Cyanobacteria as potential food preservatives and pharmaceutical supplements

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ABSTRACT

The purpose of this work is to underline the potential of cyanobacteria in the production of health foods and as an antioxidant carrier in the food and pharmaceutical industries. The present study investigates the phenolic profile of extracts of several cyanobacteria (*Nostoc* sp., *Nostoc* cf. *commune, Nodularia spumigena*, *Leptolyngbya protospira, Phormidiochaete* sp., and *Arthrospira platensis*) from the culture collection at the Spanish Bank of Algae. The use of reversed-phase high-performance liquid chromatography (RP-HPLC) permitted the identification of 6 phenolic constituents: gallic acid, (+) catechin, (-) epicatechin, syringic acid, protocatechuic acid and chlorogenic acid. The extracts were screened for their antioxidant activity in inhibiting the stable radical 1,1-diphenyl-2- picrylhydrazyl (DPPH). Cyanobacteria *Nostoc* cf. *commune* was the only one that showed the presence of phenolic compounds (71 µg of gallic acid and 2.16 µg of protocatechuic acid per gram of freeze-dried biomass). The tested phenolic compounds were not detected in the extracts derived from *Leptolyngbya protospira, Phormidiochaete* sp., *Nodularia spumigena* and *Nostoc* sp. However, these four cyanobacteria strains showed antioxidant activity.

INTRODUCTION

Phenolic compounds are secondary metabolites of plants with well known health benefits. Epidemiological studies strongly suggested that long term consumption of diets rich in phenolic compounds offered some protection against development of cancers, cardiovascular diseases, diabetes, osteoporosis and neurodegenerative diseases. In living systems under stress, the excessive generation of hydroxyl radical (OH-) and other highly reactive oxygen species (ROS) produce oxidative damage through the reaction of these species with almost every cellular biomolecules including DNA. Phenolic compounds are radical scavengers and inhibit iron-mediated oxyradical formation preventing various processes of oxidative stress considered the origin of the above cited diseases [1].

By other hand, the most widely food synthetic preservatives, butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA), have been restricted because all published findings agree with the fact that they are tumor promoters [2,3]. BHA induces tumors of the forestomach in animals, which are dose dependent, whereas BHT induces liver tumors in long-term experiments. Therefore, crude extracts of plant materials are increasingly of interest in food industry as potential sources of safe antioxidants to replace these synthetics preservatives. The increased demand for healthy foods could find a nontraditional ally in cyanobacteria. Recent studies revealed beneficial effects of plant extracts in several food preparations, improving antioxidant properties by increasing the content of phenolic compounds and carotenoids without affecting their cooking, textural and sensory properties [4]. In this sense, cyanobacteria may become an alternative source of natural antioxidants and other ingredients with potential benefits to consumers. Despite the important role of phenolic compounds, few reports have focused on the identification and quantification of polyphenols in cyanobacteria [5,6].

The main aims of the current investigation were: (i) to study the antioxidant activity of extracts derived from several cyanobacteria strains (*Nostoc* sp. (BEA 1052B), *Nostoc* cf. *commune* (BEA 0024B), *Nodularia spumigena* (BEA 0854B), *Leptolyngbya protospira* (BEA 0661B), *Phormidiochaete* sp. (BEA 0762B) and *Arthrospira platensis* (BEA 0016B); (ii) to identify and quantify the phenolic profiles of the extracts. The above cited cyanobacteria strains were bioprospected at the Canarian region and deposited at the culture collection of the Spanish Bank of Algae (Taliarte, Spain). These results will help to improve our knowledge about cyanobacteria and their potential uses.

MATERIAL & METHODS

Cyanobacteria strains were provided by the Spanish Bank of Algae (Taliarte, Spain). The standard compounds gallic

acid (GA), (+) catechin (C), (-) epicatechin (E), syringic acid (SA), protocatechuic acid (PA), chlorogenic acid (CA), BHA and BHTwere purchased from Sigma-Aldrich Chemie (Steinheim). Chromatographic analysis was performed on a Liquid Chromatography Varian system equipped with a diode array detector (DAD) and connected to a Star software. The Radical Scavenging Activity (RSA) was determined by measuring the loss of DPPH color at 515 nm after reaction with the samples. To test the antioxidant activity of the synthetic phenolic compounds BHA and BHT, the samples were prepared at concentration 1 mg mL^{-1}. Because the extracts are complex mixtures including active components at lower levels, these samples were prepared by solving 10 mg or 50 mg of extracting residue in one milliliter of solvent.

RESULTS & DISCUSSION

The in vitro antioxidant activities determined by using the DPPH assay showed that cyanobacteria *Nostoc cf. commune* and *Arthrospira platensis* did not inhibited DPPH radical, even at the highest tested proportion of 50 mg of algae biomass per mL. The remaining cyanobacteria showed low values of capacity to scavenge free radical DPPH that ranged from 7.6% (*Leptolyngbya protospira*) to 27.9% (*Nostoc* sp. (BEA 1052B)), lower values than those shown by the synthetic antioxidants BHA (91%) and BHT (26%) with the exception of *Nostoc* sp. (BEA 1052B).

The presence of polyphenols in the extracts was confirmed by comparing retention times and overlapping UV spectra with those of the standard compounds. The phenolic compounds were well resolved. All correlation coefficients for calibration curves were not less than 0.997. Among cyanobacteria extracts, gallic and chlorogenic acids were only identified in *Nostoc cf. commune* (BEA 0024B) (71 µg of gallic acid and 2.16 µg of protocatechuic acid per gram of freeze-dried biomass). Phenolic constituents gallic acid, (+) catechin, (-) epicatechin, syringic, protocatechuic and chlorogenic acids were not detected in the remaining tested cyanobacteria.

As a conclusion, the results in this study revealed that several cyanobacteria extracts (*Nostoc* sp., *Leptolyngbya protospira, Nodularia spumigena, Phormidiochaete* sp.) exhibited antioxidant activities, higher than the one shown by the preservative BHT for *Nostoc* sp. extract. Therefore, these are sufficient arguments for researching the viability of their use in the health and food industries in general, as well as in the pharmaceutical industry.

ACKNOWLEDGMENTS

The authors would like to express their gratitude to José Juan Santana Rodríguez for allowing the use of the HPLC equipment and to the Spanish Bank of Algae for providing microalgae strains. This research was supported by the sponsors “Familia Megías Martínez” and “Satocán Group” (Innova Program 2020 - Fundación Universitaria de Las Palmas).

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