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Editorial

Antioxidant, Phytochemical and Enzymatic Characteristics of Selected Medicinal Plants from the Republic of Korea: A commentary

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Recently, there has been significant interest in the literature that is orientated toward the compositional analysis of traditional medicinal plants from around the world. This interest has been predominately fueled by consumer demands toward naturally derived remedies and the potential efficacy of bioactive compounds identified in medicinal plants which could be developed into pharmaceuticals or nutraceuticals. In the latest issue of Exploratory Research and Hypothesis in Medicine, Phull *et al.* published "Antioxidant Potential, Urease and Acetylcholine Esterase Inhibitory Activity and Phytochemical Analysis of Selected Medicinal Plants from the Republic of Korea".[1] The authors of this manuscript identified an essential need for comprehensive compositional information related to the use of the plants as a part of traditional Korean medicine.[2] In particular, the authors describe the analysis of methanolic extracts from the barks of 20 different medicinal plants that were purchased from a commercial supplier. Phytochemical screening (alkaloid, saponin, cardiac glycoside, and terpenoid content), phenolics and flavonoids assays (total phenolic content and total flavonoid content), antioxidant activity potential (2,2-diphenyl-1-picryl-hydrazyl-hydrate (DPPH) free radical and total antioxidant capacity assays) and enzyme inhibitory activities (acetylcholine esterase and urease inhibition assays) were performed on 20 plant methanolic extracts.

During the extraction of different phytochemicals, several aspects need to be considered, such as the selection of extraction solvent, duration of extraction, and the temperature applied during the extraction procedure. In this article, the authors used one solvent (methanol), and therefore, did not necessarily extract all of the polar and nonpolar phytochemicals.[1] However, a strong antioxidant potential and rich total polyphenolic, flavonoid, alkaloid, saponin, glycoside, and terpenoid content were determined in some of the samples. In addition, the selection of extraction time (3 days at room temperature) might influence the overall antioxidant capacity, as some phytochemicals attributed to the antioxidant content might have been oxidized due to the temperature and ambient lighting.

It is well-known that the antioxidant content of different plant foods and plant-based food products is commonly associated with potentially beneficial health outcomes. Antioxidants modulate cellular physiology at the molecular level in response to oxidative stress and further exert biological effects in the whole organism via the modulation of several different pathways, such as gene expression and intracellular signaling.[3] To establish the antioxidant potential of medicinal plant extracts, the use of multiple different antioxidant assays is critical. At least two antioxidant assays should be used to assess antioxidant potential. The main reason for this is because, assays for antioxidant capacity differ in their strengths based on the specificity, reaction media, and time of analysis. Therefore, the potential antioxidant activity might be under- or over-represented in particular plant extracts due to the limiting capacities of the method utilized. For example, the DPPH assay is an accepted method that is used for screening the antioxidant activity of plants. It utilizes a free radical molecule (DPPH) that is stable at room temperature, and its violet color is reduced to yellow by the addition of different extracts in a concentration-dependent manner. In addition, DPPH assay is widely used to determine the antioxidant activity of crude extracts or purified compounds from different plants. Furthermore, other methods, such as oxygen radical absorbance capacity are temperature and oxygen-sensitive and might have limited effectiveness in nonenzymatic systems. Phull *et al*.[1] used two antioxidant determination methods, which reduced the likelihood of false-negative errors during analysis.[1] Therefore, the use of more advanced analytical techniques and applications of additional antioxidant methods, such as 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid), and/or ferric reducing antioxidant power assays might have provided more in-depth data on the antioxidant properties. Hence the selection of appropriate assays is crucial in the analysis of food and plant extracts.

Polyphenols and other phenolic compounds are well-established as classes of compounds that have shown strong antioxidant properties, and as such, the determination of polyphenolic content should be performed with all relevant antioxidant analysis. Phull *et al*.[1] performed polyphenolic screening using the well-established

Abbreviations: Ach, acetylcholinesterase; DPPH, 2,2-diphenyl-1-picryl-hydrazyl-hydrate.

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Folin-Ciocalteu method (with modifications) that utilized spectrophotometric microplate reader analysis.[4] This method relies on the transfer of electrons from phenolic compounds to form phosphomolybdic/phosphotungstic acid complexes that can be determined spectrophotometrically at 725 nm. However, the assay has limitations because it is not only specific to polyphenols and nearly any reducing agent could provide a high score and potentially be assigned as an antioxidant, which in some cases might not necessarily be correct.[5] This can pose one of the major challenges in polyphenolic compositional analysis, and the utilization of high-performance liquid chromatography analysis, most predominately with ultraviolet detection, is commonly implemented in the further identification of polyphenolic compounds.[6]

Acetylcholinesterase (ACh) is the primary cholinesterase in the body and catalyzes the breakdown of acetylcholine and some other esters that function as neurotransmitters. During neurotransmission, ACh is released from presynaptic neurons into the synaptic cleft that is followed by binding to the ACh receptors that are located on the postsynaptic membrane that relays the signals from nerve to nerve. Therefore, medications and pharmaceuticals that reversibly inhibit ACh are of particular interest when managing and treating symptoms of Alzheimer's disease. A decrease in ACh levels in the brain has been implicated in the pathophysiology of the cognitive decline that occurs in people with Alzheimer's disease, and several pharmaceuticals are available that provide symptomatic relief.[7] However, the findings from *in vitro* studies should always be interpreted with caution when describing the pathogenesis of human disease. In addition, due to the absence of successful pharmaceutical treatments for Alzheimer's disease, further investigation of medicinal plants, such as those described by Phull *et al*.[1] are required. Plant-based ACh inhibitors could be less toxic and might possess synergistic effects that could help in the prevention and treatment of cognitive decline. Currently, the discovery and development of medications for several chronic and metabolic diseases, are being investigated using plant extracts, secondary metabolites, and individual compounds as potential backbones for pharmaceuticals. Of interest, the high-end characterization of lead compounds from plant-based extracts and their structural characteristics are playing an important role in this research.

In summary, the findings described in this article provide preliminary screening data for medicinal plants that are used in traditional Korean medicine.[1] The 20 plants described in this article have all provided relatively strong antioxidant potential and are rich in polyphenolic content, which adds to the limited pool of information related to their medicinal properties. Of note, this article provides the general characteristics of specific plants that require further investigations related to the toxicity and applicability of these extracts as human trial candidates for potential nutraceutical development. Furthermore, this article provides an exploratory hypothesis that demonstrates the much needed connection between incorporating the findings from plants that are used in traditional medicine and their role in research and development in current medicine.

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Conflict of interest

The authors declare no conflict of interest.

Author contributions

First draft written by NN, review of the literature and critical revision of the manuscript (NN, NMD). All authors have made a significant contribution to this study and have approved the final manuscript.

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