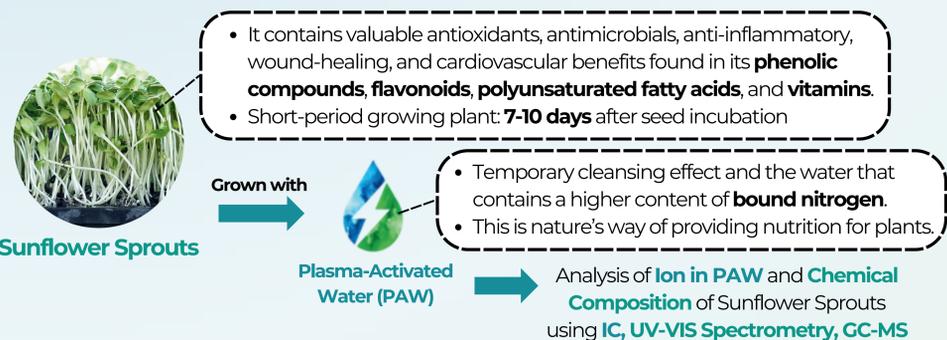


## Abstract

This study analyzed the effects of plasma-activated water (PAW) on sunflower sprouts compared to tap water (TW). PAW was generated with 60, 90 seconds, and 5 minutes generation times before germination. Ion chromatography (IC) analysis showed higher nitrate ( $\text{NO}_3^-$ ) and nitrite ( $\text{NO}_2^-$ ) levels in PAW, enhancing nutrient absorption and photosynthesis. Growth analysis indicated that PAW promoted sprout weight during the first 8–10 days but declined by day 12 due to excessive nitrate and nitrite accumulation, potentially leading to toxicity. Chemical composition analysis revealed increased chlorophyll, total phenolic content (TPC), and total flavonoid content (TFC) in the early phase, but their levels dropped in later stages. Antioxidant activity (DPPH assay) was higher in PAW-treated sprouts initially but declined over time due to oxidative stress. GC-MS analysis identified increased terpene compounds, such as 1S-alpha-Pinene and  $\beta$ -Calarene, which have antioxidant and antimicrobial properties. In conclusion, PAW enhances early growth, bioactive compound accumulation, and antioxidant activity in sunflower sprouts, but excessive nitrate and nitrite levels in later stages may impact quality and safety. Further optimization of PAW conditions is needed for safe agricultural applications.

## Introduction

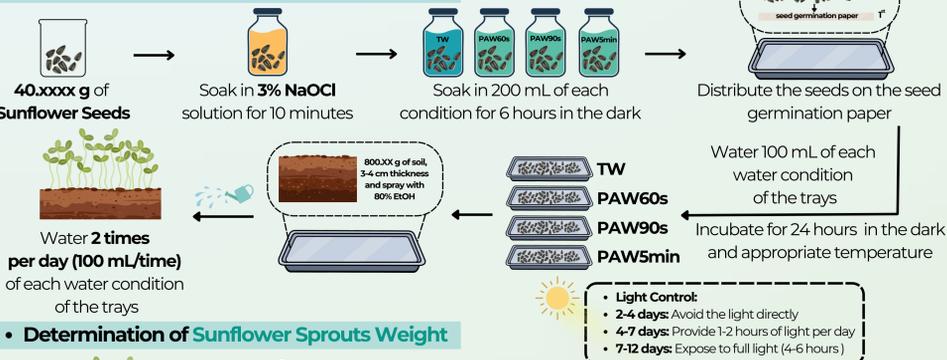


## Methodology

### Preparation of Plasma-Activated Water (PAW)



### Planting and Growing the Sunflower Sprouts



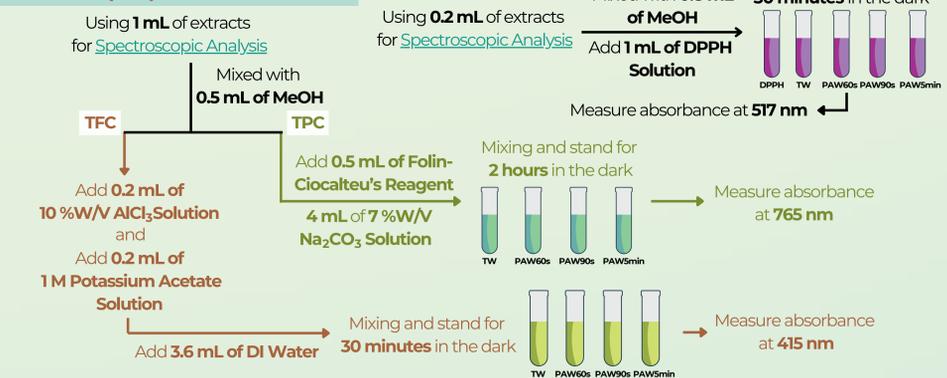
### Determination of Sunflower Sprouts Weight



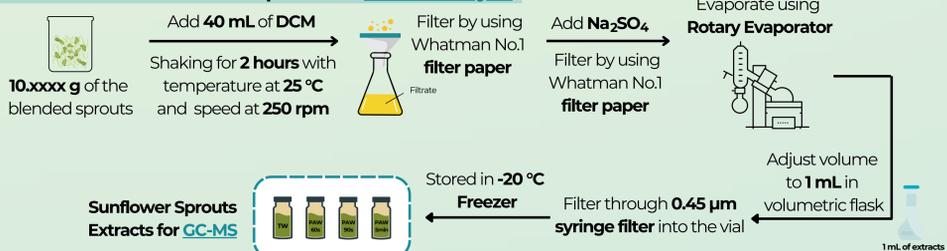
### Extraction of Sunflower Sprouts for Spectroscopic Analysis



### Determination of Total Phenolic Content (TPC) and Total Flavonoid Content (TFC)



### Extraction of Sunflower Sprouts for GC-MS Analysis



## Results

### Analysis of Ion in PAW using Ion Chromatography (IC)

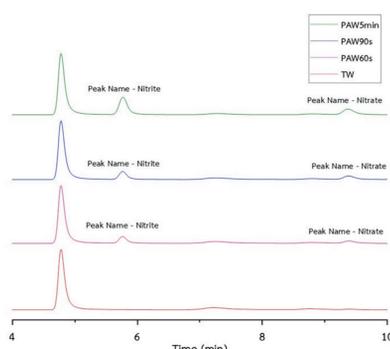


Fig.1 IC Chromatogram of TW, PAW60s, PAW90s and PAW5min

Table 1 Concentration of Chloride, Nitrate, Nitrite in TW, PAW60s, PAW90s and PAW5min

Condition	Chloride (ppm)	Nitrate (ppm)	Nitrite (ppm)
TW	320.6	0.3949	N/A
PAW60s	307.0	0.7947	2.925
PAW90s	311.4	1.111	3.604
PAW5min	325.5	1.675	9.062

### Determination of Chlorophyll Content

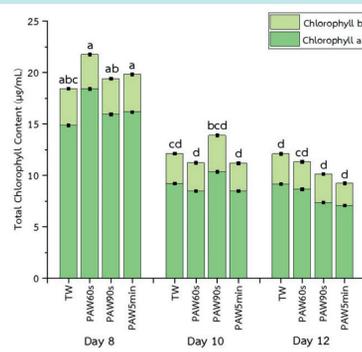


Fig.2 Chlorophyll Content of Sunflower Sprouts Grown with TW, PAW60s, PAW90s and PAW5min

### Analysis of Sunflower Sprouts using GC-MS

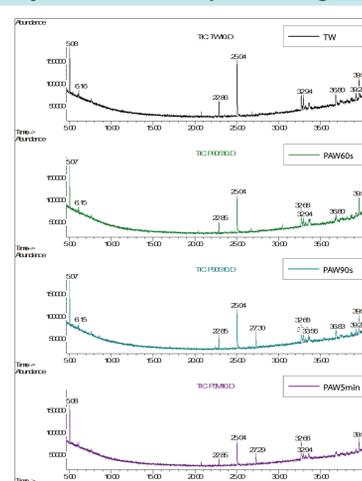


Fig.7 Chromatogram of Sunflower Sprouts Grown with TW, PAW60s, PAW90s and PAW5min

Table 2 Compounds in TW, PAW60s, PAW90s and PAW5min detected by GC-MS

Compound	Structure	Activity
1S-alpha-Pinene	<chem>C1=CC2=C(C1)C(C2)C</chem>	Antimicrobial, Anti-inflammatory, Bronchodilator and Enhances brain function
$\beta$ -Calarene	<chem>C1=CC2=C(C1)C(C2)C</chem>	Antimicrobial, Antioxidant, Anti-inflammatory, insect repellent and Used as a component in essential oils and perfumes
$\beta$ -Bisabolene	<chem>C1=CC2=C(C1)C(C2)C</chem>	Antimicrobial, Anti-inflammatory and Used in the fragrance industry
Cyclofenchene	<chem>C1=CC2=C(C1)C(C2)C</chem>	Antimicrobial and Used as a component in essential oils and cosmetics

### Determination of Sunflower Sprouts Weight

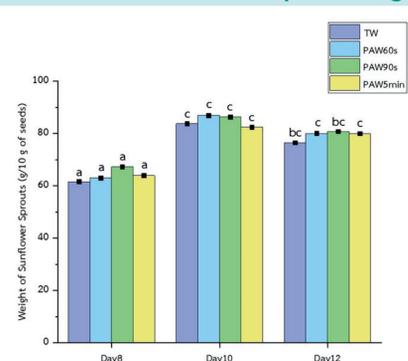


Fig.3 Weight of Sunflower Sprouts Grown with TW, PAW60s, PAW90s and PAW5min

### Determination of Total Phenolic Content (TPC)

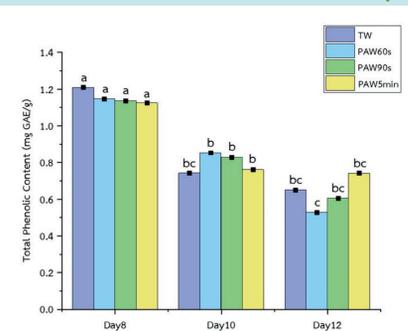


Fig.4 TPC of Sunflower Sprouts Grown with TW, PAW60s, PAW90s and PAW5min

### Determination of Total Flavonoid Content (TFC)

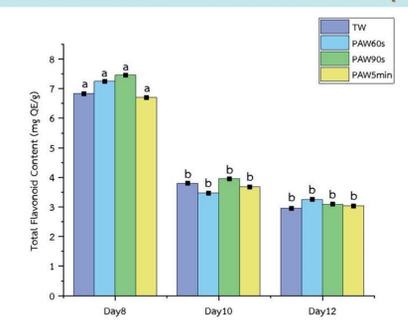


Fig.5 TFC of Sunflower Sprouts Grown with TW, PAW60s, PAW90s and PAW5min

### Determination of Antioxidant Activity using DPPH assay

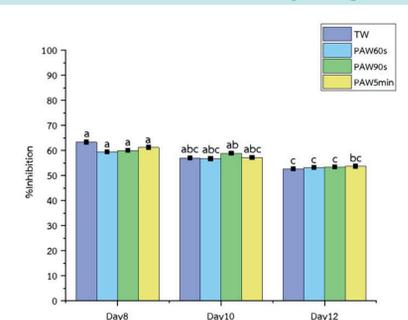


Fig.6 %Inhibition of Sunflower Sprouts Grown with TW, PAW60s, PAW90s and PAW5min

## Conclusion

PAW boosted early growth, chlorophyll, and antioxidants in sunflower sprouts but caused growth decline by day 12 due to nitrate/nitrite accumulation. It also increased bioactive terpenes with antioxidant and antimicrobial properties. Optimization is needed for safe agricultural use.

### Acknowledgements

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