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Toxic trace elements in selected edible rhizomes of medicinal plants using INAA and ICP-MS techniques

Abstract

Consumption the crop is one of the main sources of dietary exposure to toxic trace elements. In order to assess the level of toxic trace elements from selected herbs and to make an assumption on their consumption level of concern, fourteen elements in *Zingiber zerumbet*(lempoyang), *Boesenbergia rotunda* (temu kunci), *Zingiber officinale* var rubrum (halia bara) and *Zingiber officinale roscoe* (halia) have been determined via ICP-MS (Cd, Be, Ti, Pb) and INAA (As, Al, Ba, Cr, Co, Sb, Sr, Th, U and V) methods. It was revealed that the concentrations of these elements in most selected rhizomes did not exceed the standard dangerous toxic level. However, 47% cadmium accumulationa was detected in *Zingiber officinale* var rubrum grown in poly-bags.

Keywords: toxic element, herbs, rhizomes, inaa, icp-ms

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Abbreviations: Cd, cadmium; Be, beryllium; Ti, thallium; Pb, lead; As, arsenic; Al, aluminum; Ba, barium; Cr, chromium; Co, cobalt; Sb, antimony; Sr, strontium; Th, thorium; U, uranium; V, vanadium; MRL, minimal risk level; INAA, instrumental neutron activation analysis; ICP-MS, inductively coupled plasma/mass spectrometry

Introduction

The interaction between chemical extracted compounds from plants and the human body go through the same identical process to those well understood for the chemical compounds in conventional drugs. Similarly, the herbal medicine may cause the same potential to cause a side effect.[1] *Zingiber zerumbet*(lempoyang), *Boesenbergia rotunda* (temu kunci), *Zingiber officinale* var. rubrum (halia bara) and *Zingiber officinale roscoe* are belonging to Zingiberaceae or Ginger family consisting of aromatic perennial herbs with creeping horizontal or tuberous rhizomes planted locally. The same species can be found throughout tropical Africa, Asia, and the America. These rhizomes are a common edible ingredient in many countries, in South East Asia and serve as culinary herbs due to their aromatic flavor to promote appetite.

Their popularities as folk medicine have drawn further interest amongst researchers to investigate on various perspectives about their medicinal properties. Eng-Chong et al.,[2] Sivasothy et al.,[3] & Sontakke et al.,[4] have been reported on medicinal crop areas. A list of possible treatments for illnesses using the described rhizomes is shown in Table 1.

Trace elements may take by medicinal plants from the surrounding mineral or contaminated soil environment via the root system and translocation within at various part of the plant such as in the rhizome, stems, and leaves. Some plants can absorb trace elements from the soil in high quantity and do not present toxicity symptoms or have their growth affected. These plants are suitable for remediation of polluted soils known as Phytoremediation.[5] Accumulation of toxic trace element above minimal risk level (MRL) value or provisional tolerable index level, ingested by humans for a long term, will give an adverse effect to human health depending on the type of trace elements present.

The present study was undertaken to determine the level of toxic trace elements found in the rhizome samples and to make an assumption on their consumption level of concern if ingested by an adult based on the MRL tabulated by the Agency for Toxic Substances and Disease Registry.[6]

Materials and method

The rhizomes of four species, namely *Z. zerumbet* (A), *B. rotunda* (B, C), *Z. officinale* var. rubrum (D, E) and *Z. officinale Roscoe* (F) were collected from the surrounding area in the University of Malaya. The *B.rotunda* was separated into a center piece or the top part and the tubular shape and *Z. officinale* var. rubrum were taken from the wild and planted in polybag condition.

The samples were pre-rinsed with deionized water and dried at 39°C in the oven for five hours. The dried samples were powdered using mortar and pestle to make a dried rhizome powder. The powders were sieved using a standard set of sieves. About 15- 100g of grounded sample was weighed and sealed in the polyethylene vials and tagged as A, B, C, D, E and F according to the species and their origin. A duplicate was used up for each analyte sample and blank for error correction.

Standard coal ash SRM–1632a based on (NIST)[7] was employed as a multi element comparison standard. The Analyte and standard samples were stacked up in a rotary rack at different positions ready for irradiation.

Irradiation and counting

The irradiation facility was carried out by TRIGA MK II (Malaysian Institute of Nuclear Technology, MINT) for 6hours at a thermal flux (2×1012 ncm-2Sec-1). After irradiation, the vial is returned from the reactor by atmospheric pressure and allowed to decay to the level of activity is within acceptable limits for handling. Cooling time was arranged according to the nuclear properties of