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PHARMACOLOGICAL ASSESSMENT OF FUCOIDAN ISOLATED FROM *SARGASSUM* SP. FROM SHANKARPUR BEACH IN MEDINIPUR DISTRICT OF WEST BENGAL, INDIA

Garai P. K.[1], Gupta S.[2], Bagchi S.[3], Sil S. K.*[4]

[1]Research Scholar, Department of Botany, University of Gour Banga, Malda-732103, West Bengal, India.

[2]Assistant Professor, Department of Botany, Malda College, Malda-732101, West Bengal, India.

[3]Assistant Professor, Department of Botany, YSP Mahavidyalaya, Palpara-721458, West Bengal, India.

[4]Professor, Department of Botany, University of Gour Banga, Malda-732103, West Bengal, India.

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***Corresponding Author: Sil S. K.**
Professor, Department of Botany, University of Gour Banga, Malda-732103, West Bengal, India.
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ABSTRACT

This study presents a comprehensive pharmacological assessment of Fucoidan, a sulfated polysaccharide isolated from the brown seaweed *Sargassum* sp. collected from Shankarpur Beach in the Purba Medinipur district of West Bengal, India. Marine natural products are recognized as sustainable sources of bioactive factors with diverse health benefits. The seaweed specimens were harvested in August 2025 and processed to isolate the cell-wall matrix polysaccharides. *In-silico* pharmacokinetic profiling using SwissADME platform was employed to evaluate the molecule's therapeutic potential. Results from the "Boiled Egg" model indicated high gastrointestinal absorption and established that the molecule is not blood-brain barrier (BBB) permeant. Crucially, the Fucoidan isolate demonstrated zero violations of Lipinski's Rule of Five, alongside compliance with Veber, Egan, and Muegge drug-likeness filters, yielding a bioavailability score of 0.56. These findings confirm that Fucoidan from *Sargassum sp.* possesses favorable drug-like properties and significant potential as a bioactive component in nutraceutical and pharmacological applications, particularly for its anti-inflammatory and antioxidant activities.

KEYWORDS: Fucoidan, anti-inflammation, seaweed, bioactive components, molecular docking, Pharmacokinetics.

INTRODUCTION

Marine natural products are extensively delved and have produced colorful promising bioactive factors that can be useful functional rudiments with multiple health benefits. The field of pharmacology has drawn important attention to sulfated polysaccharides purified from brown algae. Recent studies indicate brown algae as a vital and sustainably utilizable artificial source of fucoidans.

Seaweeds are a major source of precious biomolecules that are used in both the nutraceutical and pharmacologicl diligence. In general, Phaeophycean algae are rich in matrix- sulfated polysaccharides (fucoidan) in their cell wall. Fucoidan being a productive source of bioactive factors which have acquired extraordinary interest in recent times. Considerable attention has been concentrated to insulate biomolecules from marine coffers for biomedical operations. Fucoidan substantially constituted with sulfated L- fucose fluently uprooted from the cell wall of brown seaweeds (Phaeophyceae) with hot water (Percival and Ross, 1950) or acid result (Black, 1954) reckoned further than 40 of the dry weight of insulated cell walls (Kloareg, 1984). Fucoidan is a group of marine sulfated polysaccharides set up in the cell- wall matrix of brown algae, containing large proportions of L- fucose and sulfate, together with minor quantities of other sugars like galactose, xylose, glucose, mannose, uronic acids and rhamnose (Chandia and Matsuhiro, 2008; Qu et al., 2014).

Fucoidan possesses colorful biomedical parcels still it's believe that the exertion substantially depends upon their sulphate content, monosaccharide composition and molecular weight.

It has been reported that this alga contains a wide range of bioactive composites and a broad diapason of natural conditioning that include antioxidant, antibacterial, antilipidemic, membrane stabilizing parcels, defensive against medicine metabolizing enzymes and control the excrescence necrosis factor- nascence (Raghavendran et al., 2005; Raghavendran et al., 2006; Matanjun et al., 2010). In addition it has been used to alterviate eczema, heart affections, lung conditions, renal dysfunction, scabies, ulcer, viral hepatitis, psoriasis and to promote the stashing of corrosiveness (Rioux et al., 2010).

MATERIALS AND METHODS

Healthy specimen the brown seaweed *Sargassum* sp. remain immersed in the seawater during low tide and was collected from Shankarpur Beach, located 14 km from Digha in Purba Medinipur, West Bengal during August 2025. The collected specimens was kept in plastic bags with seawater and brought to the laboratory. Specimens were cleaned by washing thoroughly with to remove epiphytes, followed by running fresh water and distilled water to remove the salts and other extraneous materials. The specimens were separated into leaf blade, air bladder and stem. After air drying in shade dry for 20 days, then the dried sample was blended in electric mixer and were pulverized into fine powder then stored airtight food grade polythene bags. Crude fucoidans obtained were estimated for their biochemical compositions such as total carbohydrate (Dubois et al., 1956), L-fucose (Dische and Shettles, 1948) and sulphate (Verma et al., 1977) contents.

RESULTS AND DISCUSSION

The study highlights the significant potential of Fucoidan isolated from *Sargassum sp.* as a bioactive marine natural product. As a sulfated polysaccharide primarily composed of L-fucose, Fucoidan serves as a critical structural component of the brown algae cell wall. The extraction and subsequent biochemical estimation confirm its complex

nature, containing not only fucose and sulfate but also minor quantities of galactose, xylose, and uronic acids. The therapeutic versatility of Fucoidan is well-supported by literature, spanning antioxidant, anti-inflammatory, and membrane-stabilizing properties. Its ability to modulate drug-metabolizing enzymes and control tumor necrosis factor-alpha suggests a protective role against hepatic toxicity, as seen in previous studies. Furthermore, the broad spectrum of clinical applications—ranging from cardiovascular protection to treating skin conditions like eczema and psoriasis—underscores its value in both the nutraceutical and pharmaceutical industries.

In-Silico Pharmacokinetics and Drug-likeness

The SwissADME analysis provides crucial insights into the "druggability" of the isolated compound: Absorption and Distribution: The compound exhibits high gastrointestinal absorption, which is a positive indicator for oral bioavailability. However, it is not BBB permeant, suggesting that its effects are likely peripheral rather than central. Metabolism: The data indicates that Fucoidan does not inhibit major Cytochrome P450 enzymes (CYP1A2, CYP2C19, etc.), implying a low risk for herb-drug interactions involving these metabolic pathways. Drug-likeness Rules: Remarkably, the compound shows zero violations of Lipinski's Rule of Five, and it also satisfies the Veber, Ghose, Egan, and Muegge criteria. This strongly suggests that the molecule possesses the physical-chemical properties required for a viable oral drug in humans. Bioavailability: With a bioavailability score of 0.56, the compound demonstrates a favorable profile for systemic exposure.

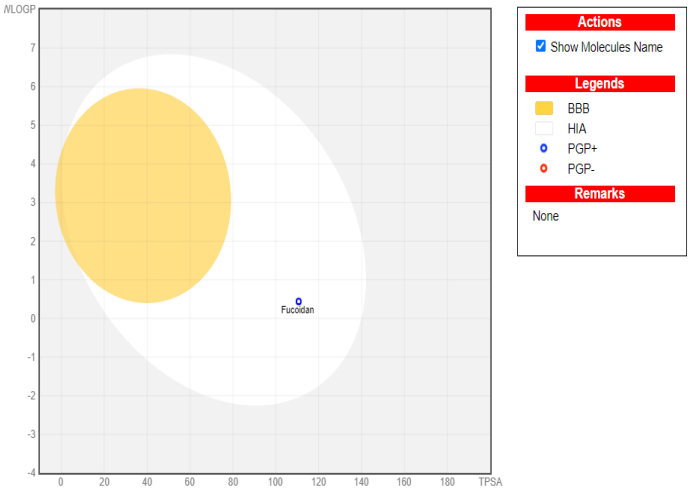

Figure 1: Boiled egg representation for the bioavailability aspect of fucoidan.

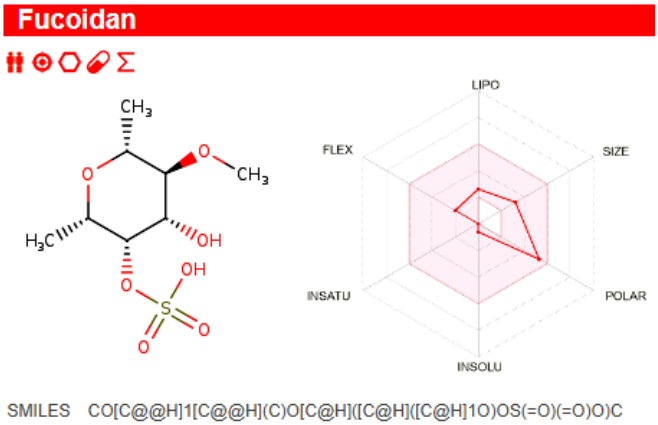

Figure 2: Molecular structure and bioavailability radar for fucoidan.

Pharmacokinetics	
GI absorption	High
BBB permeant	No
P-gp substrate	Yes
CYP1A2 inhibitor	No
CYP2C19 inhibitor	No
CYP2C9 inhibitor	No
CYP2D6 inhibitor	No
CYP3A4 inhibitor	No
Log K_p (skin permeation)	-8.56 cm/s
Druglikeness	
Lipinski	Yes; 0 violation
Ghose	Yes
Veber	Yes
Egan	Yes
Muegge	Yes
Bioavailability Score	0.56
Medicinal Chemistry	
PAINS	0 alert
Brenk	1 alert: sulfonic_acid_2
Leadlikeness	Yes
Synthetic accessibility	4.60

Figure 3: Scan-shot of the Swiss-ADME output portal showing the different parameters suitable for the drug likeliness of fucoidan.

CONCLUSION

This study successfully isolated and characterized Fucoidan from *Sargassum sp.* sourced from the coastal region of West Bengal. The biochemical analysis confirmed a rich composition of sulfated L-fucose, while *in-silico* pharmacological profiling demonstrated that the isolate possesses excellent drug-likeness and high gastrointestinal absorption without significant metabolic toxicity.

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