

Chemometric analysis of antioxidant properties of herbal products containing *Ginkgo biloba* extract

Research Article

Joanna Ronowicz*, Bogumiła Kupcewicz, Elżbieta Budzisz

Department of Inorganic and Analytical Chemistry,
Faculty of Pharmacy, Collegium Medicum,
Nicolaus Copernicus University,
85-094 Bydgoszcz, Poland

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Abstract: *Ginkgo biloba* extract is a popular ingredient in pharmaceutical formulations. The level of bioactive compounds determines final antioxidant activity of an extract and its therapeutic efficiency. The aim of the project was to assess phytopharmaceuticals containing *Ginkgo* extracts in terms of their chemical characteristic and antioxidant activity using selected chemometric methods. The aim of the study was also to investigate whether the antioxidant activity of phytopharmaceuticals can be successfully predicted based on their chromatograms. Total polyphenol content and antioxidant activity of methanolic *Ginkgo* extracts were determined using a spectrophotometric technique. Comparative chemometric analysis of investigated pharmaceutical formulations was carried out using hierarchical and non-hierarchical segmentation algorithms. Samples of herbal drug products were clearly separated from samples of dietary supplements. A tree regression method was used to predict the antioxidant activity of pharmaceuticals based on the chromatographic description. The correlations between the predicted (by regression model) and experimental values of IC_{50} for training and testing subset were 0.960 and 0.949, respectively. The chemometric techniques, combined with instrumental analysis, could improve and simplify the quality control methods of herbal products. The antioxidant activity, predicted on the basis of chromatograms, may be one of measures of final product quality.

Keywords: Antioxidant activity • Total phenolic content • *Ginkgo biloba* extract • Exploratory data analysis • Fingerprint chromatography

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1. Introduction

In recent years, increased interest in medicinal plant has been observed. This is due to the presence of enormous amount of bioactive compounds in herbs. These compounds are related to various beneficial effects on human health [1]. *Ginkgo biloba* L. is one of the most popular medicinal plants. Both herbal drug products and dietary supplements contain extracts of *Ginkgo biloba* leaves. This herbal extract is a rich source of bioactive compounds. Phytopharmaceuticals containing *Ginkgo* extracts are used in the treatment of cerebral and peripheral circulatory disorders, as well as neurological dysfunctions. They improve cognitive functions (memory and concentration), particularly in elderly patients [2]. The therapeutic effect of *Ginkgo* extracts is linked with the synergistic action of their multiple components. Polyphenols (mainly flavonol glycosides) are the most significant for therapeutic applications

because of their antioxidant activity. Free radicals and reactive oxygen species react with important biological macromolecules and contribute to the pathogenesis of many degenerative diseases, such as atherosclerosis, coronary diseases and age-related degenerative brain disorders [3,4]. The antioxidants neutralize free radicals and therefore prevent destructions caused by those reactive molecules. These properties of phenolic compounds result from their ability to transfer a hydrogen atom or an electron, as well as from chelation of pro-oxidative metal ions which have the ability to generate free radicals in human cells [5].

There are many external factors (such as prolonged or improper storage) which affect the quality of herbal medicines. Improper storage conditions can lead to hydrolysis or decomposition of flavonol glycosides. The level of bioactive compounds determines the final antioxidant activity of an extract and its therapeutic efficiency. Therefore, it seems necessary to control

* E-mail: joanna.ronowicz@cm.umk.pl