# Bulk Hydrogen Analysis of Cyanogenic food plants using neutrons

**Keziah Garba[1], Jonah Sunday[2], Elewechi Onyike[3]**

[1]Department of Nuclear Engineering, LUT University, Lappeenranta, Finland
[2]Nuclear Science and Technology Section, Centre for Energy Research and Training, Zaria, Nigeria
[3]Department of Chemistry, Ahmadu Bello University, Zaria, Nigeria

FISA EURADWASTE 2025
SNETP Forum

## Introduction

Nuclear techniques extend beyond energy, finding applications in medicine, archaeology, and food safety. This study explores neutron-based methods to assess hydrogen and cyanide content in sorghum and cocoyam for improved food quality control.

## Research Problem

Food safety remains a concerning issue, affecting over 820 million people globally. In rural Africa, where 70% of staple foods contain cyanogenic glycosides, improper processing poses severe health risks. Traditional quality control methods, such as wet chemical analysis, are time-consuming, destructive, and inefficient for routine screening. This research addresses the need for a fast, non-destructive, and accurate method to assess hydrogen and cyanide content in cocoyam and sorghum using neutron-based nuclear techniques. By improving detection efficiency, this study enhances food safety monitoring and reduces the risk of cyanide poisoning.

## Aim

This research aims to investigate the bulk hydrogen content of sorghum and cocoyam about their cyanide content using neutrons for routine quality control.

## Objectives

- Determine the hydrogen content of sorghum and cocoyam
- Evaluate the cyanide content of sorghum and cocoyam
- Assess the total hydrogen content in sorghum and cocoyam as a quality control indicator of starch content.
- Re-calibrate and re-characterize the neutron reflection analytical facility at CERT, ABU, Zaria

**Figure 1:** Cocoyam

## Methodology

.

Four different varieties of sorghum and cocoyam were collected from retail outlets in Nigeria, washed clean and dried in an oven at 80ºC.

### Neutron reflection for Hydrogen assessment

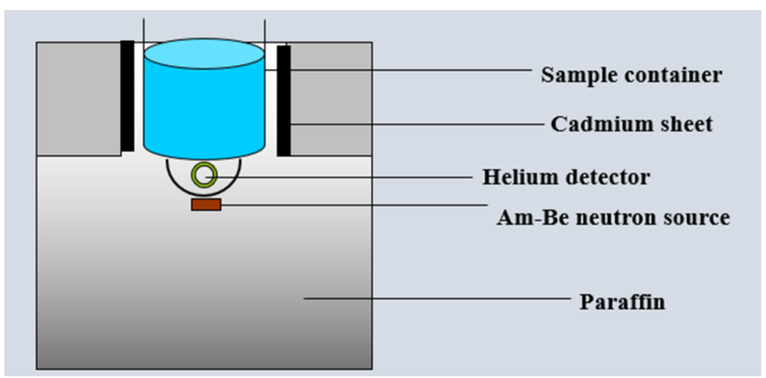


**Figure 2:** The neutron reflection set-up

- This technique utilizes the relative intensity of thermal neutrons reflected by a bulk sample to give the total hydrogen content of a sample.
- Liquid hydrocarbons were assessed to obtain a standard calibration curve for the hydrogen content.
- 400ml of each sample was measured into the sample holder and exposed to thermalized neutrons from an Am-Be source.

$$\eta = \frac{1}{\rho}\frac{I - I_0}{I_0}$$

### Alkaline Picrate Method for Cyanide Analysis

- Varying concentrations of potassium cyanide were analyzed to obtain a calibration curve for the cyanide content.
- The results were extrapolated from the standard calibration

### Results

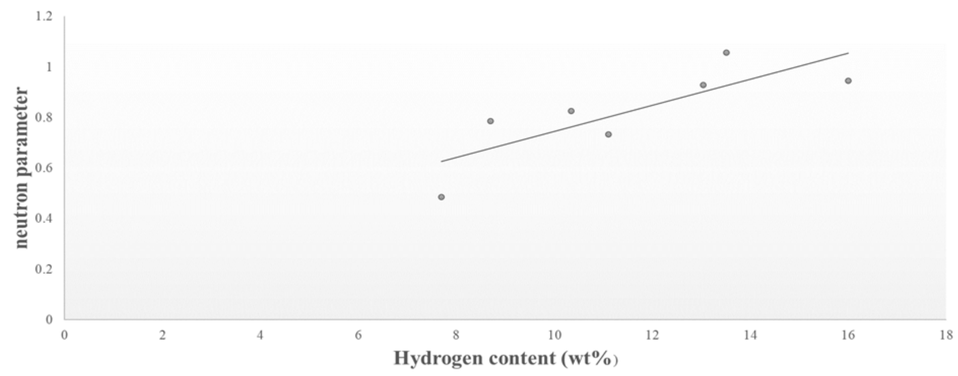


**Figure 3:** Standard Curve for Hydrogen

The hydrogen content of the food samples was obtained via extrapolation from the standard hydrogen calibration

The total hydrogen weight percent (H wt%) ranges from 6.083 ± 1.10 to 8.2854 ± 0.10.

Similarly, the cyanide content was extrapolated from the standard cyanide calibration curve.

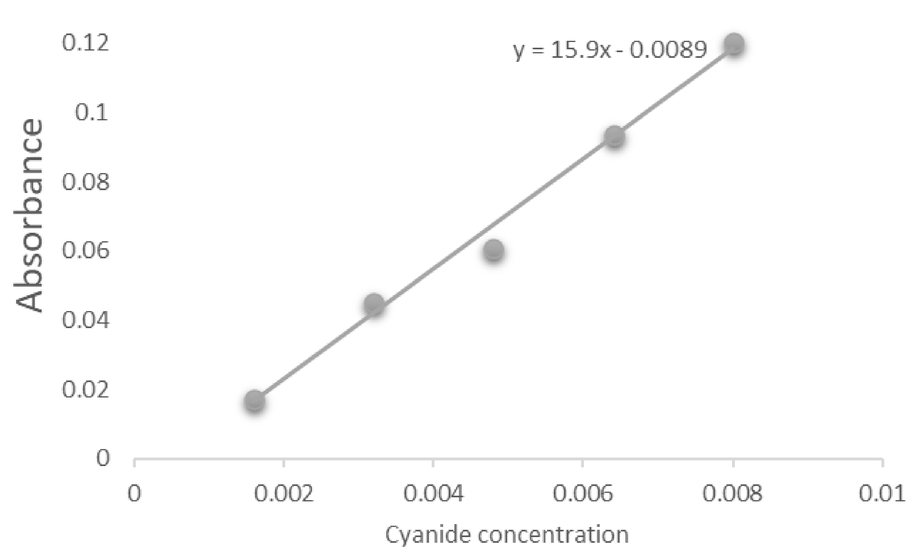


**Figure 4:** Standard Curve for Cyanide

## Discussion

- Total hydrogen weight per cent ($H\ wt\%$) was determined using a linear relationship with neutron attenuation coefficient ($\eta$), following the equation $y = 0.0515x + 0.2313$
- Neutron attenuation was balanced using sample densities, and reflection parameter values were directly proportional to hydrogen content, supporting findings by Isah et al.
- Cyanide content was extrapolated using a calibration graph with the equation, yielding values between 0.00384 ± 0.00009 and 0.00628 ± 0.0004.
- The study demonstrates the effectiveness of neutron-based techniques for food quality control, offering a rapid, non-destructive alternative to traditional chemical methods, with potential applications in large-scale food safety monitoring.

## Conclusion

- Thermal neutron reflection is reliable for probing hydrogenous samples, and its application in this study enabled accurate assessment of hydrogen and cyanide content in sorghum and cocoyam.
- Results indicate an inverse relationship between hydrogen and cyanide content, confirming previous findings on cyanogenic food plants like cassava and reinforcing the viability of neutron reflection for quality assessment.
- The neutron reflection facility can be adapted for direct hydrogen content determination in food safety applications which is a fast and non-destructive alternative to traditional chemical analysis methods.