ACCUMULATION OF GOLD NANOPARTICLES IN BRASSICA JUNCEA

Aaron T. Marshall, Richard G. Haverkamp, and Clive E. Davies
Institute of Technology and Engineering, Massey University, Palmerston North, New Zealand

Jason G. Parsons and Jorge L. Gardea-Torresdey
Environmental Science and Engineering Ph.D. Program and Department of Chemistry, The University of Texas at El Paso, El Paso, Texas, USA

Dimitri van Agterveld
Akzo Nobel Research and Technology Chemicals, Department of Chemicals Analytics and Physics, Microstructure Analysis and Atomic Spectrometry, Arnhem, The Netherlands

Enzymatic digestion is proposed as a method for concentrating gold nanoparticles produced in plants. The mild conditions of digestion are used in order to avoid an increase in the gold particle size, which would occur with a high-temperature process, so that material suitable for catalysis may be produced. Gold nanoparticles of a 5–50-nm diameter, as revealed by transmission electron microscopy (TEM), at concentrations 760 and 1120 ppm Au, were produced within Brassica juncea grown on soil with 22–48 mg Au kg\(^{-1}\). X-ray absorption near edge spectroscopy (XANES) reveals that the plant contained approximately equal quantities of Au in the metallic (Au\(^0\)) and oxidized (Au\(^{+1}\)) states. Enzymatic digestion dissolved 55–60 wt% of the plant matter. Due to the loss of the soluble gold fraction, no significant increase in the total concentration of gold in the samples was observed. However, it is likely that the concentration of the gold nanoparticles increased by a factor of two. To obtain a gold concentration suitable for catalytic reactions, around 95 wt% of the starting dry biomass would need to be solubilized or removed, which has not yet been achieved.

KEY WORDS: X-ray absorption near edge spectroscopy (XANES), Brassica juncea, catalysis, enzyme, phytomining, concentration

INTRODUCTION

The concentration of gold from ores by plants (phytomining) is a proposed alternative method of recovering gold (Anderson et al., 1999; Gardea-Torresdey et al., 2005; Lamb, Anderson, and Haverkamp, 2001a). Typically, the background level of gold naturally occurring in plants is below 10 ng g\(^{-1}\) (Anderson et al., 1999). The induced accumulation of gold into Brassica juncea by applying ammonium thiocyanate, which increased the