IMPACT OF ACTIVE COMPOUNDS ISOLATED FROM BANANA (MUSA SP. VAR. NANJANGUD RASABALE) FLOWER AND PSEUDOSTEM TOWARDS CYTOPROTECTIVE AND DNA PROTECTION ACTIVITIES

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ABSTRACT

Objective: The present study was designed to evaluate for cytoprotective and DNA protective properties of the compounds isolated from ethanol extract of banana flower (EF) and ethanol extract of banana pseudostem (EE).

Methods: The four active compounds viz., umbelliferone (C1) and lupeol (C2) from EF and stigmasterol (C3) and β-sitosterol (C4) from EE were isolated by activity-guided repeated fractionation through silica gel column chromatography. The isolated compounds were evaluated for cytoprotective on erythrocytes and pTZ57R/T plasmid DNA protection against hydroxyl radicals.

Results: The study revealed that the compounds (C1-C4) at a concentration of 1 mg/ml exhibited 90% protection on erythrocytes membrane oxidation and also protect the pTZ57R/T plasmid DNA damage induced by hydroxyl radicals.

Conclusion: These results endorse an insight for a strong chemical basis to the alleged beneficial role of EF and EE in reducing oxidative stress conditions.

Keywords: Umbelliferone, Lupeol, Stigmasterol, β-Sitosterol

INTRODUCTION

India ranks a considerable position for the largest production of banana fruit in the world followed by Brazil and China [1]. Banana (Musa spp.), as a major fruit of India accounts for about 32% of the total fruit production and is considered to be a good source of biologically active compounds such as dopamine, N-acetyl serotonin, nor-adrenaline, isochromalin-4-one derivatives and polyphenols with high antioxidant properties [2–6]. The Indian traditional forms of medicines like Ayurveda and Folkloric have been exploiting roots, stalks, leaves and different parts of the banana plant for the origin of medicinal properties for a long period of time [7]. Despribe the literature available for its utilitarian value and diverse pharmacological activities viz., antiulcerogenic [8, 9], hypolipidemic [10], antimicrobial, antihypertensive [11], wound healing, antacid, diuretic and antioxidantic activities [12], a systematic activity guided isolation, identification and characterization of antioxidants from the distinct parts of banana have not been performed to date. Isolation and identification of new antioxidants such as phenolic compounds, nitrogen compounds, carotenoids and other phytocemicals from natural sources are gaining special interest in the prevention of diseases and as well for its ample health benefits over synthetic antioxidant compounds [13]. More recently, banana flower and pseudostem being incidental or secondary products of banana were found to contain a large amount of dietary fibres conjunct with polyphenols [14]. In this context, an efficient activity-guided isolation and identification for bioactive compounds were performed in the ethanol extract of banana (Musa sp. var. Nanjungud rasa bale) flower (EF) and pseudostem (EE). Nanjungud rasa bale (Nrb) is an elitist innate variety of banana originated from a divine place known as 'Nanjungud' in Karnataka, India. Unique characteristics of Nrb such as taste, fibrous texture, nutritional content and its distinct aroma when it ripens fully makes it very popular and exotic variety of banana in Karnataka. Herein the isolation and identification of four potent active compounds, Umbelliferone (C1) and Lupeol (C2) from the ethanol extract of banana flower (EF) and Stigmasterol (C3) and β-Sitosterol (C4) from ethanol extract of banana pseudostem (EE) were illustrated by spectroscopic means [15, 16]. Therefore, the objective of this study was to investigate the protective effect of the isolated compounds by free radical-induced damage on erythrocytes and DNA.

MATERIALS AND METHODS

Chemicals

Reagents and solvents used for extraction were procured from Merck (Mumbai, India). The standard drugs were purchased from Sigma-Aldrich Chemical Co (St. Louis, MO, USA). All other reagents were of analytical grade.

Plant material

Fresh banana pseudostem and inflorescence of Musa sp. cv. Nanjungud rasa bale were collected from banana cultivating farms of Nanjungud, Karnataka, India at coordinates 12.11° 7' 11" North, 76.70° 40' 58" East. The specimen (Reg. No.: A4) was identified by the department of Horticulture, Government of Karnataka, Mysore, India. Peeling the thick outer leaf-sheath of the tender pseudostem, the inner pith region was collected. Flowers were separated from the inflorescence followed by discarding the spathe. Both pseudostem and flowers were cleaned, cut into small pieces and dried at 40 °C in an oven. This was powdered using a homogenizer and further stored at 4 °C until use.

Preparation of extract and isolation of active compounds

The coarse powder was subjected to hot ethanol extraction using a homogenizer and further stored at 4 °C until use. Both pseudostem and flowers were cleaned, cut into small pieces and dried at 40 °C in an oven. This was powdered using a homogenizer and further stored at 4 °C until use. The powdered samples were further extracted with ethanol in a Soxhlet apparatus (twice using 95% ethanol) and filtered. The filtrate was further concentrated in vacuo using rotary evaporator (Rotavapor R-200, Buchi, Switzerland). The active compounds present in EF were identified as Umbelliferone and Lupeol, while...
Stigmasterol and β-Stoesterol from EE using various spectroscopic methods via successive solvent extraction followed by repeated silica gel column chromatography [15, 16].

DNA protection assay

The extent of protection against pTZ57R/T plasmid-DNA damage by isolated bio active compounds was evaluated as described by Lee et al., [17]. 2 µl of plasmid DNA was incubated with Fenton’s reagent (30 mmol H2O2, 50 µM ascorbic acid and 80 µM FeCl3) containing 0.2 mg/3 µl of compounds and final volume of the mixture was raised up to 15 µl with sterile water. The latter was then incubated for 30 min at 37 °C followed by the addition of loading dye. The DNA was analyzed on 1% agarose gel by carrying out the electrophoresis in TAE buffer (40 mmol Tris base, 16 mmol acetic acid, 1 mmol EDTA, pH 8.0) and further stained with ethidium bromide using gallic acid as positive control.

Cytoprotective studies of active compounds on erythrocytes

The cytoprotective studies of erythrocyte oxidation were done according to Suwalsky et al., [18]. Briefly, blood sample was collected from healthy donors in heparinized tubes. The tubes were gently mixed and centrifuged at 1000 g for 15 min to sediment the erythrocytes. The supernatant containing plasma was discarded. The pellet containing erythrocytes was washed 2-3 times with PBS (20 mmol, pH 7.4, NaCl- 0.9%) and re-suspended with four times the volume of PBS. The compounds were added at 1 mg/ml volume, pre-incubated at room temperature for 5 min followed by addition of hydrogen peroxide (30 mmol), ferric chloride (80 µM) as well as ascorbic acid (50 µM) and incubated at 37 °C for 1 h. During the course of incubation, the reaction mixture was gently shaken to ensure constant proper mixing. The morphological changes were observed and captured (Olympus12.8 megapixel digital camera, DP72) using Olympus microscope (BX41, DSS Imagetech Pvt. Ltd., New Delhi, India).

RESULTS AND DISCUSSION

DNA protection assay

DNA protective ability of the compounds (C1)-(C4) were evaluated to test their efficacy in protecting the DNA against oxidative damage (fig. 1). The oxidative damage induced by Fenton’s reagent generates hydroxyl free radical leading to DNA fragmentation with increase in its electrophoretic mobility [19] as evident in lane 2. This DNA fragmentation was recovered upon treatment with the compounds and gallic acid (lane 3-7).

In agreement to the gel documentation analysis, higher protection (80%) was observed in gallic acid treated sample, whereas 75%, 67%, 56% and 59% protection was observed for compounds (C1) - (C4) treated samples respectively.

Cytoprotective studies of erythrocyte oxidation

Erythrocytes are extensively used model cells for studies on oxidative stress induced cell damage. Oxidative stress induces an echinocytic type of cell alteration and characterized protuberance over the cell membrane [20]. Therefore the protective ability of the isolated compounds on erythrocyte oxidation was studied as there were no reports found on cytoprotective abilities of these compounds.

Fig. 1: Electrophoretic analysis of DNA protection by isolated compounds (C1)-(C4) in addition with standard gallic acid (0.2 mg/3 µl concentration). Lane 1-Native DNA, Lane 2-DNA+Oxidant, Lane 3-DNA+Compound 1 (umbelliferone)+Oxidant, Lane 4-DNA+Compound 2 (lupeol)+Oxidant, Lane 5-DNA+Compound 3 (stigmasterol)+Oxidant, Lane 6-DNA+Compound 4 (β -sitosterol)+Oxidant, Lane 7-DNA+Gallic acid+Oxidant

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The optical micrographs (fig. 2a-f) show the presence of normal cells in addition to oxidised cells indicating the cytoprotective role of compounds (C1)-(C4) treated samples. As compared to normal erythrocytes (fig. 2a) subjected to hydrogen peroxide and ascorbate/Fe²⁺ led to the oxidation of cell membrane rendering distorted and clustered appearance (abnormal erythrocyte—fig. 2b). From our results, it is evident that the isolated compounds were efficient in bringing down the oxidative stress-induced erythrocyte damage and could also revert back the echinocytic shape alteration as well the characteristic protuberances of the cell membrane as observed in fig. 2c-f.

Plants being a rich source of a myriad of bioactive ingredients and phytoconstituents, are the most attractive options to circumvent the problems faced by the administration of synthetic drugs. References of traditional form of medicine have provided a basis for research on such natural products in the treatment of several diseases [21]. Secondary metabolites isolated from banana flower and pseudostem such natural products in the treatment of several diseases [21].

CONCLUSION

In conclusion, this study endows the additional data to the literature about potential bioactive compounds from EF and EE. Also it suggests that this traditional form of medicine could be supplemented as a diet or in the form of nutraceutical for the treatment of oxidative damage diseases.

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AUTHORS CONTRIBUTION

M N NAGENDRA PRASAD: Designed the work

RAMITH RAMU: Data collection and analysis

PRITHVI S SHIRAHATTI: Wrote the manuscript

SHRISHA NAIK BAJPE and VARSHA REDDY S V: Contributed the materials/analysis tools/reagents

CONFLICT OF INTERESTS

There is no conflict of interest to declare

REFERENCES


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