

A Promising Nutraceutical *Eriodictyon californicum*, a “Holy Herb,” with its Healing Abilities against Oxidative Stress [†]

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Abstract: Antioxidant-rich natural products can be included in the daily diet and represent a growing range of nutraceuticals. In search of effective nutraceutical agents, we studied the antioxidant potential of an herb, *E. californicum*, also known as yerba santa or “holy herb.” Ethanol extract of *E. californicum* leaves were screened for important classes of bioactive molecules. Total phenolic and flavonoid contents were quantified. Antioxidant capacity was evaluated by 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay and ferric reducing/antioxidant power (FRAP) assay. To explore the mechanism of action for antioxidant activity, the effect of the extract was studied on superoxide and hydroxyl radicals. Qualitative studies determined the presence of saponins, phlobatannins, phenols, tannins, terpenoids, cardiac glycosides, and steroids, and flavonoids in yerba santa. The leaves were found to be rich in phenol content ($78.58 \pm 0.016 \mu\text{g GAE/mg}$) and flavonoid content ($6.76 \pm 0.003 \mu\text{g QE/mg}$). At a concentration of 1.0 mg/mL, the extract showed 93.39% inhibition of DPPH radicals, 57.36% inhibition of superoxide radicals, and 80.89% inhibition of hydroxyl radicals. This study reveals that *E. californicum* leaves are a rich source of antioxidants and can be used as a nutraceutical.

Keywords: nutraceutical; antioxidant; oxidative stress; natural products; *Eriodictyon californicum*; yerba santa; medicinal plants; free radicals

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1. Introduction

Nutraceuticals are a growing source of study in the pharmaceutical field. Nutraceuticals can be consumed in the diet and have physiological benefits. Significant sources of nutraceutical ingredients are bioactive phytochemicals, including alkaloids, various terpenoids, and polyphenols, which act as antioxidants to defend the body against reactive oxygen species (ROS) [1]. In living organisms, ROS and free radicals pose a threat to the stability of macromolecules and cell membrane permeability by increasing oxidative stress (OS). OS has been implicated in many chronic diseases, including atherosclerosis, diabetes, rheumatoid arthritis, stroke, cancers and many more. Oxidative damage can also speed up the effects of aging in the body [2].

For decades before and throughout the development of modern medicine, plants and herbs have been used as dietary and nutritional supplements to treat illness. Today, these natural products are a leading area of drug discovery due to their wide diversity, of both chemical structure and biological functionality. This research is key in developing medications as roughly a quarter of the drugs approved by the Food and Drug Administration are plant-based and a third are based on natural products [3].

Eriodictyon californicum (Boraginaceae), also called yerba santa or “holy herb,” is native to Oregon, California, and Northern Mexico and it has been traditionally consumed in tea or eaten as herb by Native Americans and Spanish settlers to treat headaches, res-

piratory and gastrointestinal problems [4]. This plant is rich in flavonoids, and the flavonoid sterubin has been found to be the active ingredient, which has been identified as a potent anti-inflammatory and neuroprotective component [5]. Although *E. californicum* has not previously been studied in the context of antioxidant potential. Hence the current study was designed to evaluate its antioxidant activity of extract of leaves. The mechanisms of action behind antioxidant activity was also studied. This study showed that *E. californicum* has antioxidant potential and it can be a promising nutraceutical to combat OS borne diseases.

2. Materials and Methods

2.1. Plant Material and Extraction

E. californicum dried leaves were procured from Monterey Bay Spice Company, Watsonville, California, USA. The dried leaves were ground to a coarse powder. 50 g of the powder were placed in a soxhlet and extracted with 95% ethanol at 60–80 °C for 12 h. The plant extract was concentrated through rotovapping and desicating [6].

2.2. Qualitative Phytochemical Analysis

Phytochemical constituents including saponins, phlobatannins, phenols, tannins, terpenoids, cardiac glycosides, steroids, and flavonoids were measured as per the standard tests [7].

2.3. Quantification of Total Phenolic and Flavonoid Content

The Folin–Ciocalteu method was used to determine total phenolic content in yerba santa using gallic acid as standard. Results are expressed in Gallic Acid Equivalents (GAE)/mg of plant material. Total flavonoid content was determined using the aluminum chloride method, using quercetin as standard, and the results were expressed in Quercetin equivalent (QE)/mg of plant material [6].

2.4. Antioxidant Potential

Antioxidant potential of the *E. californicum* leaf extract was investigated by employing various established in vitro systems, including ferric reducing antioxidant power (FRAP) assay, 1, 1-diphenyl-2-picrylhydrazyl (DPPH), superoxide radical and hydroxyl radical scavenging [6–8]. Ascorbic acid was used as the standard in the study.

2.5. Statistical Analysis

Results are expressed mean value \pm standard deviation (SD) of measurements obtained by independent experiments ($n = 3$). Data analysis was based on one-way analysis of variance. All statistical analysis was performed using Microsoft Excel Version 2010.

3. Results and Discussion

3.1. Phytochemical Analysis

Plant material extraction yield was 35.07%. The qualitative phytochemical analysis of *E. californicum* leaf extract showed the presence of various bioactive phytochemicals such as phlobatannins, phenols, tannins, terpenoids, cardiac glycosides, and steroids, and flavonoids.

3.2. Phenol and Flavonoid Content

The presence of a high amount of phenol content and flavonoid content was observed in ethanolic extract of *E. californicum* leaves (Table 1).

Table 1. Polyphenol contents of the ethanolic extracts of the leaf of *E. californicum*.

Phenolics.	<i>E. californicum</i> Leaf Extract
Total phenol	78.58 ± 0.016 µg GAE/mg plant material
Flavonoids	6.76 ± 0.003 µg QE/mg plant material

Data given are mean of three replicates ± SD.

3.3. Antioxidant Potential

Antioxidant potential of ethanolic extract of *E. californicum* leaves as determined by the FRAP assay is depicted in Figure 1a. The reducing power was evaluated by transforming Fe^{+3} to Fe^{+2} by plant extract. The concentration dependent increase in absorbance indicated the possession of reducing property. Figure 1b shows the reducing property of ascorbic acid, which was used as the standard.

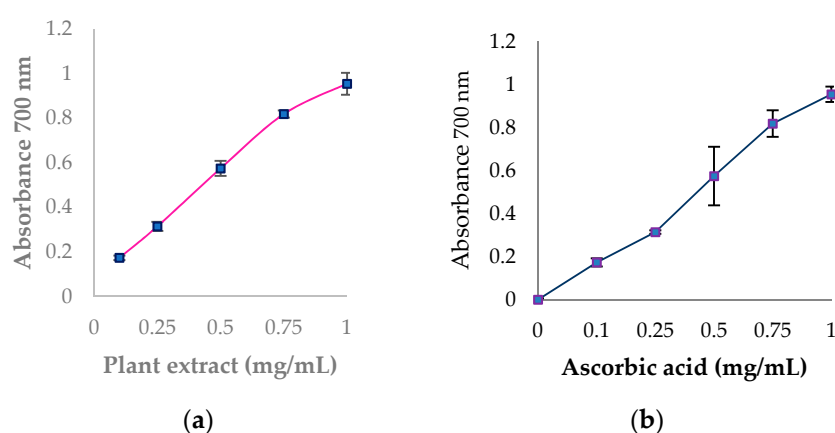


Figure 1. The reducing power ability of (a) ethanol extract of *E. californicum*, and (b) ascorbic acid. Data given are mean of three replicates ± SD.

The reductive potential indicated the presence of phytoconstituents in *E. californicum* extract with an electron donating ability. This property was further explored to evaluate the effect of plant extract on a synthetic free radicals (DPPH) and oxygen free radicals (superoxide and hydroxyl). Free radical scavenging activity was determined in terms of percentage inhibition. The study revealed that, at a concentration of 1.0 mg/mL, the plant extract showed 93.39% inhibition of DPPH radicals, 57.36% inhibition of superoxide radicals, and 80.89% inhibition of hydroxyl radicals. A dose-dependent response was observed on all the three radicals under study. Ascorbic acid was used as the standard for DPPH and superoxide radicals, and mannitol as the standard for hydroxyl radicals (Figure 2).

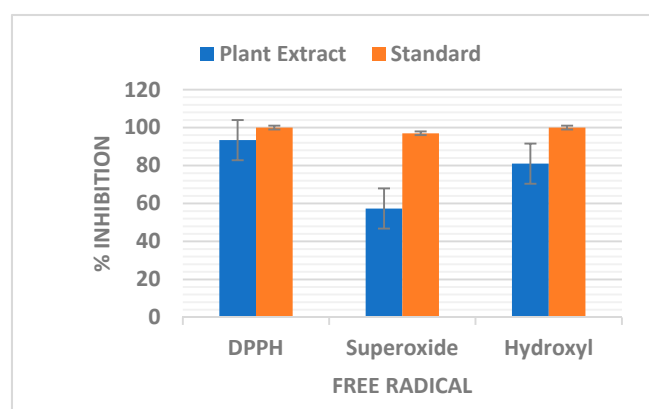


Figure 2. Free radical scavenging activity of *E. californicum*, ascorbic acid as a standard on DPPH and superoxide radicals, and mannitol on hydroxyl radicals.

4. Conclusions

We cannot meet the requirements of essential nutrients through our normal diet and that is where antioxidant-rich nutraceuticals play an important role. They are considered effective in health promotion and in the prevention of various life-threatening diseases. The present study has revealed that the leaves of *E. californicum* contains a substantial amount of total phenolic and flavonoid content. It possesses a strong reducing potential and scavenges reactive oxygen species (superoxide and hydroxyl radical). Thus, *E. californicum* leaves with considerable antioxidant properties may be a promising nutraceutical that can help combat oxidative stress-induced diseases. It can also be used as an additive to preserve food products by reducing or inhibiting oxidative damage. This study also supports the traditional use of *E. californicum* leaf extract as a flavoring agent in food and beverages [9].

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Conflicts of Interest: The authors declare no conflict of interest.

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