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Chemical and Electrochemical Syntheses of Two Organic Components of Ginger

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Abstract : Ginger (Zingiber officinale) is a perennial plant from Southeast Asia, widely used as a spice, herb, and medicine for many illnesses since its beneficial health effects were observed thousands of years ago. Among the compounds found in ginger, zingerone [4-hydroxy-3- methoxyphenyl-2-butanone] deserves special attention: it has an anti-inflammatory and antispasmodic effect, it can be used in case of diarrheal disease, helps to prevent the formation of blood clots, has antimicrobial properties, and can also play a role in preventing the Alzheimer's disease. Ferulic acid [(E)-3-(4-hydroxy-3-methoxyphenyl)-prop-2-enoic acid] is another cinnamic acid derivative in ginger, which has promising properties. Like many phenolic compounds, ferulic acid is also an antioxidant. Based on the results of animal experiments, it is assumed to have a direct antitumoral effect in lung and liver cancer. It also deactivates free radicals that can damage the cell membrane and the DNA and helps to protect the skin against UV radiation. The aim of this work was to synthesize these two compounds by new methods. A few of the reactions were based on the hydrogenation of dehydrozingerone [4-(4-Hydroxy-3-methoxyphenyl)-3-buten-2-one] to zingerone. Dehydrozingerone can be synthesized by a relatively simple method from acetone and vanillin with good yield (80%, melting point: 41 °C). Hydrogenation can be carried out chemically, for example by the reaction of zinc and acetic acid, or Grignard magnesium and ethyl alcohol. Another way to complete the reduction is the electrochemical pathway. The electrolysis of dehydrozingerone without diaphragm in aqueous media was attempted to produce ferulic acid in the presence of sodium carbonate and potassium iodide using platinum electrodes. The electrolysis of dehydrozingerone in the presence of potassium carbonate and acetic acid to prepare zingerone was carried out similarly. Ferulic acid was expected to be converted to dihydroferulic acid [3-(4-Hydroxy-3-methoxyphenyl)propanoic acid] in potassium hydroxide solution using iron electrodes, separating the anode and cathode space with a Soxhlet paper sheath impregnated with saturated magnesium chloride solution. For this reaction, ferulic acid was synthesized from vanillin and malonic acid in the presence of pyridine and piperidine (yield: 88.7%, melting point: 173°C). Unfortunately, in many cases, the expected transformations did not happen or took place in low conversions, although gas evolution occurred. Thus, a deeper understanding of these experiments and optimization are needed. Since both compounds are found in different plants, they can also be obtained by alkaline extraction or steam distillation from distinct plant parts (ferulic acid from ground bamboo shoots, zingerone from grated ginger root). The products of these reactions are rich in several other organic compounds as well; therefore, their separation must be solved to get the desired pure material. The products of the reactions described above were characterized by infrared spectral data and melting points. The use of these two simple methods may be informative for the formation of the products. In the future, we would like to study the ferulic acid and zingerone content of other plants and extract them efficiently. The optimization of electrochemical reactions and the use of other test methods are also among our plans.

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