



In vitro anti-Candida activity of a *Spirulina platensis* extract: a new approach for the treatment of fungal infections?



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INTRODUCTION AND PURPOSE

The high incidence of muco-cutaneous *Candida* infections, combined with the increasing azole-resistance problem, highlights the quest for new effective therapeutic strategies. In this context, natural compounds can represent promising alternatives, but relatively few were found to be sufficiently active and non-toxic for human beings.

The cyanobacterium *Spirulina platensis*, a blue-green alga, exhibits a potential antimicrobial activity against Gram-positive and Gram-negative bacteria. Nevertheless, only few data about antifungal properties of *Spirulina platensis* are available and its potential toxic effects have not been largely investigated yet.

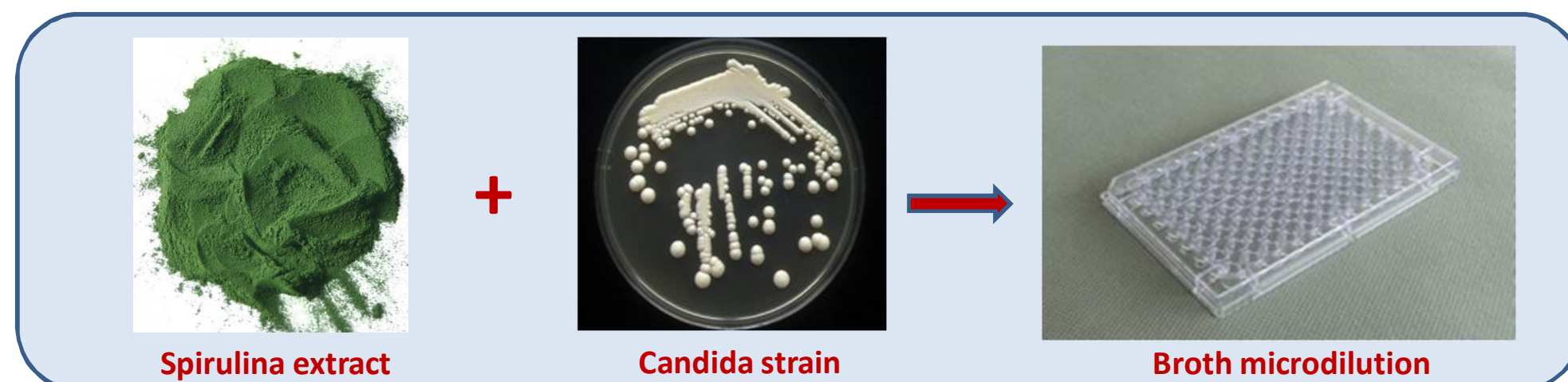
The aim of this study was to evaluate the *in vitro* activity of an extract of *Spirulina platensis* against different strains of *Candida* spp. Moreover, we investigated whether the natural compound exerts target activities on the smooth muscle of different tissues and whether it displays negative effects on the health-promoting microorganisms of the human endogenous flora.

METHODS

Spirulina platensis was kindly supplied by Alchemistry srl. *Candida* strains were isolated from vaginal and oral swabs submitted to the Microbiology Laboratory of Sant'Orsola Hospital of Bologna, Italy, for routine diagnostic procedures. A total of 26 strains belonging to the commonest clinical species were tested, determining the *in vitro* activity of the microalga extract by broth microdilution assay for antifungal agents in accordance with EUCAST guidelines (www.eucast.org). The minimum inhibitory concentration (MIC) was considered as the lowest concentration of microalga extract giving rise to an inhibition of growth of $\geq 50\%$ of that of control. Minimal fungicidal concentration (MFC) was defined as the lowest concentration showing approximately 99 to 99.5% of killing activity.

Functional studies on uterine, esophageal and tracheal smooth muscle were performed on organs excised from guinea pigs. The amplitude and the frequency of spontaneous phasic contractions were measured, after placing the organs in a buffer containing various concentrations of microalga extract.

To assess the compatibility of *Spirulina platensis* towards the endogenous microbiota, its antibacterial activity against several *Lactobacillus* and *Bifidobacterium* strains isolated from human vaginal and gastro-intestinal tracts was evaluated. The inhibitory activity was determined by the agar dilution method following the procedure defined by the National Committee for Clinical Laboratory Standards.



RESULTS

The MIC and MFC values of microalga extract ranged from 0.125 to 0.5 mg/ml. Detailed results are presented in the table below. The spontaneous motility of tissue smooth muscle was not altered by the microalga extract, as underlined by the absence of aberrant contractions. Finally, bifidobacteria and lactobacilli grew in the presence of *Spirulina platensis* up to the highest concentration tested (10 mg/ml)

Strains	Source	<i>S. platensis</i> MIC	<i>S. platensis</i> MFC	Amphotericin B MIC
<i>Candida albicans</i>	Vaginal swab	0.25 mg/ml	0.25 mg/ml	1 µg/ml
<i>Candida albicans</i>	Vaginal swab	0.25 mg/ml	0.25 mg/ml	1 µg/ml
<i>Candida albicans</i>	Vaginal swab	0.25 mg/ml	0.25 mg/ml	0.5 µg/ml
<i>Candida albicans</i>	Vaginal swab	0.25 mg/ml	0.25 mg/ml	1 µg/ml
<i>Candida albicans</i>	Vaginal swab	0.125 mg/ml	0.125 mg/ml	0.125 µg/ml
<i>Candida albicans</i>	Vaginal swab	0.25 mg/ml	0.25 mg/ml	1 µg/ml
<i>Candida albicans</i>	Vaginal swab	0.25 mg/ml	0.25 mg/ml	0.125 µg/ml
<i>Candida albicans</i>	Vaginal swab	0.25 mg/ml	0.25 mg/ml	0.125 µg/ml
<i>Candida albicans</i>	Vaginal swab	0.25 mg/ml	0.25 mg/ml	0.125 µg/ml
<i>Candida albicans</i>	Vaginal swab	0.25 mg/ml	0.25 mg/ml	0.125 µg/ml
<i>Candida albicans</i>	Vaginal swab	0.25 mg/ml	0.25 mg/ml	0.125 µg/ml
<i>Candida albicans</i>	Oral swab	0.25 mg/ml	0.25 mg/ml	0.06 µg/ml
<i>Candida albicans</i>	Oral swab	0.25 mg/ml	0.25 mg/ml	0.06 µg/ml
<i>Candida albicans</i>	Oral swab	0.25 mg/ml	0.25 mg/ml	0.06 µg/ml
<i>Candida albicans</i>	Oral swab	0.25 mg/ml	0.25 mg/ml	0.125 µg/ml
<i>Candida albicans</i>	Oral swab	0.25 mg/ml	0.25 mg/ml	0.125 µg/ml
<i>Candida glabrata</i>	Vaginal swab	0.5 mg/ml	0.5 mg/ml	0.125 µg/ml
<i>Candida glabrata</i>	Vaginal swab	0.5 mg/ml	0.5 mg/ml	0.25 µg/ml
<i>Candida glabrata</i>	Vaginal swab	0.5 mg/ml	0.5 mg/ml	0.125 µg/ml
<i>Candida glabrata</i>	Oral swab	0.5 mg/ml	0.5 mg/ml	0.125 µg/ml
<i>Candida lusitanae</i>	Vaginal swab	0.125 mg/ml	0.125 mg/ml	0.5 µg/ml
<i>Candida tropicalis</i>	Vaginal swab	0.125 mg/ml	0.125 mg/ml	0.125 µg/ml
<i>Candida tropicalis</i>	Oral swab	0.125 mg/ml	0.125 mg/ml	0.125 µg/ml
<i>Candida krusei</i>	Vaginal swab	0.125 mg/ml	0.125 mg/ml	0.25 µg/ml
<i>Candida parapsilosis</i>	Vaginal swab	0.5 mg/ml	0.5 mg/ml	0.25 µg/ml
<i>Candida guilliermondii</i>	Oral swab	0.5 mg/ml	0.5 mg/ml	1 µg/ml

CONCLUSIONS

The good antimicrobial effect against *Candida* strains in addition to the absence of toxicity, could allow the use of *Spirulina platensis* as a formulation for vaginal and oral candidiasis