



University of Venda

**Nutritional profiling and effects of processing on unripe banana cultivars in  
Limpopo province, South Africa**

By

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## Abstract

Harvested banana fruits (*Musa* spp.) in Limpopo Province of South Africa, records about 50% of postharvest loss due to underutilization and lack of processing. As a climacteric fruit with high rate of respiration and senescence, banana has a short shelflife after harvest hence its increased incidence of spoilage. In mitigating the effect of postharvest loss of fruits, indigenous banana cultivars Luvhele (*Musa* ABB), Mabonde (*Musa* AAA) and Muomva-red (*Musa balbisiana*) and commercial cultivar Williams, obtained from Thulamela Municipality, Vhembe District of South Africa and harvested at mature green state 1 of ripeness were profiled for morphological and physicochemical properties. Fruit were pretreated with organic acids having generally regarded as safe status (ascorbic, citric and lactic acid) at different concentrations of 10, 15 and 20 g/L, oven dried at 70°C and processed to unripe banana flour (UBF). The effect of processing was investigated by characterizing UBF obtained from all cultivars for morphology, nutritional, functional, antioxidant and phenolic properties. Results of physicochemical characterization showed that all three non-commercial cultivars varied significantly ( $p < 0.05$ ) in their morphology, pH, titratable acidity and total soluble solids with no significant difference in their ash content. Upon processing into flour, UBF showed marked significant differences ( $p < 0.05$ ) in functional properties including water holding capacity, bulk density, swelling power and colour (CIEL\*a\*b\* and CIELCH). Organic acid pretreatment greatly reduced browning of flour as citric acid pretreated banana flour had the least browning index among cultivars examined. Marked significant difference was however not recorded in oil holding capacity and water solubility index (WSI) of all commercial and non-commercial UBF except for Mabonde UBF, with all cultivars generally recording low values for WSI. Surface morphology obtained from scanning electron microscope (SEM) of all four cultivars showed marked variations in structure, shape and size of starch granules of the different banana flours. SEM micrographs of UBF examined suggest that flour granules were considerably irregular in structure among all four cultivars. Observed shapes of flour granules included polygonal for Luvhele, oval for Mabonde,

elongated for Muomva-red and between polygonal and spherical for Williams. Characterization of cultivars for total polyphenols (TPs) and antioxidant activity upon pretreatment with ascorbic, citric and lactic acid showed that the 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging capacity of samples varied significantly as Muomva-red cultivar ( $1.02 \pm 0.01$  mg GA/g) expressed the highest DPPH capacity at lactic acid concentration of 20 g/L. TP content was also highest for Muomva-red [ $1091.76 \pm 122.81$  mg GAE/100 g (d.w.)]. Mineral concentration of cultivars using inductively coupled plasma atomic emission spectroscopy showed the presence of essential macro: calcium (Ca), magnesium (Mg), phosphorus (P), potassium (K) and Sulphur (S) and essential trace: iron (Fe) and zinc (Zn) minerals in varying amounts. K recorded the highest level (14746.73 mg/kg d.w. Mabonde cultivar) of concentration for essential macro minerals while Zn had the least concentration (3.55 mg/kg d.w. Williams cultivar) for essential trace elements. Liquid chromatography mass spectroscopy polyphenol profile of UBF showed the presence of flavonoids (epicatechin and myricetin-O-rhamnoside) at low concentrations, while gallic acid, catechins and epigallocatechins were not detected in flour of all three cultivars. Williams UBF recorded the highest concentration of epicatechin,  $3.24 \pm 0.58$   $\mu\text{g/g}$  at ascorbic acid pretreatment concentration of 20 g/L while Luvhele UBF recorded the highest concentration of myricetin-O-rhamnoside ( $17.33 \pm 2.31$   $\mu\text{g/g}$ ), at ascorbic acid pretreatment concentration of 10 g/L. The high concentration of minerals, antioxidant activities and TPs present in these cultivars make them suitable source of bio-nutrients with medicinal and health functions. Organic acid pretreatment at oven dried temperature of 70°C therefore enhances the functional, nutritional, antioxidant and phenolic properties of UBF. This will increase utilization of UBF and help mitigate postharvest loss of banana fruit.

**Keywords:** *Musa* species, physicochemical profile, banana cultivars, banana flour, functional properties, morphology, total polyphenol, antioxidant activity, phenolic compounds, postharvest utilization.