# Total Phenolic Contents and Antioxidant Activity of *Musa* AAA Berangan after UV-C Radiation

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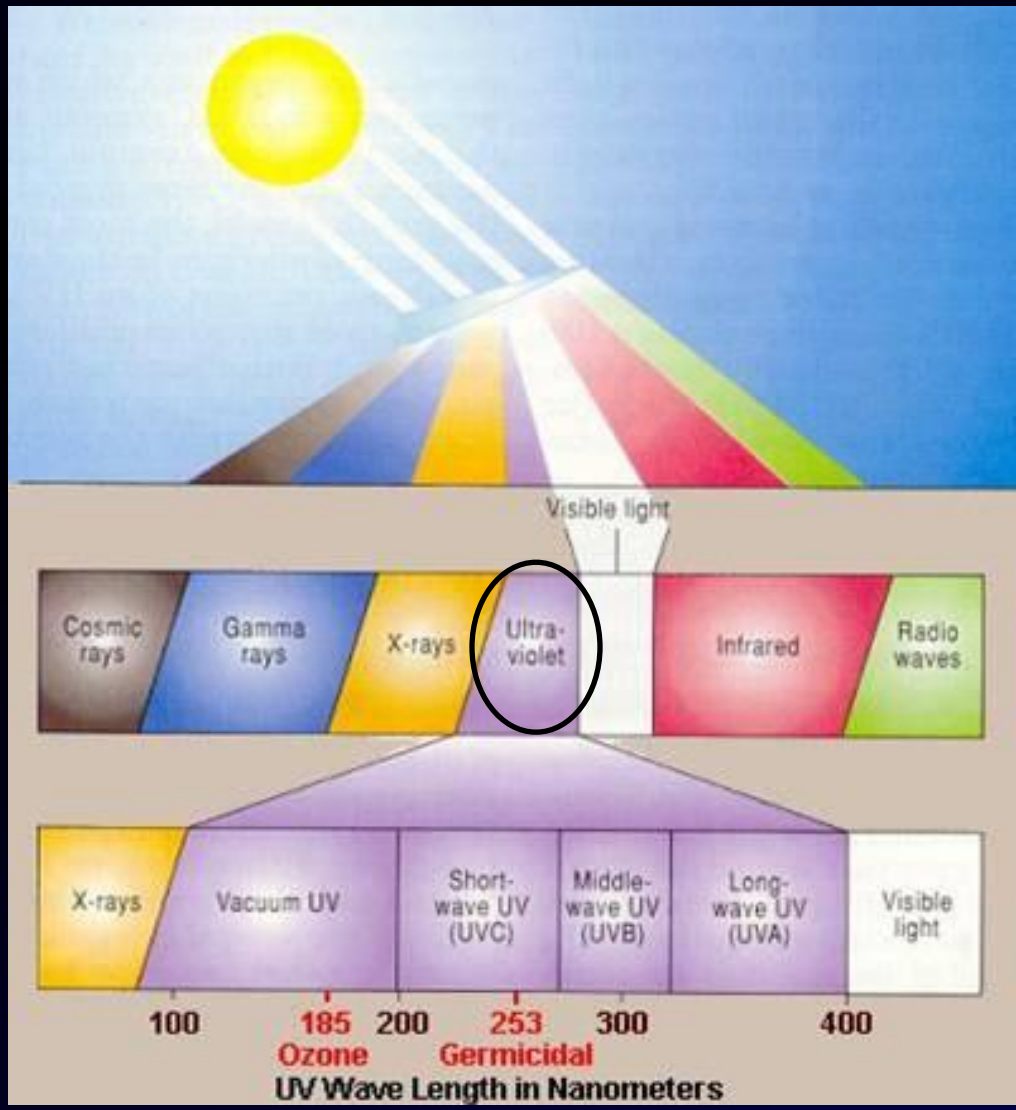
# What is ultraviolet (UV) radiation?

- **Definition:**

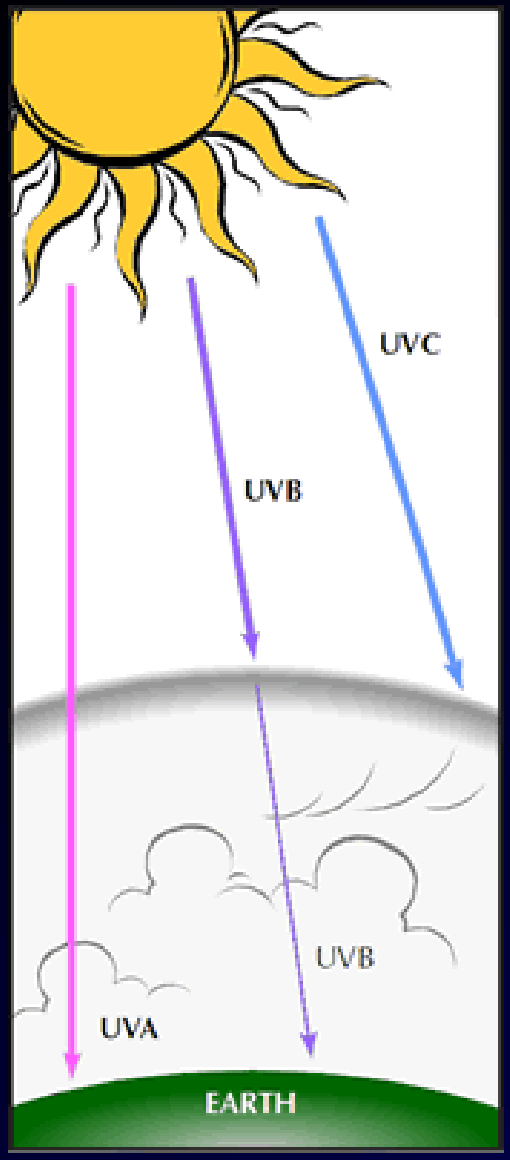
  The portion of the electromagnetic spectrum between X rays and visible light

(Health Physics Society, 2009)



# Ultraviolet (UV) Light

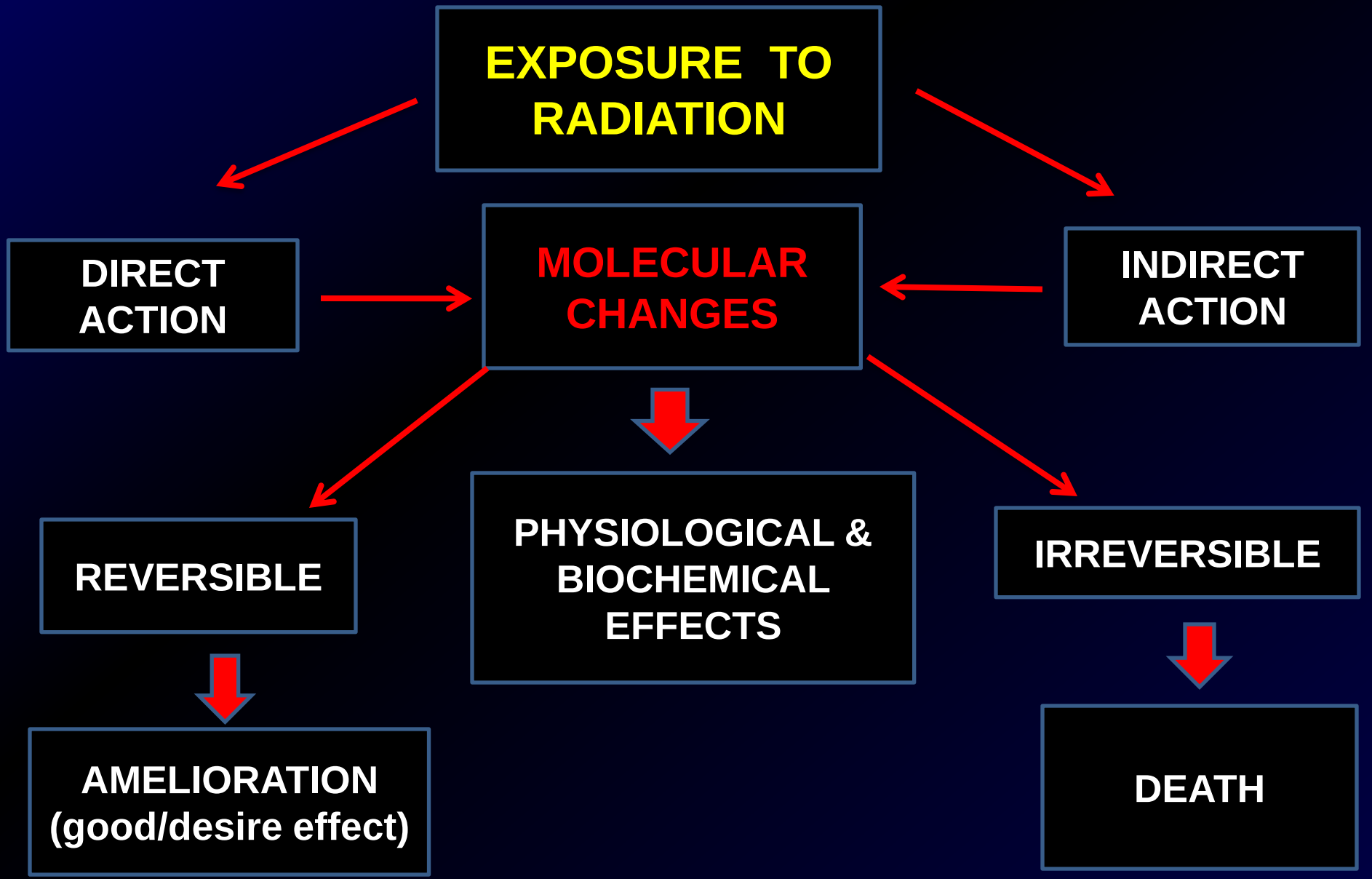
- Five ranges of wave lengths
  i. UV-A (320 – 400 nm)
  ii. UV-B (290 – 320 nm)
  iii. UV-C (220 – 290 nm)
  iv. Far UV (190 – 220 nm)
  v. Vacuum UV (40 – 190 nm)



# UV-C in Daily Life

- 1900 – Water disinfection
- 1930s – As food preservation techniques
- 1980s – Widely accepted to treat drinking water
- 2005 – 30% total market drinking water treatment
- Food related industries:
  - Food contact surfaces
  - Air in food preparation area
  - Packaging materials
- Hospitals, laboratories and drug facilities

# Photobiological Effects



# Physiological and Biochemical Changes after UV-C Radiation

| Crop | Findings | References |
|---|---|---|
| **Strawberries** | • ‘Camarosa’ - Phenolic and vitamin C content reduced<br>• Antioxidant activity and enzyme activities (glutathione peroxidase, glutathione reductase, superoxide dismutase, ascorbate peroxidase, guaiacol peroxidase, monodehydroascorbate reductase and dehydroascorbate reductase) increased<br>• Phenolic content increased<br>• Softening delayed<br>• Gene that encode proteins and enzymes involved in cell wall degradation being modified and gene expression being reduced<br>• Gene expression and enzymatic activity related to plant defense against pathogens were modified | Allende et al. (2007)<br>Erkan et al.(2008)<br>Pombo et al. (2009, 2011) |

# Physiological and Biochemical Changes after UV-C Radiation

| Crop | Findings | References |
|---|---|---|
| **Watermelon (fresh-cut)** | • More effective than chlorine and ozone<br>• Microbial populations decreased<br>• Colour slightly affected<br>• Lycopene content preserved at 2.8 kJ/m$^2$ or slightly decreased at 1.6 kJ/m$^2$<br>• Vitamin C not affected<br>• Catalase activity and total polyphenols decreased | Artes-Hernandez (2010) |
| **Papaya ('Golden')** | • Not able to control *Colletotrichum gloesporioides*<br>• Causing scald | Cia et al. (2007) |
| **Mango ('Haden')** | • Overall appearance maintained<br>• Decay reduced<br>• Total phenols and flavonoids increased<br>• Lipoxygenase and phenylalanine ammonia-lyase increased | Gonzalez-Aguilar (2007) |

# Physiological and Biochemical Changes after UV-C Radiation

| Crop | Findings | References |
|---|---|---|
| **Blueberries** | • Decay decreased<br>• Total anthocyanin, total phenolics and antioxidant activity increased<br>• Total flavonoids increased<br>• 0.43 kJ/$m^2$ could increase phenolics and anthocyanins | Perkins-Veazie et al. (2008)<br>Wang et al.(2009) |
| **Apples (fresh-cut)** | • 1.2 – 24.0 kJ/$m^2$ reduced total viable counts<br>• Antioxidant activity, total phenols, anthocyanins, quercetin glycocides, chlorogenic acid and ascorbic acid increased<br>• Skin colour improved<br>• Soluble solids concentration, titratable acidity and weight loss not affected | Manzocco et al. (2011)<br>Hagena et al. (2007) |

# Physiological and Biochemical Changes after UV-C Radiation

| Crop | Findings | References |
|---|---|---|
| **Grapes for winemaking** | • Produced stilbene (protect lipoproteins from oxidative damage and to have cancer chemopreventive) enriched red wine | Guerrero et al. (2010) |

# Advantages of UV-C Radiation

- Inexpensive
- Simple technique (although subject to certain safety precautions)
- Lack of residual compounds
- Avoidance of chemicals that can cause ecological problems and/or potentially harmful to humans
- Penetrates only 5 – 30 μm of tissue

# Berangan Banana

- One of the six fruit crops for development under Entry Point Project of NKEA
- Most favorite among local
- Comprises 50% of banana growing land
- Characters of bunch:
  - ✓ Weight: 12 – 20 kg
  - ✓ Hand: 6 – 10
- Characters of hand:
  - ✓12 – 20 fingers/hand
  - ✓12 – 18 cm in length
  - ✓3 – 4 cm in diameter

# Objective

To determine the antioxidant content and activity of Berangan banana after exposure to UV-C radiation

# Methodology

**UV-C radiation**

**(0, 0.01, 0.02, 0.03 and 0.04 kJ/m$^2$)**

**Ripening initiation**

**(1 ml/l $C_2H_4$/24 h)**

**Extraction**

**(Pulp freeze-dried → extract using 50 ml 80% methanol)**

**Total phenolic contents**

**(Using Folin-Ciocalteu assay and result was expressed as mg gallic acid equivalents (GAE)/ g dry weight)**

**Antioxidant activity**

**(FRAP, DPPH and ABTS assays and results were expressed in μmol trolox/g dry weight)**

**Analyse at day 0, 1, 3 and 5 after ripening initiation**

FRAP = Ferric-reducing antioxidant power
DPPH = 1,1-Diphenyl-2-picrylhydrazl
ABTS = 2,2',-Azino(bis-3-ethyl-benzothiozoline-6-sulfonic acid)

# Irradiation Treatment

Low pressure mercury lamp – 254 nm

# Statistical Analysis

- Factorial arrangements:
  - 5 UV-C radiation dose x 4 ripening stages
- Randomized complete block design
- 3 replications
- Data analyzed using ANOVA
- Means separation using least significant difference
- Correlation analysis was performed to correlate antioxidant content and antioxidant activities

# Results and Discussion

**Table 1: Effect of UV-C dose and day after ripening total phenolic contents and antioxidant activity (FRAP, DPPH and ABTS) of Berangan banana**

| Factors | Total phenolic contents (mg GAE/g) | FRAP (μmol trolox/g) | DPPH (μmol trolox/g) | ABTS (μmol trolox/g) |
|---|---|---|---|---|
| UV-C dose | 5.54** | 4.28* | 2.92* | 2.99* |
| Day after ripening | 157.69** | 112.02** | 53.86** | 149.11** |
| Interaction | 2.00* | $1.28^{NS}$ | $0.93^{NS}$ | $1.62^{NS}$ |

*, ** or NS **Significant, highly significant or non significant at P≤ 0.05, respectively**.

# Interaction Effect of TPC

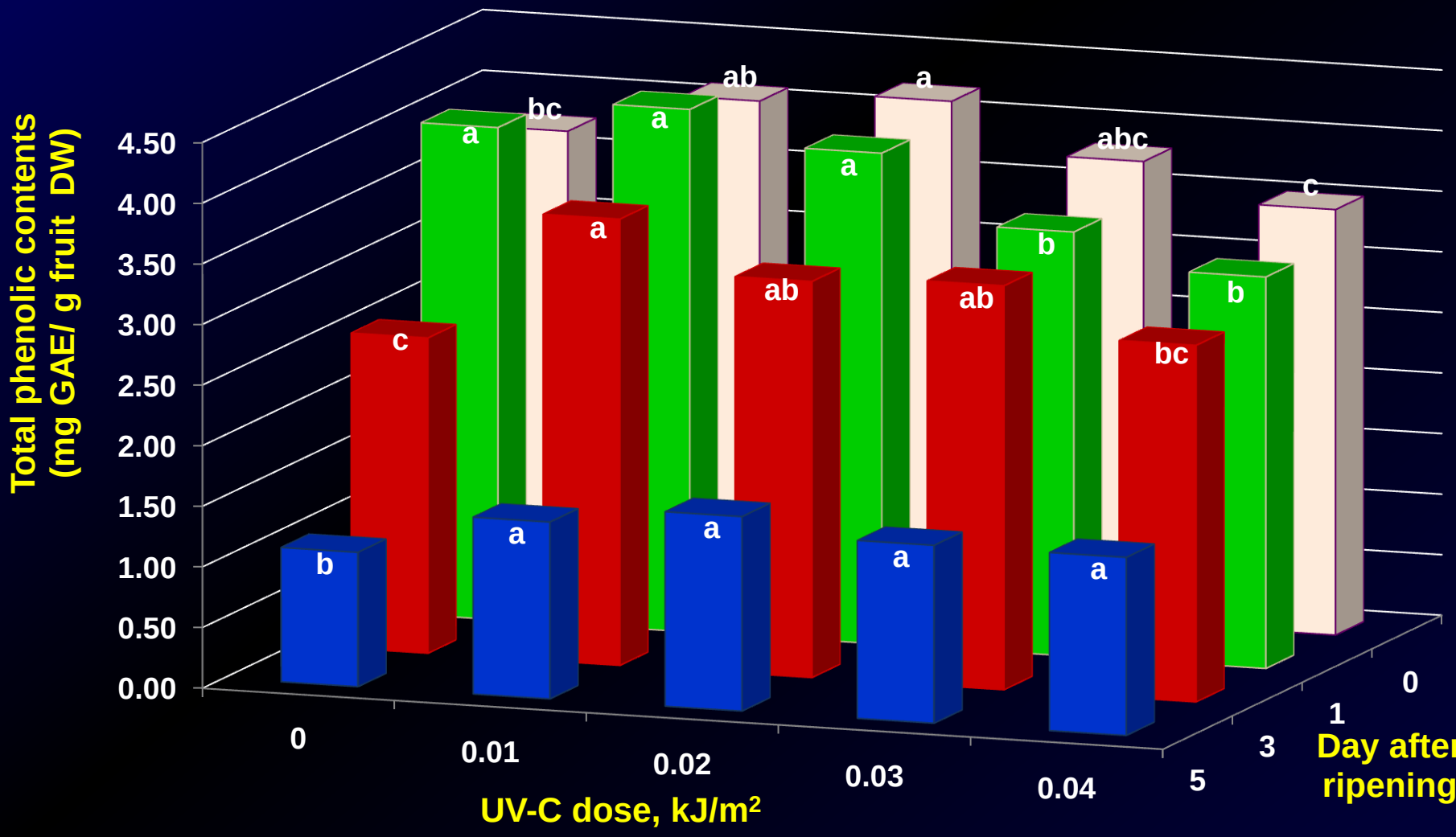
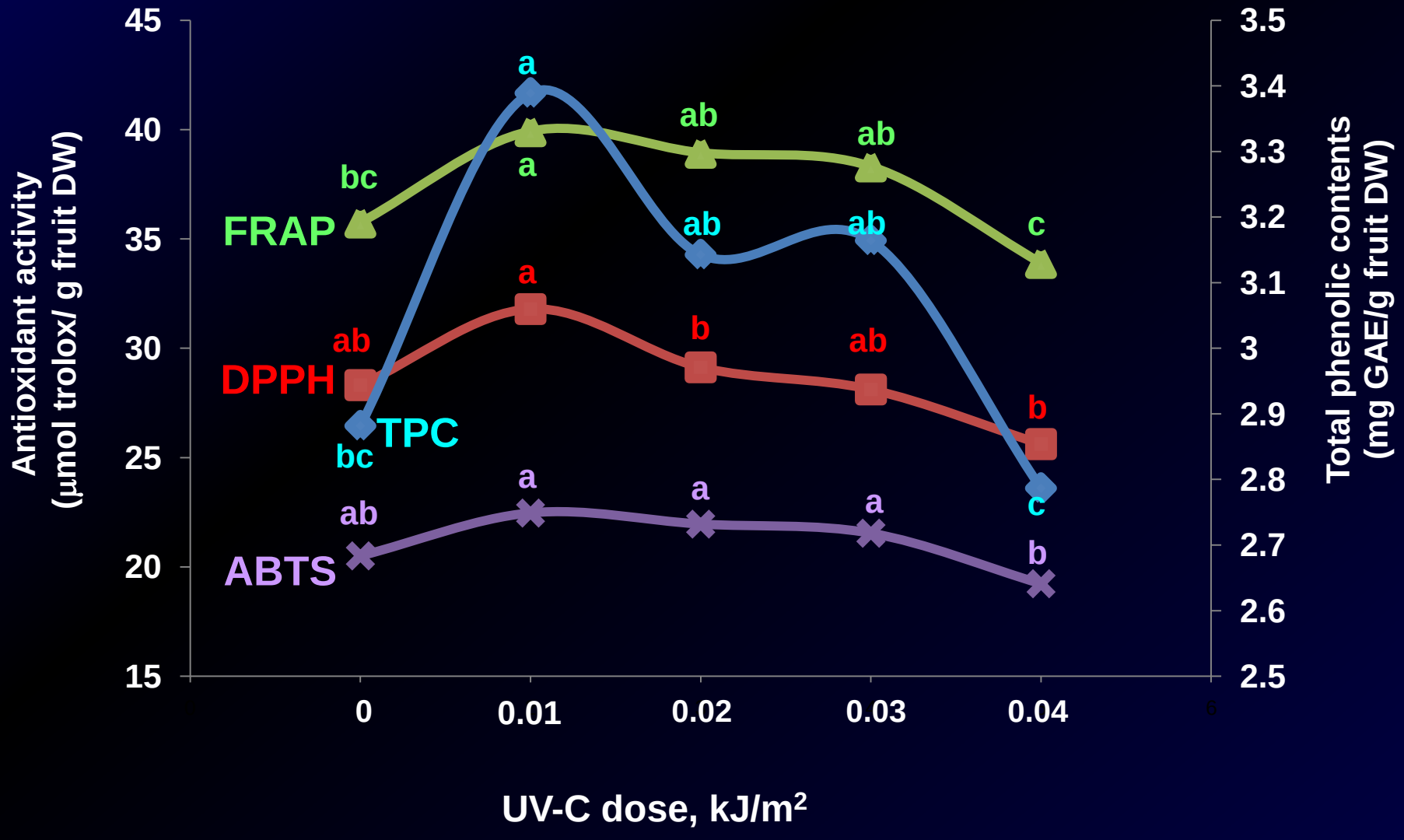
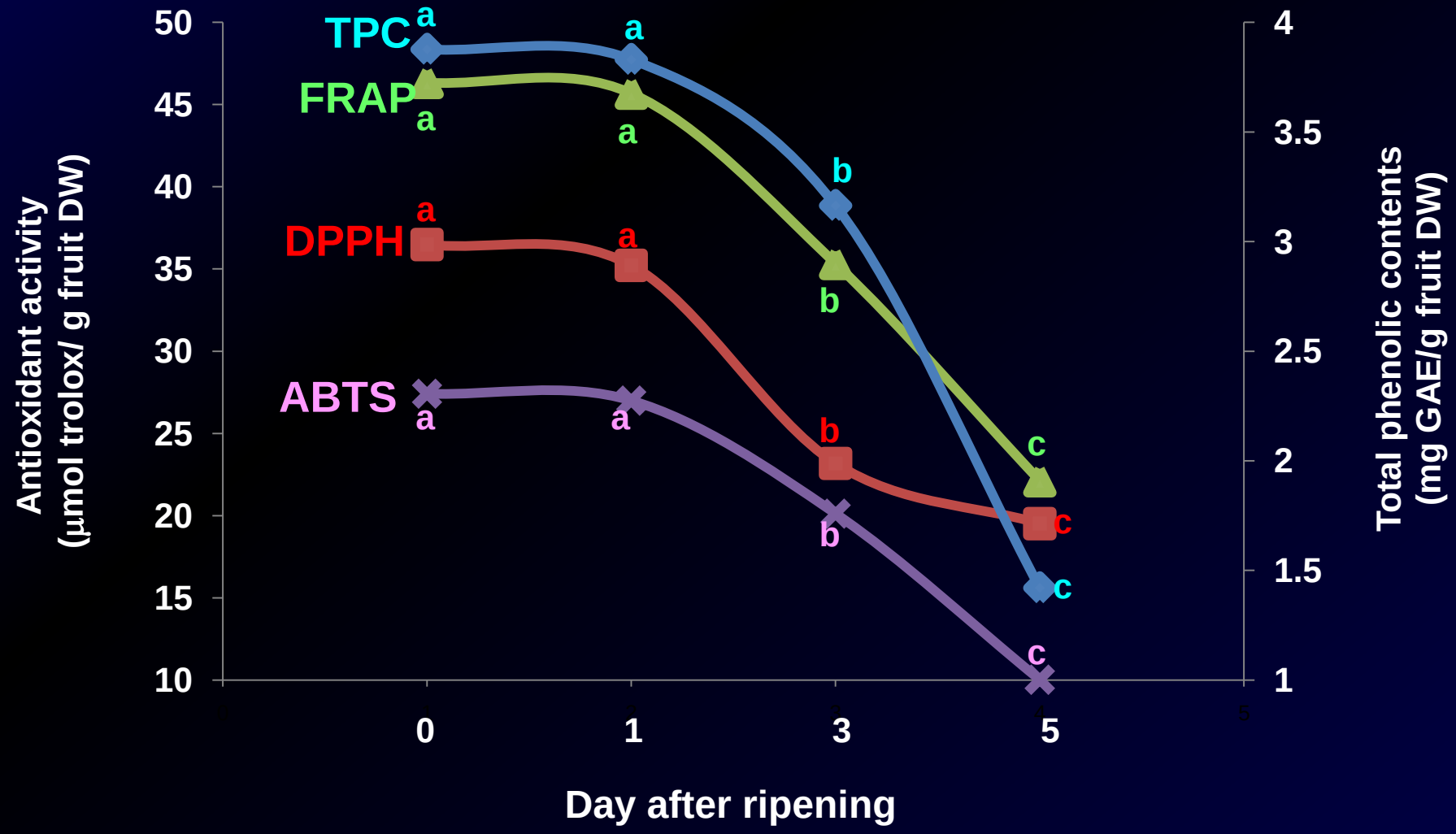



Fig. 1. Effects of UV-C radiation x ripening day on total phenolic contents of Berangan banana. Means separations pertaining to each ripening day followed by the same letters are not significantly different by LSD at (P< 0.05).

# Main Effects of UV-C Dose on TPC and Antioxidant Activity



# Main Effects of Day after Ripening on TPC and Antioxidant Activity



# Correlation Coefficient of TPC and Antioxidant Activity

| | TPC | DPPH | FRAP | ABTS |
|---|---|---|---|---|
| TPC | - | | | |
| DPPH | 0.613** | - | | |
| FRAP | 0.909** | 0.674** | - | |
| ABTS | 0.921** | 0.717** | 0.930** | - |

** Highly significant at P≤ 0.05.

# Conclusions

- UV-C radiation has preserved total phenolic contents of fruit during ripening
- 0.01 kJ/$m^2$ UV-C is able to increase total phenolic contents and antioxidant activity
- Total phenolic contents is major contributor to antioxidant activity

# Thank you