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Climate Change Issue and Utilization of Nuclear Technology in Environmental Research: Bangladesh Perspective



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Climate Change Issues and Bangladesh

- Bangladesh is one of the **highly climate vulnerable countries** with less than 1% of global Green House Gas (GHG) emissions.
- Threats due to climate change include here mainly **sea level rise, droughts, floods, and cyclones**.
- Bangladesh is nevertheless taking steps to reduce its future emissions through the development of renewable energy, the use of natural gas (relatively clean) and nuclear energy.
- Bangladesh committed to reduce GHG emissions in the power, industry and transport sectors by **5% unconditionally** below BAU (business as usual) GHG emissions by 2030 or by a **conditional 15%** below BAU GHG emissions **within 2030** if sufficient and appropriate support is received from developed countries.

As a result, a target set in the power system master plan to deliver 5% of energy from renewable sources including nuclear power by 2015, and 10% by 2020 has been set by the Bangladesh government.



Fig. 1: Projected nuclear power development in PSMP-2016.

Nuclear Technology in Bangladesh for Adaptation with Climate Change

Bangladesh's priorities on climate change issues are mainly on adaptation.

- **The main research areas in Bangladesh for climate change adaptation are:**

- **Mutation breeding**

- **Different dating methods (Pb-210 and C-14 etc.)**

ACIEVMENTS IN MUTATION BREEDING in bangladesh

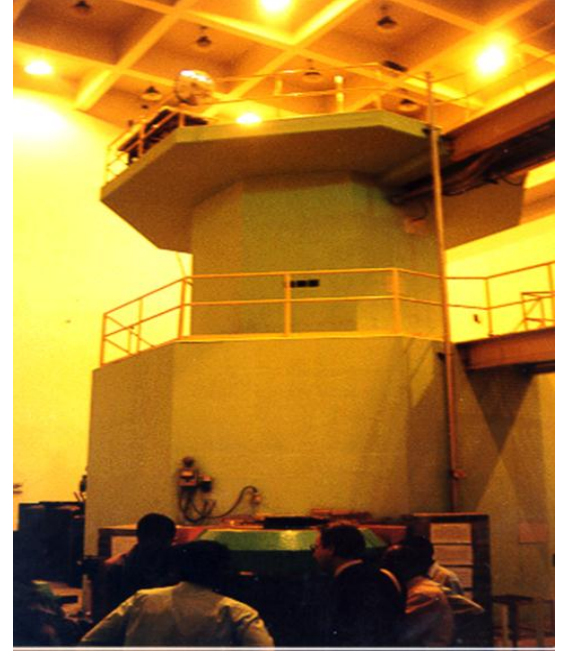
In Bangladesh more than 44 mutant varieties belonging to 12 different crops species have been released through mutation breeding. BINA in mymenshingh is the primary centre for mutation breeding.



Fig. 4 - High yielding mutant rice varieties are being widely cultivated in remote mountain areas for the profit of poor farmers (Photo courtesy of Q. Liang, NAFA)

Nuclear Techniques for Environmental Contamination and Monitoring Study

- **The following nuclear techniques are used for environmental study:**
- **TRIGA Reactor-based Neutron Activation analysis (NAA)**
- **ED-XRF technique**
- **Neutron Radiography**
- **Natural radioactivity monitoring using gamma-ray spectrometry system**
- **Others non-nuclear techniques used**
 - ICP-MS**
 - AAS**



BAEC TRIGA Research Reactor



Gamma-ray spectrometry system

Subjects of Monitoring

The heavy metal contamination and natural radioactivity monitoring of the following subjects are performed-

- Soil and sediments (river and coastal)**
- Water**
- Food (Essential and toxic metal contents and health risk assessments)**
- Air particulate**

Challenges in Implementation

- Research reactor is old (35 years). So frequently in maintenance which hampered NAA.**
- At this moment isotopic analysis technique with enough sensitivity is not available.**

Food Safety and Health Risk Assessment

➤ Food safety has been a general concern all over the world.

➤ Health risks associated with toxic elements in food stuffs

➤ Evaluated by:

-Dietary intake

-Target hazard quotient

-Target carcinogenic risk indices

➤ These types of studies along with food provenance study will significantly contribute to the field of food safety and sustainable agriculture in Bangladesh.

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Characterization of chemical elements in common spices of Bangladesh for dietary intake and possible health risk assessment by INAA and AAS techniques

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Abstract

In this study, total concentrations of seventeen chemical elements (Al, As, Br, Cr, Cd, Cl, Cs, Co, Fe, K, Mn, Ni, Pb, Se, V and Zn) in Bangladeshi common spices were determined using instrumental neutron activation analysis and atomic absorption spectrometry techniques. This study indicates that spices are a good source of a combination of Cu, Fe, K, Mn, Na and Zn minerals. The concentrations of the elements As, Cd, Cr and Pb in some spices were higher than WHO and FAO permissible levels. However, health risks associated with these elements evaluated by dietary intake, target hazard quotient and target carcinogenic risk indices indicate that people would experience no potential risks due to consumption of the spices.

Keywords Spices · Instrumental neutron activation analysis · Atomic absorption spectrometry · Chemical elements · Health risk assessment

Introduction

In recent years, food safety has been a general concern all over the world. Element contamination in agricultural production sector is one of the major concerns in worldwide [1, 2]. Although many chemical elements are essential to metabolic functions of the human body, they can produce toxic effects when they are consumed in high concentrations, whereas some elements have toxic effects even at very low concentrations for human health [3]. Elements having toxic effects occur naturally in the environment as well as from various human activities and their

concentrations are rising rapidly in the environment [4]. Chemical elements are also known to cure many diseases. Elements have strong link between micronutrient of plants, animals and humans [5, 6]. Spices contain macro and micronutrients like Ca, Fe, Mg, K, Mn and Zn that are useful for the growth of living organisms [7]. Among the micronutrients, K is a vital element for proper functioning of blood pressure and in transmitting nerve impulses to muscles [8]. Zinc is also important for metabolic and physiological processes in living organism [9]. However, exceeding the standard limits of the elements can induce harmful effects on health like cardiovascular, kidney, nervous and bone diseases [10].

The determination of chemical elements in plant and spice samples is performed using mainly the following analytical techniques: atomic absorption spectrometry (AAS) with flame and flameless, gas and liquid chromatography, inductively coupled plasma optical emission spectrometry and inductively coupled plasma mass spectrometry. These techniques need sample digestion using chemical treatments. There are also some techniques that use only finely ground homogeneous powder without further sample preparation and non-destructive: instrumental neutron activation analysis (INAA) is one of them and it is

Concentrations and Health Risk Assessment of Trace Elements in Cereals, Fruits, and Vegetables of Bangladesh

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Assessment of Essential and Potentially Toxic Elements and Possible Health Risks in *Hylocereus undatus* and *Punica granatum*

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Abstract

This study evaluates essential and toxic element contents in dragon (*Hylocereus undatus* (Haworth) Britton and Rose) and pomegranate (*Punica granatum* L.) and possible health risks through the consumption of these fruits. Total concentrations of 15 chemical elements (Al, Br, Ca, Cd, Cl, Cs, Cu, Fe, Hg, K, Mn, Ni, Pb, and Zn) were determined by instrumental neutron activation analysis (INAA) and atomic absorption spectrometry (AAS) techniques. This study indicates that these fruits are a vital source of essential elements for human health. It is observed that Pb concentrations were higher in both fruits whereas Cd concentrations were slightly higher than WHO/FAO tolerable levels only in pomegranate. The estimated daily intake (EDI) of the chemical elements was within the maximum tolerable daily intake (MTDI) values. Furthermore, target hazard quotient (THQ) values were also within the safe level (THQ < 1). However, the calculated target carcinogenic risk (TCR) values of Cd for pomegranate and Cr for dragon fruit were higher than the maximum limit (1.0×10^{-6}) for children. Finally, this study will create public awareness about micronutrient contents as well as metal contamination of the studied fruits.

Keywords Essential elements · Toxic elements · Fruits · Dietary intake · Health risks · Instrumental neutron activation analysis · Atomic absorption spectrometry

Introduction

Fruits are one of the major sources of micronutrients that keep the body fit and strong. But nowadays, fruits may be contaminated by many ways like environmental pollution, water pollution, industrial effluents, and excess uses of agricultural pesticides [1–3]. The total production of fruits are growing up due to high consumption and high profit worldwide. Recently, there are a number of researchers working in the field of food safety and health issues [4]. Some elements act against the diseases in the body at a certain concentration level and give support to carry out of biochemical functions in all living

organisms. However, several researchers have informed that essential elements may cause many types of diseases in the body when these elements are consumed at high concentrations [5, 6]. On the other hand, some elements (toxic) have toxic effects even at very low concentrations for human health. Therefore, characteristics and functions of the elements depend on the types of the elements and their concentration levels [7, 8].

Toxic elements in fruits are generally classified into two groups—essential (copper, zinc, iron, manganese, cobalt, etc.) and toxic (arsenic, cadmium, lead, mercury, nickel, etc.) [9]. Essential elements take place a vital role in the body functions due to chemical, nutritional, and biological properties [10]. Toxic elements may damage human and animal organs due to non-biodegradable behavior, long half-lives, and high accumulation behavior in different body parts [11, 12]. This accumulation occurs carcinogenic, non-carcinogenic, and mutagenic effects in the body [12].

Pomegranate (*Punica granatum* L.) is cultivated in tropical and subtropical regions of the world. It is also cultivated in Bangladesh from ancient time and popular for its nutrient values [13]. Pomegranate is also a medicinal fruit that is used for cancer treatment [14] and potential dietary fiber source for food enrichment [15]. On the other hand, dragon fruit

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Aquatic/Coastal Pollution

- **Anthropogenic pollutants in the environment-**
 - Heavy metals (HMs)**
 - Polycyclic aromatic hydrocarbons (PAHs)**
 - **Monitoring and radiological hazard assessments of natural and anthropogenic radioactivity concentration.**
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- **Mohammad Amirul Islam et al., 2020. Heavy metal contamination and ecological risk assessment in water and sediments of the Halda river, Bangladesh: a natural fish breeding ground. *Marine Pollution Bulletin (Elsevier)*, 160, 111649.**
 - **R. Khan et al., 2020. Distribution, sources and ecological risk of trace elements and polycyclic aromatic hydrocarbons in sediments from a polluted urban river in central Bangladesh. *Environmental Nanotechnology, Monitoring & Management (Elsevier)*, 14, p.100318.**
 - **M. A. Islam, 2017. Contamination and ecological risk assessment of trace elements in sediments of the rivers of Sundarban mangrove forest, Bangladesh, *Marine Pollution Bulletin (Elsevier)*, 124, 356-366.**

Summary

- **Although Bangladesh is responsible for less than 1% of global GHG emissions, it is one of the highly climate vulnerable countries of the world. Bangladesh is nevertheless taking steps to reduce its future emissions through the development of different initiatives.**
- **Bangladesh is utilizing nuclear technology for environmental contamination monitoring, food safety and agricultural sustainability.**
- **Collaboration with international forum like IAEA, FNCA and other organizations will strengthen these activities in future.**

Thank you