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Antimycobacterial and Anti-Inflammatory Potential of the Antarctic Alga *Desmarestia anceps*: Identification of Potential Leads

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INTRODUCTION & AIM

Tuberculosis (TB), caused by *Mycobacterium tuberculosis* (Mtb), remains the leading cause of infectious mortality worldwide, and the emergence of drug-resistant strains has intensified the search for new therapeutic agents[1]. Marine macroalgae from extreme and underexplored ecosystems such as Antarctica represent promising sources of bioactive metabolites[2,3]. This study investigated the chemical diversity and biological potential of the Antarctic macroalgae *Desmarestia anceps*. Extracts from eight Antarctic Peninsula sites were screened for antimycobacterial and anti-inflammatory activities, identifying the Penguin Island extract as the most active. Bioassay-guided fractionation revealed DAF2 as the most potent fraction, exhibiting dual antimycobacterial and immunomodulatory effects without cytotoxicity. Chromatographic and spectroscopic analyses characterized the active fractions, leading to the identification of bioactive metabolites belonging mainly to the sterol, diterpene, and fatty acid classes.

METHOD

Study Sites and Organisms

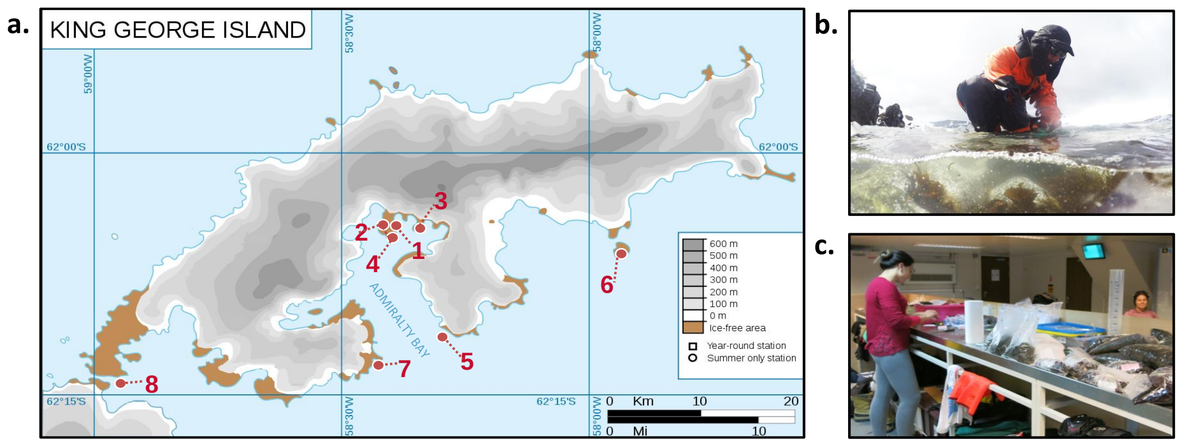
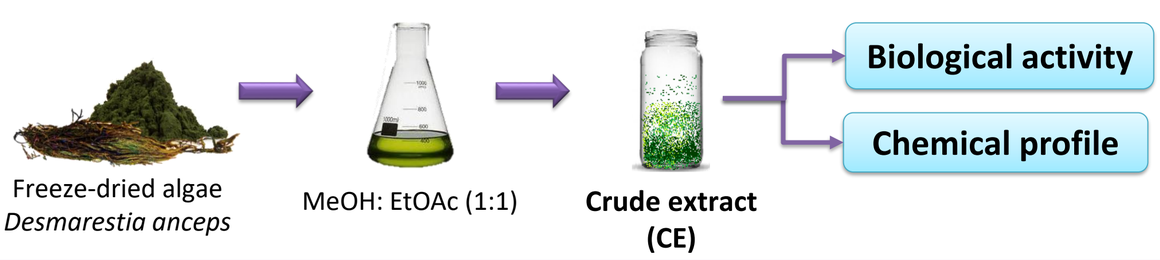
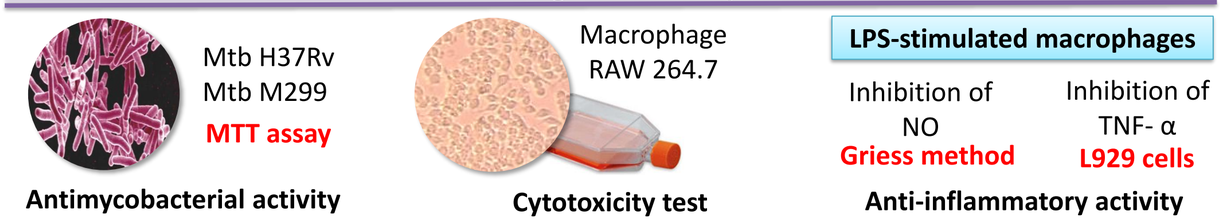


Figure 1. a. Sampling sites of marine macroalgae collected on Antartic Peninsula. 1. Comandante Ferraz Antarctic Station (EACF), 2. Ipanema, 3. Punta Ullmann, 4. Punta Plaza, 5. Vaureal Peak, 6. Penguin Island, 7. Demay Point, 8. Two Summit Island. **b.** Macroalgae collection. **c.** Screening.

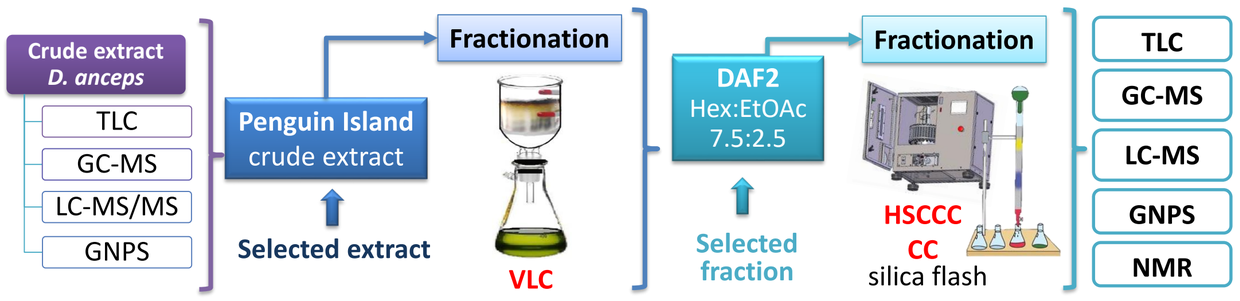
Macroalgae extract preparation



Biological activity



Fractionation and analysis of the chemical profile



RESULTS & DISCUSSION

Table 1. Antimycobacterial, anti-inflammatory, and cytotoxic activities of crude extract from *D. anceps.*

Sample	Mtb H37Rv	NO	TNF-α	MTT
	MIC_{50} µg/mL	IC_{50} µg/mL	IC_{50} µg/mL	CC_{50} µg/mL
EACF	80.8 ± 1.0	8.8 ± 1.1	12.6 ± 1.1	41.5 ± 1.1
Ipanema	10.3 ± 1.1	8.0 ± 1.1	14.1 ± 1.1	40.4 ± 1.1
Punta Ullmann	70.5 ± 1.0	91.0 ± 1.0	70.1 ± 1.1	44.4 ± 1.1
Punta Plaza	21.6 ± 1.1	16.2 ± 1.0	11.1 ± 1.1	15.2 ± 1.1
Two Summit Island	>100	25.6 ± 1.0	29.7 ± 1.1	19.2 ± 1.1
★ Penguin Island	**6.6 ± 1.1**	**4.2 ± 1.1**	**21.4 ± 1.1**	**16.8 ± 1.1**
Demay Point	>100	20.8 ± 1.1	36.7 ± 1.0	36.7 ± 1.0
Vaureal Point	83.8 ± 1.1	20.9 ± 1.0	24.4 ± 1.1	32.0 ± 1.0

Figure 2. Chemical profile analysis of the crude extract from *D. anceps* collected at different sites along the Antarctic Peninsula.

Table 2. Antimycobacterial, anti-inflammatory, and cytotoxic activities, and Selectivity Index (SI) of the crude extract and its fractions obtained from *D. anceps* collected at Penguin Island.

Sample	MIC_{50} (µg/mL)		IC_{50} (µg/mL)	CC_{50} (µg/mL)
	Mtb H37Rv	Mtb M299	NO	RAW 264.7
Penguin Island	**6.6 ± 1.1**	**75,9 ± 1,1**	**4.2 ± 1.1**	16.8 ± 1.1
★ DAF2	**16.9 ± 1.3**	**61.7 ± 1.5**	30.0 ± 1.2	**>100**
DAF3	**16.7 ± 1.3**	**61.7 ± 1.5**	**3.7 ± 1.2**	11.1 ± 1.1
DAF4	42.8 ± 1.5	>100	**7.0 ± 2.0**	23.8 ± 1.2
DAF5	**16.1 ± 1.3**	>100	25.2 ± 1.1	68.5 ± 1.0
DAF6	>100	>100	**9.7 ± 1.2**	**>100**
Rifampicin	0.2 ± 0.1	1.1 ± 0.1	xx	xx
L-NMMA	xx	xx	17.7 ± 1.3	xx

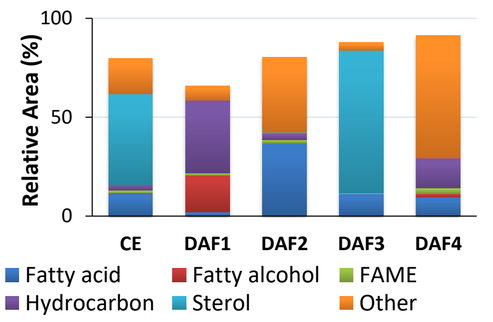


Figure 3. Analysis of the chemical profile based on the relative area percentage identified by chemical class of the CE and nonpolar fractions of *D. anceps* collected from Penguin Island.

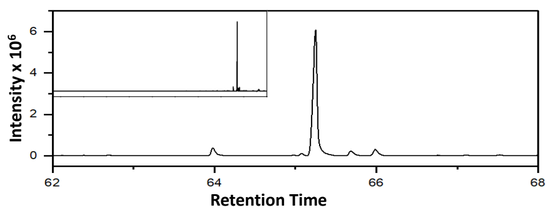


Figure 4. Chromatogram obtained from the subfraction analyzed by GC–MS, showing a major peak corresponding to isolated compounds **PB1**

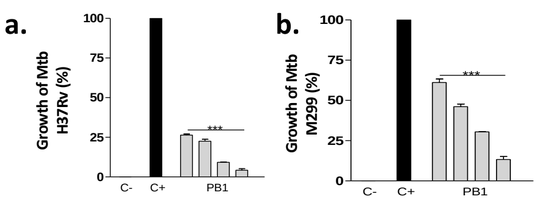


Figure 5. Inhibitory effect of the isolated compound **PB1** on the growth of Mtb H37Rv (a) and hypervirulent Mtb strain M299 (b).

Table 3. Inhibitory effects of the isolated compound **PB1** on growth of Mtb H37Rv and M299 in culture, on production of NO by LPS-stimulated RAW 264.7 macrophages and evaluation of cytotoxicity.

Sample	Mtb H37Rv		Mtb M299		MTT	NO
	MIC_{50} (µg/mL)	MIC_{90} (µg/mL)	MIC_{50} (µg/mL)	MIC_{90} (µg/mL)	CC_{50} (µg/mL)	CC_{50} (µg/mL)
PB1	0.37 ± 0.09	3.47	3.05 ± 1.11	28.18	51.45 ± 0.69	49.12 ± 1.15
Rifampicin[1]	0.009 ± 0.001	XX	1.0 ± 0.1	XX	XX	XX
L-NMMA[2]	XX	XX	XX	XX	XX	13,2 ± 0,6

[1]Standard antimycobacterial drug; [2]Nitric oxide inhibitor; Mean value ± SD; n = 3; XX – not defined.

CONCLUSION

Analyses revealed site-dependent metabolic diversity in *D. anceps* extracts, with the Penguin Island sample showing the strongest dual antimycobacterial and anti-inflammatory activity. Bioassay-guided fractionation identified DAF2 as the most active fraction, containing a major bioactive compound **PB1** among the compounds detected with potent and selective inhibition of both Mtb H37rv and hypervirulent strain M299. These findings underscore the therapeutic potential of Antarctic macroalgae for TB drug discovery.

FUTURE WORK / REFERENCES

Next steps will involve testing *D. anceps* metabolites, in macrophage infection models and *in vivo* TB studies to confirm their antimycobacterial and anti-inflammatory effects and explore their potential as new therapeutic agents.

[1]World Health Organization. **2024**.

[2]Avila, C. Planta Med., **2016**, 82, 767–774.

[3]Lim, M. *et al.* Fitoterapia, **2024**, 176, 106025.