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Assessment of heavy metals in Mukunuwenna (*Alternanthera sessilis*) collected from production and market sites in and around Colombo District, Sri Lanka

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Abstract

The present study was conducted to evaluate the levels of trace metals (Ni, Cd, Cr, Pb and Cu) in *Mukunuwenna* (*Alternanthera sessilis*) samples randomly collected from the production and market sites located in and around Colombo District, Sri Lanka, using the Atomic Absorption Spectrophotometry. Significant differences in heavy metal concentrations were observed between both the production sites and market sites ($P<0.05$). Heavy metal accumulations in *Mukunuwenna* tested were higher at the market sites than at the crop production sites. The average concentrations (mg kg^{-1}) of heavy metals in *Mukunuwenna* samples collected from the production sites were estimated as Ni (6.48±6.74), Cd (0.20±0.11), Cr (3.36±2.76), Pb (2.96±2.16) and Cu (11.85±7.51). The mean concentrations (mg kg^{-1}) of Ni, Cd, Cr, Pb and Cu in *Mukunuwenna* samples collected from different marketing sites were reported as 7.90±5.98, 0.25±0.18, 4.09±3.36, 3.63±3.65, 13.05±5.15 respectively. The highest contaminated field and market samples were reported from the Kolonnawa area. The samples collected from the market sites were subjected to three processing treatments (raw, cooked and stir-fried) and analyzed for heavy metals, in order to find out the effect of food processing techniques on reducing the heavy metal contaminations of *Mukunuwenna* samples. The average levels (mg kg^{-1}) of metals detected in raw, cooked and stir-fried *Mukunuwenna* samples were as follows: Ni (2.20±1.04, 1.77±0.84, 1.46±1.03), Cd (0.19±0.11, 0.12±0.07, 0.10±0.06), Cr (2.37±1.58, 2.27±1.57, 2.20±1.54), Pb (0.26±0.39, 0.22±0.34, 0.21±0.34) and Cu (9.59±4.48, 8.29±3.35, 7.45±3.72). The results showed no significant differences in heavy metal contents among three processing methods ($P<0.05$). Therefore, the type of processing method has a minimal effect on reducing the heavy metal contents of *Mukunuwenna* samples.

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1. Introduction

Green leafy vegetables are a major component of the Sri Lankan meal. Among them, sessile joyweed (*Alternanthera sessilis*), which is locally popular as *Mukunuwenna*, is the most widely produced and consumed green leafy vegetable in Sri Lanka. The crop is native to Brazil and inhabit in many tropic and subtropical regions all over the world. There is an increased trend in consumption of this vegetable among the urban community of Sri Lanka because it is cheap, convenient and providing wide range of nutrients (fiber, vitamins, minerals and anti-oxidants). However, as reported by many previous studies, it is well known that leafy vegetables are heavy metal accumulators[1]. In Sri Lanka, extensive cultivation of *Mukunuwenna* is practiced primarily in and around Colombo District which is the commercial capital of Sri Lanka. In addition, the crop is mostly sold in the urban roadside open markets, where the environment is heavily polluted with heavy metal-laden exhaust. Consequently, these toxic metals can be deposited on the vegetable surfaces during their production, transport and marketing[2].

Food safety and security is a foremost public concern in global context. Recently, the increasing demand for food safety has inspired more research concerning the risks associated with the consumption of foods polluted with heavy metals. The implication associated with heavy metal contamination is of great concern, since they can cause numerous health hazards in mankind. Even though *Mukunuwenna* is a Sri Lankan staple food, scanty literature is available on the trace metal contaminations of the crop from production and market areas of Sri Lanka. Therefore, the experiment was conducted to determine the Ni, Cd, Cr, Pb and Cu concentrations of *Mukunuwenna* samples collected from selected production and market areas in and around Colombo District, Sri Lanka. Further, the study focused on determining the effect of different food processing methods on minimizing the heavy metal contamination of the food crop.

2. Methodology

2.1 Study area

Based on the preliminary investigation carried out, six production areas (Piliyandala, Bandaragama, Kahathuduwa, Wellampitiya, Kolonnawa and Kottawa) and vendors from eight marketing areas (Piliyandala, Wellampitiya, Kolonnawa, Kottawa, Bandaragama, Kahathuduwa, Pettah and Delgoda) were selected for the experiment.

2.2 Mukunuwenna sampling and analysis

Mukunuwenna samples were randomly collected from field and market sites, in appropriately labeled polyethylene bags and brought to the laboratory. Samples were washed thoroughly with running tap water to remove soil, dirt and other air-borne pollutants. The edible parts were chopped in to small pieces. Test samples were dried in a drying oven, at 105°C, until a constant weight was obtained and then cooled to ambient temperature, crushed by means of a clean pestle and mortar to obtain homogenized samples. The ground samples were analyzed by Atomic Absorption Spectroscopy (AAS) after dry ashing technique as described in AOAC 975.03[3].

2.3 Effect of different processing techniques on heavy metal content of Mukunuwenna samples

Fresh *Mukunuwenna* samples (n=10) were collected from different marketing points located in and around Colombo District. The cleaned edible portions of each single sample were divided into three portions (200 g each). One portion was analyzed as fresh (raw) sample and the other two portions were prepared by cooking and stir-frying as described below;

Preparation of *Mukunuwenna* by cooking: 200 g of washed and sorted *Mukunuwenna* sample was finely cut and