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Evaluation of Different Sample Preparation Procedures Using Chemometrics: Comparison Among Photo-Fenton Reaction, Microwave Irradiation, and Direct Determination of Minerals in Fruit Juices

Caio Fernando Gromboni · Rodolfo Carapelli · Edenir Rodrigues Pereira-Filho · Ana Rita Araujo Nogueira

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Abstract In this work, an exploratory study about the mineral characteristic of some fruit juice (passion fruit, pineapple, orange, and grape) applying chemometric tools was made. The juices analyzed were separated in different groups by principal components analysis and hierarchical components analysis in accordance with their minerals contents. Barium, C, Ca, K, Mg, Mn, Na, and Sr were determined by inductively coupled plasma optical emission spectrometry. Addition and recovery methods were used for confirmation of the results. The recovery range for microwave sample preparation was from 81% (for K) to 111% (for Mn), for photo-Fenton from 102% (for Ca e Mg) to 128% (for Na), and the direct analysis, without sample preparation step, from 96% (for K) to 139% (for Mn). A new method based on photo-Fenton reaction coupled with microwave radiation for juice decomposition was proposed; the obtained results were satisfactory and compatible with the conventional methods of analysis in accordance with Student's statistic *t* test and chemometric tools.

Keywords Sample Preparation · Photo-Fenton · Fruit Juices · Microwave Radiation · Ultraviolet Radiation · Direct Determination

C. F. Gromboni · R. Carapelli · A. R. A. Nogueira (✉)
Grupo de Análise Instrumental Aplicada,
Embrapa Pecuária Sudeste,
Rodovia Washington Luiz, Km 234, P.O. Box 339,
13560-970 São Carlos, São Paulo, Brazil
e-mail: anarita@cppse.embrapa.br

C. F. Gromboni · R. Carapelli · E. R. Pereira-Filho
Departamento de Química, Universidade Federal de São Carlos,
Rodovia Washington Luiz, Km 235, P.O. Box 676,
13565-905 São Carlos, São Paulo, Brazil

Introduction

Fruit juices are consumed and appreciated worldwide being source of important minerals and vitamins. Some minerals present in the juices are essential to the human health, performing regulatory functions, such as the metabolism of several enzymes, the acid–base balance, and the osmotic pressure (Shils et al. 1994). Otherwise, other elements do not participate in any metabolic activities, and some of them may have toxic effects.

Elements like strontium that in low doses (<4 g L^{-1}) act in bone metabolism (Cabrera et al. 1999); sodium and potassium, essentials in the blood pressure control; calcium and magnesium that participate in muscle contraction process (Wilkins and Wilkins 2002); and manganese that helps to maintain healthy nerves and immune system and to regulate blood sugar are examples of essential minerals (Pearson and Greenway 2005). In contrast, barium does not have metabolic function; therefore, it is not essential and may be considered toxic element. Its elevated consumption may cause some diseases like cardiac arrhythmia and skeletal muscle paralysis (Choudhury and Cary 2001). Therefore, owing its essentiality or toxicity, the mineral determination in foods and beverages is very important for quality control.

In the elemental determination, the sample preparation is an inevitable procedure. This step in the analytical sequence can be defined as the transformation of the target analytes in an appropriate form for separation or detection (Chen et al. 2008). Otherwise, procedure is also time limiting, requiring ca. 61% of the total time to be performing the complete analysis, and it is responsible for 30% of the total analysis error (Oliveira 2003). In elemental analysis, most