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ORIGINAL RESEARCH

Synergistic Radioprotection with 2-Deoxy-D-Glucose and Antioxidant Plant Extracts: An In Vivo and In Vitro Study

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ABSTRACT
This study investigates the combined effects of 2-deoxy-D-glucose (2DG) with grape seed (Vitis vinifera), green tea (Camellia sinensis L.), and ginger (Zingiberofficinale) extracts on antioxidant activity during radiotherapy in mice. The research measures concentrations of α-tocopherol, ascorbate, total flavanols, total antioxidant activity, and reducing power in individual and combined extracts. Results indicate that combined extracts significantly enhance antioxidant activity, suggesting a synergistic effect that could potentially mitigate radiation-induced oxidative stress.
Keywords: Radiotherapy, Antioxidants, Grape Seed Extract, Green Tea Extract, Ginger Extract, 2-Deoxy-D-Glucose, Oxidative Stress, Murine Model

INTRODUCTION
Radiation therapy is a pivotal cancer treatment, but it often induces significant oxidative stress, leading to damage in normal cells. This study explores the potential of combining 2-deoxy-D-glucose (2DG) with selected medicinal plant extracts to enhance antioxidant defenses and protect against radiation-induced damage.

MATERIALS AND METHODS
Preparation of Plant Extracts: Grape seed, green tea, and ginger extracts were prepared using solvent extraction methods optimized for polyphenolic compound recovery. Extracts were standardized based on their polyphenol content.

Biochemical Estimations: Biochemical estimations included the determination of α-tocopherol, ascorbate, total flavanols, total antioxidant activity, and reducing power.

Statistical Analysis: Data were analyzed using one-way ANOVA and Tukey-Kramer multiple comparisons test. Significance was set at $p<0.05$.

RESULTS
Concentration of α-Tocopherol and Ascorbate: The highest concentrations of α-tocopherol and ascorbate were found in grape seed extract. However, the combination of grape seed, green tea, and ginger extracts showed a significant increase in these antioxidants compared to individual extracts.

Table 1: Concentration of α-Tocopherol and Ascorbate

Plant Extracts	α-Tocopherol Concentration (mg/L)	Ascorbate Concentration (mg/L)
Grape Seed	15.2	12.5
Green Tea	8.7	6.3

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Ginger	3.9	4.1
Combination	16.8	13.9

Total Flavanols Content: Total flavanol content was significantly higher in grape seed extract. The combination of grape seed and green tea extracts exhibited the highest flavanol content, indicating a synergistic effect.

Table 2: Total Flavanols Content

Plant Extracts	Total Flavanols Content (mg/g)
Grape Seed	42.6
Green Tea	35.2
Ginger	18.9
Combination	49.8

Total Antioxidant Activity: Total antioxidant activity increased with higher concentrations of plant extracts. Grape seed extract showed significant antioxidant activity, especially when combined with green tea and ginger extracts.

Table 3: Total Antioxidant Activity

Plant Extracts	Total Antioxidant Activity (mmol Trolox Equivalents/g)
Grape Seed	2.3
Green Tea	1.8
Ginger	1.5
Combination	2.6

Reducing Power: Reducing power increased with the concentration of the extracts. Grape seed extract exhibited significant reducing power, particularly when combined with green tea extract.

Table 4: Reducing Power

Plant Extracts	Reducing Power (Absorbance at 700 nm)
Grape Seed	0.78
Green Tea	0.62
Ginger	0.55
Combination	0.83

Changes in Body Weight of Mice: The body weights of mice were monitored throughout the study. Mice receiving the combined treatment of 2DG and plant extracts maintained or gained weight, unlike the irradiated group without supplementation.

Table 5: Changes in Body Weight of Mice

Group of Mice	Dietary Treatment	Initial Avg. Body Wt. (gm)	Avg. Body Wt. after 45 Days (gm)	Avg. Body Wt. after 60 Days (gm)
Group 1	Normal diet	34.9 ± 3.15	43.7 ± 4.6	52.5 ± 5.4
Group 2	Radiation + Normal diet	33.9 ± 3.1	44.3 ± 3.4	38.8 ± 2.9
Group 3	Radiation + Normal diet + 2DG	33.7 ± 2.5	42.3 ± 2.5	46.7 ± 2.8
Group 4	Radiation + Normal diet + 2DG + GS	33.9 ± 2.5	43.3 ± 4.4	50.5 ± 5.4
Group 5	Radiation + Normal diet + 2DG + GT	33.7 ± 2.9	38.0 ± 3.2	46.0 ± 5.3
Group 6	Radiation + Normal diet + 2DG + Gin	34.7 ± 2.4	43.6 ± 4.2	50.2 ± 4.3
Group 7	Radiation + Normal diet + 2DG + GS + GT	34.5 ± 3.1	39.6 ± 2.5	45.5 ± 1.5
Group 8	Radiation + Normal diet + 2DG + GS + Gin	34.8 ± 2.4	41.6 ± 3.4	47.2 ± 4.4
Group 9	Radiation + Normal diet + 2DG + GT + Gin	33.1 ± 2.8	39.3 ± 3.8	50.1 ± 5.3
Group 10	Radiation + Normal diet + 2DG + GS + GT + Gin	33.6 ± 2.4	41.1 ± 3.3	48.4 ± 3.8

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DISCUSSION

The study demonstrates that selected medicinal plant extracts, particularly in combination, significantly enhance antioxidant activity. This synergistic effect suggests potential benefits in mitigating radiation-induced oxidative stress. The combination of grape seed, green tea, and ginger extracts provides a robust antioxidant defense, likely due to the diverse range of polyphenolic compounds acting at various points in the oxidative stress pathway.

CONCLUSION

Combining grape seed, green tea, and ginger extracts enhances antioxidant defenses, potentially offering a protective strategy against radiation-induced damage during cancer treatment. This preclinical evidence advocates for the translational exploration of polyphenolic-rich phytoextracts as a complementary therapeutic modality in oncological radiotherapy.

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