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EVALUATION OF NUTRITIONAL, PHYTOCHEMICAL PROFILE AND *IN VITRO* ANTI-OBESITY ACTIVITY OF SEAWEED *Gracilaria edulis*

Nageshwari R and Karthika N*

PG and Research department of Botany, Kunthavai Naacchiyar Govt Arts College for Women (Autonomous), Thanjavur, Tamil Nadu, S. India

*****Corresponding author

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ABSTRACT

The chronic metabolic disease known as obesity is brought on by an imbalance between energy imbalances. Obesity and overweight are characterized by excessive or aberrant fat accumulation that poses a health risk. A global health concern is obesity. Inhibiting the pancreatic lipase enzyme can help treat obesity by reducing the systemic absorption of dietary fat. In the aim of the present study Evaluation of nutritional, phytochemical profile and *in vitro* anti-obesity activity of seaweed *Gracilaria edulis* ethanolic extract. *Gracilaria edulis* seaweeds containing primary and secondary metabolites of saponin, steroids, terpenoids, alkaloids, polyphenol, protein, carbohydrates, amino acids, and lipids. Proximate results point to a strong nutritional value that could be utilized as a human nutrient source and treatment. Additionally minerals and vitamins are screening with supported by Nutritional and biological properties. The ethanolic extract of *Gracilaria edulis* was found to have concentration-dependent lipase inhibitory activity, with an IC_{50} value of 290.72 µg/mL. Overall, it appears that inhibiting lipase enzymes has a significant impact on the biochemical composition of *Gracilaria edulis*. The phytochemicals involved in these bioactive compounds are linked to biological activities that prevent and reduce obesity.

Keywords: *Gracilaria edulis,* Seaweeds, Nutritional, Phytochemical, Anti-obesity.

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INTRODUCTION

Obesity is a major public health issue globally (Al-Snafi and Alfuraiji, 2023; Gołacki and Matyjaszek-Matuszek, 2024). Obesity has raised concerns about a number of diseases, including cancer, dementia, dyslipidemia, hypertension, and type 2 diabetes mellitus (T2-DM) (Youn et al., 2024). Obese people frequently have lipid abnormalities, such as elevated triglycerides, low-density lipoprotein (LDL), and cholesterol levels. There are anti-obesity drugs, but they frequently have unfavorable side effects that can damage the liver, kidneys, and lungs. Alternatively, because they are frequently eaten as food, medicinal plants are used because they are less expensive and are thought to be safe. The anti-obesity properties of medicinal plants have been extensively researched (Al Jaberi et al., 2024). One of the most extensively researched techniques for assessing the possible ability of natural products to prevent the absorption of dietary fat is the inhibition of pancreatic lipase, the enzyme that breaks down and absorbs triglycerides. Inhibiting this enzyme may be a great way to reduce energy intake from dietary fat and prevent and treat obesity (Kim et al., 2016). It is well known that pancreatic lipase inhibition, which lowers fat absorption, helps control obesity (Ahn et al., 2012).

The potential uses of macroalgae in the pharmaceutical and nutraceutical industries as a source of bioactive pharmaceuticals and food ingredients have generated a lot of interest (Gómez-Zorita et al., 2020). Both macro and micronutrients can be found in seaweeds. They are actually known to be high in water- and lipid-soluble vitamins and minerals, especially iron and magnesium. Because they contain all of the essential amino acids, marine algae are a good source of proteins when it comes to macronutrients (Cherry et al., 2019; Gómez-Zorita et al., 2020). Antioxidant, antimicrobial, anti-inflammatory, anti-cancer, anti-diabetic, anti-hypertensive, anti-hyperlipidemic, and anti-obesity properties have been demonstrated for macroalgae and their extracts (Roohinejad et al., 2017). The effectiveness and mode of action of anti-obesity components derived from marine origin, particularly edible sources, such as lipids, polysaccharides, phlorotannins, carotenoids, and others, are summarized. These marine-derived compounds may be great sources for the creation of functional foods that combat obesity because of their anti-obesity effect (Hu et al., 2016). Vitamins, proteins, omega-3 polyunsaturated fatty acids, essential minerals and trace elements, carotenoids, polyphenols, enzymes, and carbohydrates are just a few of the highly valuable bioactive compounds found in seaweeds. Numerous biological activities, including antioxidant, anticancer, antidiabetic, antimicrobial, anticoagulant, antiviral, anti-inflammatory, immunomodulatory, prebiotic, and hypocholesterolemic effects, have been linked to their bioactive compounds (Matos et al., 2024). One promising source of anti-obesity agents is marine algae, particularly seaweeds. Seaweeds contain four main bioactive compounds that may be used as anti-obesity agents (Wan-Loy and Siew-Moi, 2016).

Seaweeds contain pancreatic lipase inhibitors, which reduce the absorption of dietary fat in the gut by preventing its breakdown into fatty acids. The current study aims to evaluate the seaweed *Gracilaria edulis* nutritional profile, phytochemical profile, and in vitro anti-obesity activity.

MATERIALS AND METHODS

Collection and extraction of seaweed

Gracilaria edulis seaweed was obtained from Sethubavachatram, Thanjavur, Tamil Nadu, India, in 2025. After cleaning and drying, it was ground into a fine powder and stored in a refrigerator. 2 grams of the powder of seaweed were transferred into two conical flasks (250 ml). The conical flask contains 50 ml of ethanol and 50 ml of aqueous solvent. The conical flask containing *Gracilaria edulis* was shaken well for 45 minutes by hand. After 24 hrs, the extracts were filtered using Whatman filter paper no. 1, and the filtrate was used for further analysis.

Phytochemical screening and quantification

Phytochemical tests were carried out by Sofowara (1993), Trease and Evans (1989), and Harborne (1973, 1984). Total phenols were estimated by the method of Edeoga *et al*. (2005). Total terpenoid content in the leaf extracts was assessed by the standard method (Ferguson, 1956).

Qualitative analysis of Inorganic elements and vitamins

2 g of sample was prepared and treated with 37.5 ml HNO_3 and 12.5 ml HCl (3:1 v/v) for 1 hour. After the filtration, the filtrate was used to perform the inorganic elements tests (Khandelwal, 2006). Extraction of Water-Soluble Vitamin (Vitamin C). Vitamin C was extracted according to a modification of the method by Babarinde and Fabunmi (2009) and the extraction of fat-soluble vitamins (vitamin A, E, and beta-carotene). Vitamin A, E, and beta-carotene were extracted by Aumaporn (2009) and Jun *et al.* (2007).

Proximate analysis

Protein was estimated by the method of Lowry *et al.* (1951). Total lipids in tissues were estimated by the method of Folch *et al.* (1957). To estimate the amount of carbohydrate present in the given sample by using the Anthrone method (David and Plummer, 1990). Amino acids in tissues were estimated by the method of Rosen (1957).

In vitro anti-obesity activity

In vitro anti-obesity activity of *Gracilaria edulis* ethanolic extract was carried out by Rashmi Shivanna *et al*., (2017).

RESULTS AND DISCUSSION

Phytochemicals and nutrient profile

Seaweed is a significant source of primary and secondary metabolites, with involved in different pharmacological activities are exhibited by these bioactive compounds (Almeida *et al.*, 2011; Zandi *et al.*, 2010). Present *Gracilaria edulis* seaweed secondary metabolites containing saponin, steroids, terpenoids, alkaloids, and polyphenol in both extracts of aqueous and ethanol, while primary metabolites of protein, carbohydrates, amino acids, and lipids (Tables 1 and 2). The significant amounts of total phenol (139.43±10.03 mg/gm) and terpenoids (10.07±3.59 mg/gm) were, respectively. The inorganic components and vitamins of *Gracilaria edulis* are displayed in Table 3. Micronutrient components noticed in *G. edulis*, which are in vitamins A, E, and C, indicate that seaweeds have a high nutritional value (Sakthivel and Devi, 2015). *Gracilaria edulis* primary metabolites of protein (7.40±1.05 mg/g), carbohydrates (31.37±4.67 mg/g), amino acids (400.00±22.19 mg/g of protein), and lipids (7.00±0.16 mg/g), respectively (Table 4). Similarly, Sakthivel and Devi (2015) studied *Gracilaria edulis*, nutritional profiles of dietary fiber (8.9 ± 0.62%), carbohydrate (101.61 ± 1.8 mg/g), crude protein (6.68 ± 0.94 mg/g), and lipid content (8.3 ± 1.03 mg/g).

Table 1: Qualitative screening of secondary metabolites of *Gracilaria edulis* seaweed

S. No	Phytochemicals	Aqueous	Ethanol
1	Tannin	-	-
2	Saponin	+	+
3	Flavonoids	-	-
4	Steroids	+	+
5	Terpenoids	+	+
6	Alkaloids	+	+
7	Antroquinone	-	-
8	Polyphenol	+	+
9	Glycoside	-	-
10	Coumarins	-	-

(+) Presence, and (–) Absences

Table 3: Qualitative screening of primary metabolites of *Gracilaria edulis* seaweed

S. No	Phytochemicals	Results
1	Protein	+
2	Carbohydrate	+
3	Amino acids	+
4	Lipids	+

(+) Presence, (++) High concentrations and (–) Absences

Table 3: Qualitative analysis of minerals and vitamins in *Gracilaria edulis* seaweed

S. No	Minerals	*Gracilaria edulis*
1	Calcium	++
2	Magnesium	+
3	Sodium	++
4	Potassium	+++
5	Iron	+
6	Sulphate	-
7	Phosphate	+
8	Chloride	++
9	Nitrate	++

S. No	Vitamins	*Gracilaria edulis*
1	Vitamin A	+
2	Vitamin C	+
3	Vitamin D	-
4	Vitamin E	++

(+) Presence, (++) High concentration and (-) Absence

Table 4: Proximate composition of *Gracilaria edulis* seaweed

S. No	Analysis	Results
1	**Protein (mg/gm)**	7.40±1.05
2	**Carbohydrates (mg/gm)**	31.37±4.67
3	**Amino acids (mg/g of protein)**	400.00±22.19
4	**Lipids (mg/gm)**	7.00±0.16

Values expressed as Mean ±SD (N=3)

Marine environment naturally provided rich source of secondary metabolites, including alkaloids with involved in biological properties (Karnan *et al.*, 2022; Karnan *et al.*, 2023). Total phenol content is higher in *G. corticata* (4.00 ± 0.35 mg GAE/g) than in *G. edulis* (3.4 ± 0.21 mg GAE/g). There was a significant difference in the total flavonoid content between the extracts of *G. corticata* and *G. edulis*, with 3.33 ± 0.12 and 2.6 ± 0.08 mg CE/g DW, respectively (Arulkumar et al., 2018). The antiproliferative activity properties of *G. edulis* secondary metabolites have been reported by Sakthivel et al. (2016), Asik et al. (2019), and Patra and Muthuraman (2013). Seaweeds have the potential for future industrial uses and research, so it will be beneficial to study and determine their nutritional values (Premarathna et al., 2022). These results indicate that *G. edulis* has a high nutritional value and may be utilized for human biological purposes and as a source of nutrients, including reduced the obesity development.

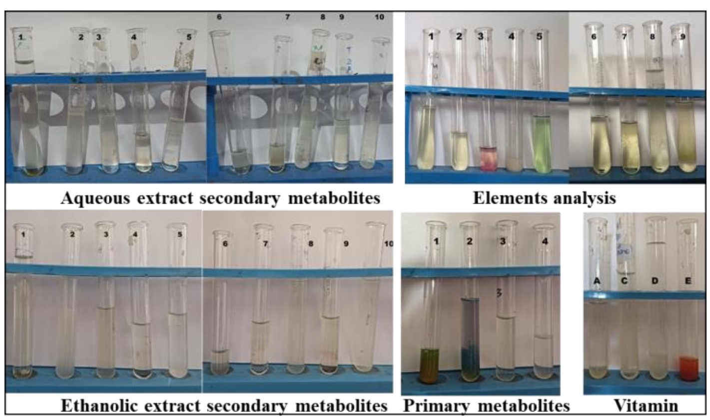

Figure 1: *Gracilaria edulis* seaweed biochemical screening

***In vitro* anti-obesity activity**

Obesity has emerged as a global health concern that impacts individuals worldwide, in both developed and developing nations. The breakdown of lipids into fatty acids is aided by pancreatic lipase, and when its activity is inhibited, the body absorbs fewer monoglycerides. Finding the pancreatic lipase inhibitor was the aim of the lipase inhibition (Iswantini *et al.*, 2021). The ethanolic extract of the seaweed Gracilaria edulis has been shown to have anti-obesity properties in vitro through pancreatic lipase inhibition. The *in vitro* lipase inhibitory activity of *Gracilaria edulis* ethanolic extract was found an IC_{50} value of 290.72 µg/mL, compared to 46.67 µg/mL for the positive control (Std. Orlistat drug) with demonstrated concentration-dependent (Figure 2).

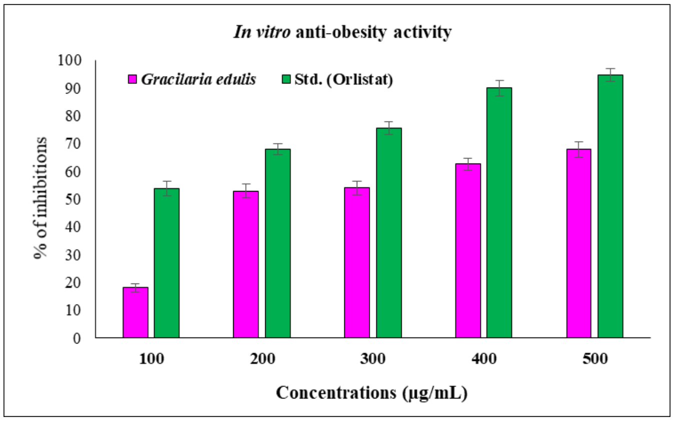

Figure 2: *In vitro* anti-obesity activity of *Gracilaria edulis* seaweed ethanolic extract

Plants and algae known as seaweed can be found growing in lakes, rivers, and oceans. According to studies, seaweed may be used therapeutically to control obesity and body weight (Yadav et al., 2024). Globally, the therapeutic potential of the abundance of naturally occurring seaweed bioactive compounds for the treatment of obesity has been investigated (Yadav et al., 2024). Both primary and secondary metabolites are found in seaweeds; primary metabolites, such as fiber and carbohydrates, help prevent obesity and cardiovascular disease, while secondary metabolites combat stress. It has been observed that secondary metabolites like fucoxanthin and polyphenols reduce obesity and suppress appetite (Yadav et al., 2024). Consuming seaweed has been shown to have potential therapeutic benefits in the treatment of obesity and body weight (Lange *et al.*, 2015). By decreasing the absorption of carbohydrates and dietary lipid, *M. domestica* and *Canarium sp.* prevent the accumulation of fat (Utami *et al.*, 2019). *Sargassum polycystum* is a seaweed that has been reported by Awang *et al.* (2014) to be a promising anti-obesity agent. The ethanolic extract of *Gracilaria edulis* seaweed showed promise in preventing obesity and had a positive effect on lipase enzyme inhibition.

CONCLUSION

Gracilaria edulis seaweed contains active compounds of saponin, steroids, terpenoids, alkaloids, and polyphenols, while also containing inorganic elements and vitamins such as vitamin C and vitamin E, which respond to the antioxidant and anti-obesity properties of *Gracilaria edulis* seaweeds. Finding the pancreatic lipase inhibitor of seaweed *Gracilaria edulis*, whose results have been shown to have anti-obesity properties, which results in preventing obesity. Overall, the biochemical composition of *Gracilaria edulis* seems to be strongly influenced by inhibiting lipase enzymes, with the involved phytochemicals of *Gracilaria edulis* bioactive compounds being associated with the biological activities of anti-obesity.

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