer and energy source in the manufacture of baked goods and confectionaries [1]. In the soap and detergent industry, it is transformed into salts known as palmitates which have valuable emulsifying characteristics. They are extensively used in formulating soaps and other cleaning agents [2]. Palmitic acid is widely used by the cosmetics industry due to its skin-softening and moisturizing properties. It enables as an ingredient in lip balms and skincare products which aids in skin hydration and lip balms [3]. Moreover, in the candle and lubricant industries, it is used in the production of candles and industrial lubricants because of its ability to confer solid consistency and thermal stability.

Recent investigations indicate that palmitic acid is of main importance in drug and bioactive compound research due to its broad range of biological activities. Certain studies have shown that palmitic acid possesses multifunctional activities such as antioxidant, antimicrobial, and even anticancer properties 4. Particularly interesting is the fact that those bioactive compounds can easily be extracted from natural sources, for example from algae, bacteria and even some medicinal plants 5,6. Furthermore, more recent studies 7 have shown that palmitic acid, in addition to its possible role in controlling the expression of inflammatory response genes, may also be useful in the development of drug nanocarriers which would enhance the efficiency of getting the drugs to the target cells. Biochemically, palmitic acid is known to have an important function in metabolism. It can be utilized as a major energy fuel and also serves in the construction of several complex lipid molecules, for example, sphingolipids and the glycolipids. A number of recent studies have shown that acs,

while abundant, also have some health risks, for instance chronic inflammation and an increase in insulin resistance, could be associated with healthier risks [8, 9].

1. Antioxidant Activities of n-Hexadecanoic (Palmitic Acid)

n-Hexadecanoic acid has mild antioxidant properties, mostly attributed to ability interact with and stabilize free radicals. Modulation of membrane fluidity and integrity, which may prevent oxidative damage. The antioxidant action is thought to occur via indirect pathways, including Modulation of gene expression of antioxidant enzymes like superoxide dismutase (SOD) or catalase. Interactions with lipid peroxidation processes, possibly preventing or slowing peroxidative damage [10, 11]. Palmitic acid (Pal), a type of saturated fatty acid, has been widely recognized for its role in triggering pro-inflammatory responses in hepatocytes. Excessive exposure to Pal has been shown to result in the accumulation of triglycerides within specific cellular structures known as lipid droplets. In the hepatic insulin resistance and hepatic lipotoxicity, Pal has been linked to induction of oxidative stress, glucotoxicity, apoptosis and dysfunction of both endoplasmic reticulum (ER) and mitochondrial health in HepG2 cells [12, 13]. In agreement with In accordance with earlier findings, the existing study moreover demonstrated treatment with Pal brought about a They showed that marked lipid accumulation and lipid droplet formation in HepG2 cells. In addition, evidence from Pal studies with lipidomic-based approaches showed that the Lipid Profile changed significantly influences lipid metabolism [14,15]. For instance, Pal exposure has been associated. with changes in important fat substances like phosphatidylethanolamine (PE), phosphatidylserine, phosphatidylcholine, and glycerophosphocholine (GPC) [15]. Stable isotope-labeled lipidomics approaches have been used to Exposure to Pal in HepG2 cells causes considerable changes in cell morphology. There's presence of many types of lipids, like phospho and cere. Involves in the biosynthesis of (cer), glycerolipids (gl), and others, utilises. small water-soluble molecules (especially DGs) Dihydroceramide, Cers, sphingomyelin, PC, PE, lyso-phosphatidic. acid (LPA), and lysophosphatidylethanolamine [14]. Lipidomic study showed that Pal treatment caused in our study. HepG2 Cells Exhibit Crippling Lipid Homeostasis Disturbances Specifically, we.17 Types of Differentially Expressed Lipids Were Identified Between Pal-Treated and Control. The major groups are ceramide (Cer), phophocholine (PC), triglyceride (TG), phosphatidylethanolamine (PE), sphingosine (Sph) and sphingomyelin (SM). The. Most of the glycerolipids (GLs), the glycerophospholipids (GPs) and sphingomyelin. After Pal exposure, a Pal species experienced a substantial upregulation. Pal prompts substantial fat build-up and dysfunction in liver cells.

2. Antibacterial Activities of n-Hexadecanoic (Palmitic Acid)

Palmitic acid is present throughout nature in many animal and plant products. Important animal sources of fats include butter, mutton fat and lard [16]. Palmitic acid has also been found in plant oils, such as palm oil and coconut oil considerable amounts. Studies found that palmitic acids primarily inhibited the.release of extracellular organic matter during early osmotic stress, ultimately causing death of cells. Higher DOC level in culture medium. The main extracellular organic matter components were aromatic proteins and humic acid-like substances. The trends in Chl-a levels, Fv/Fm values, and the ETR in response to fatty acids aligned with changes in cell density. Analysis of oxidative enzyme activity revealed that fatty acids damage M. aeruginosa's antioxidant enzyme activity, disrupt cell membrane permeability, and harm the unsaturated fatty acids in cell membranes [16]. A study of extracts from Caspian Sea (Persian Gulf) algae found that stearic acid, along with hexadecanoic acid (palmitic acid), was a major component of the free fatty acids. These compounds exhibited antibacterial activity against Staphylococcus aureus and Bacillus subtilis, with minimum inhibitory concentrations (MICs) ranging from 0.125 to 2 mg/mL—indicating effective inhibition at acceptable concentrations [17].

3. Antifungi Activities of n-Hexadecanoic (Palmitic Acid)

Palmitic acid and its methyl and ethyl esters exhibit broad-spectrum antimicrobial activity, effectively inhibiting the growth of various plant and human pathogens. These include plant pathogens such as *Alternaria solani* and *Fusarium oxysporum*, as well as human-associated pathogens like *Aspergillus* species, *Candida tropicalis*, and *Candida albicans* [18]. Experimental evidence indicates that palmitic acid, individually or synergistically with oleic acid, suppresses Candida glabrata biofilm development and reduces cell viability, thereby reinforcing its antifungal and anti-inflammatory potential [19]. Palmitic acid exerts its antifungal activity through multiple interconnected mechanisms. As a saturated long-chain fatty acid (C16:0), it can incorporate into fungal cell membranes, destabilizing the lipid bilayer and disrupting membrane integrity, which may impair nutrient uptake and membrane-bound enzyme functions [20, 21]. In addition to these physical effects, palmitic acid induces oxidative stress by promoting the generation of reactive oxygen species (ROS), particularly in *Candida parapsilosis*. This oxidative burden leads to damage of DNA, proteins, and organelles, with heightened sensitivity observed in mutants deficient in fatty acid desaturation. Furthermore, palmitic acid may inhibit key lipid biosynthesis pathways—such as triacylglycerol and sphingolipid production—that are essential for fungal growth, membrane structure, and morphogenesis. It also has the capacity to competitively inhibit phospholipase A_2 (PLA_2), a critical enzyme involved in phospholipid metabolism and inflammatory signaling. While this inhibitory effect is well-documented in mammalian systems, similar mechanisms in fungi may interfere with phospholipid remodeling and further contribute to antifungal efficacy [22, 23].

CONCLUSION

n-Hexadecanoic acid, extracted from algae, is a multifunctional bioactive compound exhibiting antioxidant, antifungal, antibacterial, and anti-inflammatory properties. It can influence cancer cells through several mechanisms, including the induction of apoptosis, cell cycle arrest, and modulation of cellular signaling pathways, thereby opening new avenues for therapeutic and industrial applications. However, recent research underscores the need for more comprehensive clinical and applied studies to fully explore and develop products based on this bioactive fatty acid.

REFERENCE

1. Santos-Sánchez, N. F., et al. (2021). *Biological activities of palmitic acid: A review*. Journal of Oleo Science, 70(5), 653–664
2. Yang, J., et al. (2022). *Palmitic acid: metabolism, mechanisms of action and potential applications*. Frontiers in Nutrition, 9, 867352
3. Balogun, F. O., et al. (2023). *Antimicrobial and anticancer potentials of saturated fatty acids from natural*
4. Zhao, Z., Wang, J., Kong, W., Newton, M. A., Burkett, W. C., Sun, W., and Bae-Jump, V. L. (2024). Palmitic acid exerts anti-tumorigenic activities by modulating cellular stress and lipid droplet formation in endometrial cancer. *Biomolecules*, *14*(5), 601.
5. Carta, G., Murru, E., Banni, S., & Manca, C. (2017). Palmitic acid: physiological role, metabolism and nutritional implications. *Frontiers in physiology*, *8*, 902.
6. Salahuddin, A., et al. (2023).Biological activities of palmitic acid from natural sources: a review.Natural Product Research, 37(18), 3245–3253.
7. Rehman, M., Tahir, N., Sohail, M. F., Qadri, M. U., Duarte, S. O., Brandão, P., and Fonte, P. (2024). Lipid-based nanoformulations for drug delivery: An ongoing perspective. *Pharmaceutics*, *16*(11), 1376.
8. Naqvi, S. A. R., Sherazi, T. A., Hassan, S. U., Shahzad, S. A., and Faheem, Z. (2022). Anti-inflammatory, anti-infectious and anti-cancer potential of marine algae and sponge: A review. *European Journal of Inflammation*, *20*, 20587392221075514.
9. Frazzini, S., and Rossi, L. (2025). Anticancer Properties of Macroalgae: A Comprehensive Review. *Marine Drugs*, *23*(2), 70.
10. Aparna, V., Dileep, K. V., Mandal, P. K., Karthe, P., Sadasivan, C., and Haridas, M. (2012). Anti-inflammatory property of n-hexadecanoic acid: structural evidence and kinetic assessment. *Chemical biology & drug design*, *80*(3), 434-439.
11. Shawer, E. E. S., Sabae, S. Z., El-Gamal, A. D., and Elsaied, H. E. (2022). Characterization of Bioactive Compounds with Antioxidant Activity and Antimicrobial Activity from Freshwater Cyanobacteria. *Egyptian Journal of Chemistry*, *65*(9), 723-735.
12. Zang, Y., Fan, L., Chen, J., Huang, R., and Qin, H. (2018). Improvement of lipid and glucose metabolism by capsiate in palmitic acid-treated HepG2 cells via activation of the AMPK/SIRT1 signaling pathway. J. Agric. Food Chem. 66 (26), 6772–6781. doi:10.1021/acs.jafc.8b01831
13. Eynaudi, A., Diaz-Castro, F., Borquez, J. C., Bravo-Sagua, R., Parra, V., and Troncoso, R. (2021). Differential effects of oleic and palmitic acids on lipid droplet-mitochondria interaction in the hepatic cell line HepG2. Front. Nutr. 8, 775382. doi:10.3389/fnut.2021.775382
14. Shih, L. M., Tang, H. Y., Lynn, K. S., Huang, C. Y., Ho, H. Y., and Cheng, M. L. (2018). Stable isotope-labeled lipidomics to unravel the heterogeneous development lipotoxicity. Molecules 23 (11), 2862. doi:10.3390/molecules23112862
15. Cabezas, R., Martin-Jimenez, C., Zuluaga, M., Pinzon, A., Barreto, G. E., and Gonzalez, J. (2022). Integrated metabolomics and lipidomics reveal high accumulation of glycerophospholipids in human astrocytes under the lipotoxic effect of palmitic acid and tibolone protection. Int. J. Mol. Sci. 23 (5), 2474. doi:10.3390/ijms23052474
16. Hu, N., Tan, Y., Xiao, X., Gao, Y., Zheng, K., Qian, W., and Zhao, Y. (2025). Antialgal Effects of Nonanoic and Palmitic Acids on Microcystis aeruginosa and the Underlying Mechanisms. *Sustainability*, *17*(3), 1207.
17. Zarei-Ahmady, A., Zare, M., Rshidi, M., Siahpush, A., and Nabipour, I. (2025). Phytochemical analysis, antioxidant, and anticancer activities of three brown algae from the Persian Gulf. *Iranian Journal of Fisheries Sciences*, *24*(2), 385-403.
18. Egbo, C. C., Igboaka, D. C., and Uzor, P. F. (2024). Antimicrobial assay and GC-MS profile of the extract of the endophytic fungus from Annona muricata (Annonaceae) leaf. *Tropical Journal of Natural Product Research*, *8*(4), 7030-7034.
19. Mulatu, A., Megersa, N., Tolcha, T., Alemu, T., and Vetukuri, R. R. (2022). Antifungal compounds, GC-MS analysis and toxicity assessment of methanolic extracts of Trichoderma species in an animal model. *PloS One*, *17*(9), e0274062.
20. Bashir, S., Behiry, S., Al-Askar, A. A., Kowalczewski, P. Ł., Emaish, H. H., and Abdelkhalek, A. (2024). Antibacterial, antifungal, and phytochemical properties of Salsola kali ethanolic extract. *Open Life Sciences*, *19*(1), 20220962.
21. Prasath KG, Tharani H, Kumar MS, Pandian SK. Palmitic Acid Inhibits the Virulence Factors of *Candida tropicalis*: Biofilms, Cell Surface Hydrophobicity, Ergosterol Biosynthesis, and Enzymatic Activity. Front Microbiol. 2020 May 8;11:864.
22. Guimarães A, Venâncio A. The Potential of Fatty Acids and Their Derivatives as Antifungal Agents: A Review. Toxins (Basel). 2022 Mar 3;14(3):188.
23. Aparna V, Dileep KV, Mandal PK, Karthe P, Sadasivan C, Haridas M. Anti-inflammatory property of n-hexadecanoic acid: structural evidence and kinetic assessment. Chem Biol Drug Des. 2012 Sep;80(3):434-9.