

DEHYDRATION CHARACTERISTICS AND THERMODYNAMIC PROPERTIES OF UNRIPE GREEN PLANTAIN DRIED USING A REFRACTANCE WINDOW™ DRYER

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Abstract

The dehydration characteristics and the changes in thermodynamic properties of green plantain were determined at 1.5, 3.0, and 6.0 mm thickness, and temperatures of 75, 85 and 95°C in a Refractance Window™ (RW) dryer. The moisture-content history data was documented during the drying process. The drying times for the plantain slices to reach a moisture-content of 0.10g-water/g-solid, varied between 25 to 220 minutes. Also, the drying times decreased exponentially as the drying temperature increased for a given slice size, and increased with slice size for a given drying temperature. The Haghi and Ghanadzadeh thin-layer drying model was observed to fit the moisture-content history data best. With the moisture-content history data, the estimated effective moisture diffusivity varied from 7.80×10^{-10} to $3.66 \times 10^{-09} \text{ m}^2\text{s}^{-1}$. Also, the activation energy of dehydration, for different slice sizes, estimated from the moisture-content history data was observed to vary between 18.10 and 28.44 kJ/mol. The thermodynamic properties such as changes in Enthalpy, ΔH , Entropy, ΔS , and Gibbs Free Energy, ΔG , subsequently estimated were observed to vary between 15,045 and 25,546 J.mol⁻¹, -189.22 and -188.77 J.K⁻¹.mol⁻¹, and 80,978 and 94,952 J mol⁻¹, respectively. The data obtained in the study will be useful in the design, modelling, and operation of RW dryers.

Keywords: Dehydration Characteristics, Plantain, Refractance Window™ Drying, Thermodynamic Properties.

1 INTRODUCTION

Unripe green plantains, sometimes known as cooking plantains are firm and starchy and are from the banana cultivars in the genus *Musa*. The energy value of 100g of plantain is 120 kcal. Plantain slices consist of 65% water, 31.89% carbohydrates, 10% sugars, and 2.3g %dietary fiber by weight. Plantain fruits are rich in vitamins C at 18.6 mg per 100g serving (USDA, 2019).As the plantain ripens, it becomes sweeter, and

its colour changes from green to yellow to black, just like bananas. In Nigeria, unripe plantain slices are dried, made into powder and used to prepare a cuisine called *elubo*.

The sun-drying method is the most common method of dehydrating the plantain slices in rural Nigeria (Taiwo, 1985). The problem is that the quality of dehydrated plantain slices degrades when dried using this method. This