Celery Science: *Apium Graveolens* Unleashing Osmotic Potential

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Abstract

This study explores the impact of *Apium graveolens* (AG) (celery) extract (AGE) concentration on osmotic pressure in a semi-permeable membrane in vitro. Aligning with the supplement industry's interest in natural remedies for health concerns, the research examines celery's potential diuretic properties relevant to conditions like hypertension and kidney disease. Findings suggest a correlation between celery concentration and osmotic pressure changes, shedding light on potential applications for kidney health. While revealing insights, the study prompts questions about celery's broader physiological effects.

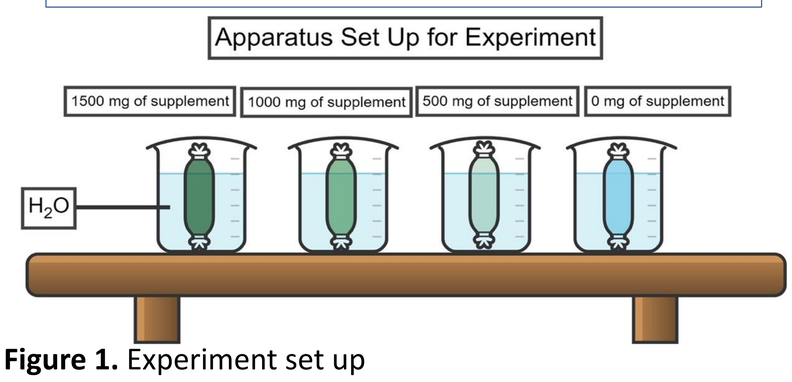

Figure 1. Experiment set up

Introduction

In an era marked by a surge in health awareness and the pursuit of immunity-enhancing superfoods, the exploration of medicinal herbs gains prominence due to concerns regarding the adverse effects of pharmacological drugs (Faris et al., 2018; Aresnov et al., 2021). Drug-induced diuresis, acknowledged for its therapeutic potential, offers promise in treating ailments like hypertension, chronic kidney disease, nephritic syndrome, and hypertensive neuropathy (Faris et al., 2018; Dong et al., 2021). Hypertension, is significantly linked to kidney disease, wherein renin secretion and fluid management orchestrate blood pressure homeostasis. Perturbations in this equilibrium can instigate hypertension. The kidney's vulnerability to ischemia-induced renal tubular sensitivity disrupts function, leading to waste accumulation, inflammation, and potentially elevating hypertension risk (Dong et al., 2021; Tedla et al., 2011).

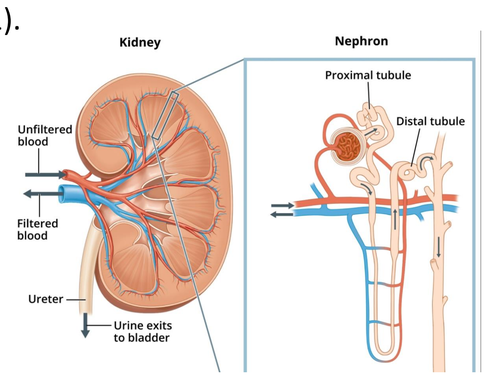

Figure 2. Kidney Structure (National Institute of Diabetes and Digestive and Kidney Diseases, 2020)

Apium graveolens, a staple in traditional Chinese medicine, garners attention for its diuretic and anti-inflammatory attributes (Houston, M.C., 2018; Dong et al., 2021). Enriched with compounds like flavonoid apigenin (see Figure 3), 3-n-Butylphthalide (NBP), and d-limonene (see Figure 4), celery holds promise in combating oxidative stress—an instigator of inflammation and hypertension. Apigenin showcases potential in countering renal damage by boosting antioxidants and curbing lipid hydroperoxides (Xu et al., 2022; Zhu et al., 2016). Demonstrating renal fibrosis mitigation through calcium ion-regulated pathways, apigenin offers a therapeutic pathway (Xu et al., 2022; Wei et al. 2017). Celery's flavonoids, functioning as metabolites, could potentially influence electrolyte reabsorption, leading to increased fluid excretion via osmosis (Rahnia et al., 2022; Roumelioti et al., 2018; Lopez and Hall, 2023).

The compound 3-n-Butylphthalide (NBP) from celery seeds emerges as a protective agent against hypertensive neuropathy, attributed to its antioxidant capabilities and mitigation of inflammatory factors (Hedayati et al., 2019; Dong et al., 2021).

Methods and Materials

All glassware underwent rinsing with distilled water to eliminate any residue from prior experiments.
A celery supplement, with 500mg AGE per capsule, facilitated solution preparation. Solution 1 was created by opening one capsule and combining its content with 15mL water in a 150mL beaker. This process was replicated for Solution 2 (2 capsules, 1000mg) and Solution 3 (3 capsules, 1500mg).
Ensuring no solution loss, solutions were accurately transferred to 3 dialysis tubes; a distilled water control solution served as a baseline. Between solutions, glassware rinsing upheld precision. Refer to Table 1 for concentration outcomes. Dialysis tubes' masses were measured and placed into separate 300mL beakers containing distilled water, covered by polyethylene film to prevent evaporation (see Figure 1).
Data collection focused on mass changes of dialysis tubing per concentration, measured initially and after 72 hours using a Digitech electric balance. This process was replicated 20 times across five tests.

Results

The scatter plot (see figure 5) depicts the average change in mass (in grams) over the AG concentration (in milligrams per milliliter, mg/mL). The correlation ($y = 0.0492x - 0.1397$, $r = 0.91$, $P < 0.01$), indicates a strong positive correlation between the AGE concentration and the average changes in mass.

The ANOVA F test, which is an inferential statistic, was conducted to determine the variance between the dependant variable, the change in mass, and the independent variable, the four concentration groups of AGE (0 mg/mL – control, 33.33 mg/mL, 66.67 mg/mL, 100 mg/mL). The results were statistically significant, and the null hypothesis was rejected as p-value 2.16618E-05 < 0.01.
H_0: There is no relationship between the average change in mass and the concentration of AGE.
H_A: The average change in mass increases as the concentration of AGE increases.

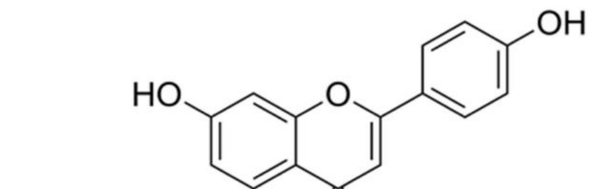

Figure 3: Chemical structure of apigenin (Xu et al., 2022)

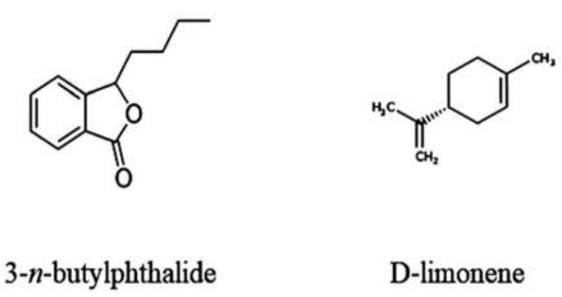

Figure 4: Chemical structure of some effective components of celery (Hedayati et al., 2019)

Discussion

The experiment notably influenced water mass within the dialysis tube, affecting water movement through the semipermeable membrane. Average results displayed a 4g mass shift from control (0mg/mL AGE) to 100mg/mL AGE group (Figure 5), affirming the strong positive correlation (r = 0.91) revealed in the regression analysis and Figure 5. This supports the hypothesis that celery extract concentration influences water movement. Despite statistically significant results (p-value 2.16618E-05) and rejection of the null hypothesis, large standard deviation was observed. Additionally, only 5 concentrations were tested and therefore a more extensive spread on concentrations might reveal different trends.
Measures minimized random and systematic errors, enhancing accuracy. Limitations stemmed from grade C measuring cylinders and a small sample size (n=20), affecting measurement precision and reliability. While internal validity and generalizability were reinforced, construct validity was restricted by the simplified model's inability to fully represent celery's physiological effects. Further human studies are essential for comprehensive insight into supplement potential and its broader implications in treating conditions like hypertension and renal disease.

Conclusions

The report aimed to investigate the effect of the concentration of AGE on osmotic pressure in a semi-permeable membrane in vitro. The findings confirmed the hypothesis through depicting a strong relationship between both variables. Further research is warranted to explore AG's potential as an antihypertensive and anti-inflammatory agent, representing a valuable avenue for investigation in modern medical contexts.

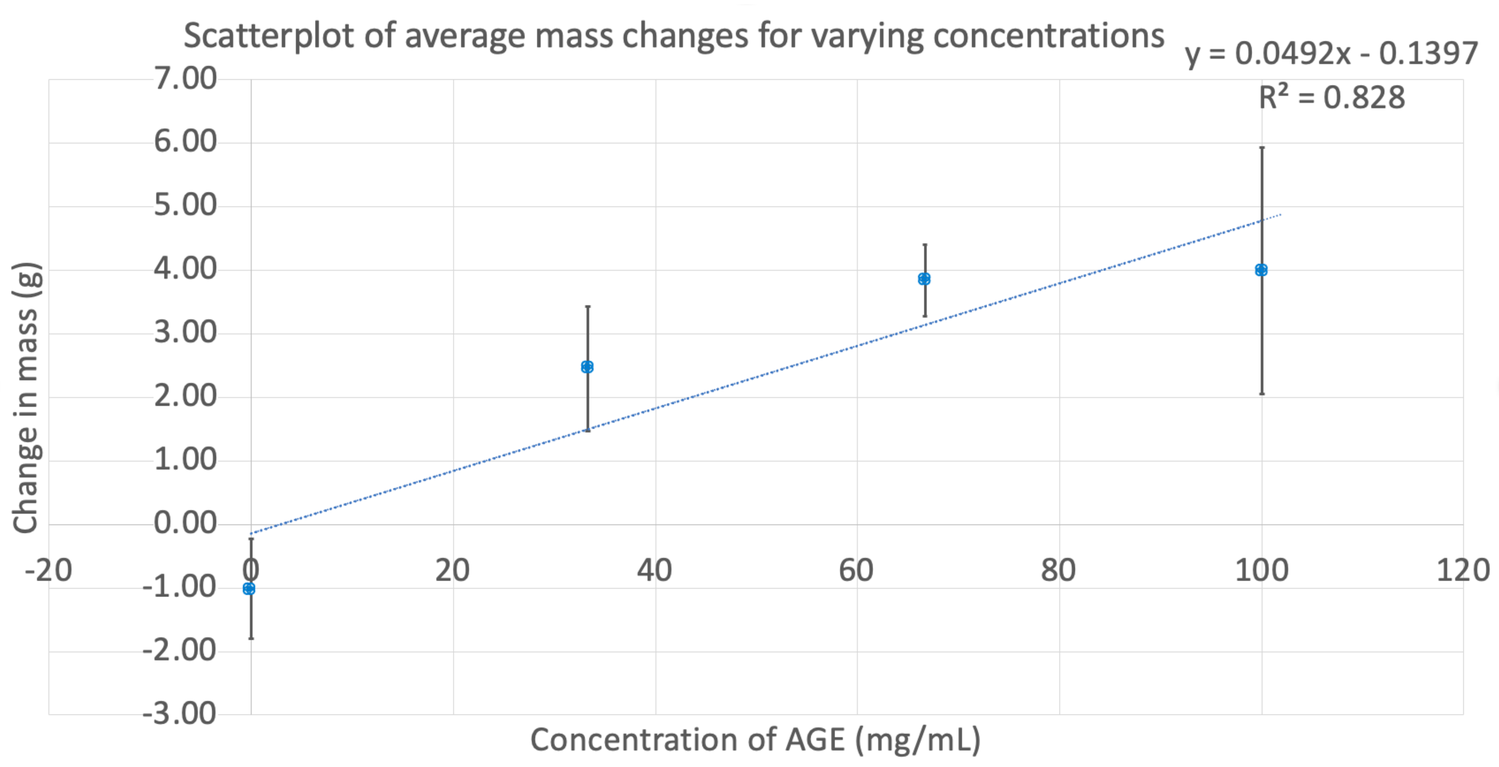

Figure 5: A graphical representation of the data