

ABSTRACT

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Title: Studies on the development of L-tryptophan-serotonin-melatonin rich nutraceutical food and supplement from gamma-irradiated green plantains (*Musa paradisiaca*)

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The local or 'desi' variety of green plantains (*Musa paradisiaca* L.) of the family 'Musaceae' is extensively cultivated in India including West Bengal. For being low-priced and rich in carbohydrates, resistant starches, dietary fibres, minerals including iron, and phytochemicals, it has been explored since ages for its numerous health benefits. However, they are less recognized for their abundant bioactive antioxidants, namely L-tryptophan, serotonin, and melatonin. In plants (including plantains), the amino acid L-tryptophan synthesizes serotonin through a cascade of biological reactions and is finally converted into melatonin and the abundance of these molecules depends on the state of maturity of the plantains.

In the present investigation, a value-added food product, *i.e.*, an antioxidant-rich (containing 4.54 μ g/g, 1.83 μ g/g, and 1.23 μ g/g of L-tryptophan, serotonin, and melatonin, respectively where the natural synergy among these were unperturbed) sugar free candy was developed from the freshly harvested plantains through minimal processing techniques and underwent characterization for its sensory appeal, physicochemical attributes, and phytochemical content. The newly designed candy can be safely stored for 56 days without any physicochemical and considerable antioxidant deterioration when packaged in a 3-ply flexible (PET/MET-PET/PE) laminate wrapper. This designed candy also showed considerable release of L-tryptophan, serotonin, and melatonin in simulated gastric (97.17%, 62.59%, and 95.05%, respectively, after 60 min), intestinal (90.16%, 99.73%, and 90.78%, respectively, after 60 min), and rectal (88.57%, 71.52%, and 95.66%, respectively, after 90 min) buffers mimicking the digestive process *in vitro*. In an *in vivo* study involving feeding of Sprague Dawley rats, a considerable enhancement in levels of L-tryptophan, serotonin, and melatonin in the rat blood serum was observed after 30 min of consuming the designer candy; and their levels started to decline 60 min onwards. Additionally, the effect of the candy consumption on insulin sensitivity as well as glucose uptake were also explored using the non-invasive model of iHOMA2.

Extension of the shelf-life of raw plantains is crucial for complete utilization of this agricultural produce. By employing the non-thermal green technology of gamma-irradiation (0.04 kGy), the shelf-life of freshly harvested plantains can be extended by 8 days. Additionally, gamma-irradiation (at 0.6 and 1 kGy) can also augment the contents of the bioactive antioxidants *viz.* serotonin and melatonin by 1.44 folds (44.10%) and 2.45 folds (146.58%), in the irradiated plantains, respectively.

The completely senesced-cum-gamma-irradiated plantains were then valorized by extracting the antioxidant-triad employing ultrasonication-assisted solvent (green) extraction, maintaining the natural antioxidant synergy in the extract. This endeavor involved judicious choice of the extraction process parameters (and their ranges of operations) and optimization using statistical tools namely, CCRD-RSM. Thereafter, the extract (containing 1.84 μ g/g, 2.45 μ g/g, and 3.31 μ g/g of L-tryptophan, serotonin, and melatonin, respectively) was utilized to develop a consumable food supplement (containing 32.98 μ g/g, 40.59 μ g/g, and 43.07 μ g/g of L-tryptophan, serotonin, and melatonin, respectively) which was characterized for its physicochemical attributes and phytochemical content. The *in vitro* release kinetics study revealed 90.41% release of L-tryptophan, 95.10% of serotonin, and 97.71% of melatonin from the food supplement after 60 min in simulated rectal buffer.

Novelty: Products: 1. A semi-hard sugar-free antioxidant rich plantain-based candy. 2. Gamma-irradiated plantains rich in serotonin and melatonin. 3. An UAE extract rich in phytomelatonin. 4. An UAE extract having synergy among the antioxidant-triad. 5. An antioxidant-rich food supplement. **Processes:** 1. The SOP for development of a candy rich in a synergistic mix of antioxidants. 2. *In vitro* release kinetics and *in vivo* bioavailability study for antioxidants. 3. Optimized processing parameters of gamma-irradiation for extension of shelf-life of plantains and augmentation of serotonin and melatonin contents in plantains. 5. The optimized processing parameters for UAE extraction to obtain two extracts rich in phytomelatonin and having synergy among phytomelatonin-serotonin-L-tryptophan. 7. SOPs for development of a lyophilized powder and a food supplement from the UAE extract of plantains.

Forwarded & Recommended

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