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Research Article

Effects of Seed Soaking in Cucumber and Carrot Aqueous Extract on Germination and Vigor of Rice Seeds

Pharadee Saeung *

Agricultural Program, Science and Technology Faculty, Phranakhon Si Ayutthaya Rajabhat University, Phra Nakhon Si Ayutthaya, Phra Nakhon Si Ayutthaya 13000, Thailand.

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ABSTRACT

Rice seed production in Thailand faces problems related to poor seed quality, resulting in yields not meeting farmers' expectations. This research studies the effects of soaking rice seeds in cucumber and carrot extracts prior to planting on their germination and vigor qualities. The hypothesis for this pre-treatment is that the technique could enhance seeding growth and increase their average yield. The rice seed variety tested was RD49. The experiment consisted of eight treatments: (1) no soaking, (2) soaking in distilled water, (3) soaking in 10% cucumber aqueous extract, (4) soaking in 20% cucumber aqueous extract, (5) soaking in 30% cucumber aqueous extract, (6) soaking in 10% carrot aqueous extract, (7) soaking in 20% carrot aqueous extract, and (8) soaking in 30% carrot aqueous extract. The results showed no statistical differences in terms of germination percentage among eight seed soaking treatments. However, soaking in 20% cucumber aqueous extract (treatment 4) improved seed vigor. The seedling growth rate (8.83 mg/plant) under this treatment was higher than that of treatments (1) and (2), in which the seeds underwent no treatment and were soaked in distilled water. Seedling growth, measured in terms of plant length (7.52 cm) and root length (8.52 cm), was highest in treatment (4) compared with all other treatments (1-3 and 5-8).

1. Introduction

Rice is an important food crop for Thai people. Farmers produce rice for both domestic and international markets. In 2023, the production of main-season and off-season rice reached as high as 33,852 thousand tons (Office of Agricultural Economics, 2024). Currently, rice seed production is insufficient to meet demand, and the use of poor-quality seeds has adverse effects on both yield and grain quality (Khatsakan and Kochsamrong, 2023).

The current situation of rice seed production for distribution to farmers shows that the types of seeds produced often do not match grower demand, resulting in surplus seed stocks that deteriorate in quality (Prasertsak *et al.*, 2010). These seeds exhibit low germination percentages and weak seedling vigor. At present, rice seeds produced by government and private sectors total approximately 265,000 tons per year, accounting for only 26.50% of total seed demand. Thus, Thailand's rice production system still lacks a significant quantity of high-quality rice seeds for cultivation each year (Pecharvut *et al.*, 2022). The estimated annual demand for rice seeds through market circulation is about 600,000 tons (Prasertsak, 2022).

In addition, rice and agricultural production in Thailand heavily rely on the use of chemical inputs. In 2022, the import volume of agricultural hazardous substances exceeded 113,640 tons (Office of Agricultural Regulation, 2023). If farmers apply these chemicals without a proper control, it may lead to chemical residue accumulation in agricultural products and farmland. Therefore, promoting good agricultural practices is one approach to help reduce chemical use in rice production.

One example is the pre-germination treatment of rice seeds to enhance germination ability and seed quality using water or certain chemical solutions (Wetchakama and Khaengkhan, 2018). High-quality seeds directly improve both the yield and quality of rice production. For instance, soaking rice or maize seed and cassava stalks in boron and zinc solutions enhances

* **Corresponding author.**

E-mail address: *parad.nuch@gmail.com*

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their strength and nutrient uptake, especially in sandy soils (Mongon *et al.*, 2017). Similarly, soaking glutinous rice seeds ("Khao Niao Khiew Ngu") in bio-fermented liquid fertilizer increases germination and seedling growth compared to soaking in plain water (Junta *et al*., 2018).

Soaking seeds in water or plant extracts is therefore an interesting method to improve seed quality prior to planting. The germination process begins when seeds absorb moisture, followed by biochemical changes leading to seedling and strong plant development. For example, soaking rice seeds in pig manure extract accelerates germination and promotes rapid shoot and root growth (Aroonrungsikul *et al*., 2014).

In this study, cucumber and carrot were selected as target plants for extract preparation. Cucumber is an easily cultivated vegetable that can be grown all year round. Its major nutritional composition includes 83.19% moisture content, 3.45% protein, 1.05% fat, and 11.45 °Brix sugar content (Minh, 2019). It also contains dietary fiber, vitamins, and natural antioxidants (Insanu *et al*., 2002). Carrot, on the other hand, is rich in beta-carotene, vitamin A, and other nutrients (Chainok, 2011). Extracts from these plants have been reported to enhance plant growth. For example, Abou El-Ghit (2016) tested cucumber and carrot seed extracts at concentrations of 10%, 30%, and 60%, and found that these extracts increased germination and growth in beans, possibly due to the auxin-like effect of the extracts.

Therefore, this research aims to investigate the effects of soaking rice seeds in cucumber and carrot extracts on seed germination and vigor. The findings of this study could serve as a guideline for improving rice seed quality using natural plant-based extracts, reducing production costs, adding value to agricultural products, and promoting higher rice productivity in the future.

2. Materials and Methods

The rice seeds used in this experiment were of the RD49 variety, which were provided by the Phra Nakhon Si Ayutthaya Rice Research Center. The seeds were harvested in May 2022 and stored in a temperature-controlled room at 5°C. The experiment was conducted during May–June 2023 in the laboratory of the Department of Agricultural Science, Faculty of Science and Technology, Phra Nakhon Si Ayutthaya Rajabhat University.

Preparation of cucumber and carrot extracts was modified from the methods of Teixeira *et al*. (2021) and Chatiyanon *et al*. (2014). Fresh cucumber and carrot fruits were peeled and finely chopped into pieces approximately 2 millimeters in size. The chopped materials were soaked in distilled water at a ratio of 5% (w/w) (20 g of cucumber or carrot per 400 mL of distilled water) for 12 hours. The mixtures were then filtered through muslin cloth to obtain the crude aqueous extracts. These extracts were subsequently diluted with distilled water to achieve the desired concentrations according to the experimental treatments, which were as follows:

1) No soaking (control),
2) Soaking in distilled water
3) Soaking in 10% cucumber extract soaking
4) Soaking in 20% cucumber extract
5) Soaking in 30% cucumber extract
6) Soaking in 10% carrot extract
7) Soaking in 20% carrot extract
8) Soaking in 30% carrot extract

For the soaking treatments, rice seeds were soaked in the prepared solutions for 24 hours. After soaking, the seeds were incubated by placing them on moist germination paper and wrapping them for 48 hours before sowing (Tipparak and Aroonrungsikul, 2011).

Statistical analysis was conducted using a Completely Randomized Design (CRD). Mean comparisons were performed using Duncan's New Multiple Range Test (DMRT).

Seed quality testing was performed according to standard procedures for seed quality assessment as follows:

1. Seed Germination Test

Germination was tested using 100 seeds per replicate, with four replications, following the *Top of Paper* method at 25°C under 12 hours of lighting. Normal seedlings those that germinated completely with all essential structures intact were counted. The first count was taken on day 5 after sowing, and the final count on day 14 after sowing. The total number of normal seedlings was recorded and reported as germination percentage, according to the International Seed Testing Association (ISTA, 2011).

2. Seed Vigor

2.1 Germination Index (GI)

The germination index was tested in the same way as the standard germination test. However, for this parameter, the number of normal seedlings was recorded daily throughout the test period (from day 1 to day 14 after sowing), following the method of Duangpatra (1986). The germination index was calculated using the formula:

$$GI = \sum \left\{ \frac{\text{Number of normal seedlings}}{\text{Days after sowing}} \right\}$$

2.2 Seedling Growth Rate (SGR)

After completion of the standard germination test, normal seedlings were collected, and both shoots and roots were separated. These were oven-dried at 80°C for 24 hours. The seedling growth rate was calculated as:

$$SGR = \frac{\text{Dry weight of normal seedlings}}{\text{Number of normal seedlings}}$$

2.3 Seedling Growth Measurement

Seeds were germinated using the *Top of Paper* method in darkness at 25°C for 7 days. After germination, normal seedlings were selected and measured for shoot length, which was reported as average shoot length (ISTA, 1995). Root length was also measured and reported as average root length.

3. Results and Discussion

The results of soaking rice seeds in cucumber and carrot extracts on seed germination (Table 1) showed that soaking seeds in 20% cucumber extract, as well as in 10%, 20%, and 30% carrot extracts, distilled water, and the unsoaked control, produced no statistically significant differences in germination percentage, which ranged from 97% to 100%. In contrast, soaking in 10% and 30% cucumber extracts resulted in slightly lower germination percentages (95%). Overall, the germination percentages among all treatments were relatively similar. This may be because the rice seeds used in the experiment had high initial viability, resulting in limited observable differences in germination response among treatments. This finding is consistent with the study by Naenfan and Pagamas (2020), who examined the seed priming of *Tagetes patula* (French marigold) and found that freshly produced, high-vigor seeds exhibited high germination regardless of the priming treatments applied.

3.1 Seed Vigor

The effects of soaking rice seeds in cucumber and carrot extracts on seed vigor included the germination index, seedling growth rate (Table 2), shoot length, and root length (Figure 1).

For the germination index, soaking seeds in 20% carrot extract resulted in the highest germination index (44.67). All soaking treatments, whether using distilled water or various extract concentrations, showed higher germination index values than the unsoaked control.

Regarding the seedling growth rate, soaking rice seeds in different concentrations of the extracts produced growth rates ranging from 8.20 to 9.23 mg per seedling, which were higher than those of seeds soaked in distilled water and those without soaking.

For shoot length, soaking seeds in cucumber extract at concentrations of 10%, 20%, and 30% resulted in the highest average shoot lengths (6.89–7.60 cm), which were greater than those obtained from soaking in carrot extract, distilled water, or without soaking.

As for root length, soaking in 20% cucumber extract yielded the greatest average root length (8.52 cm), exceeding that of the 10% and 30% cucumber extract treatments, as well as those using carrot extract, distilled water, and the untreated control.

The results of this study revealed that soaking rice seeds in cucumber and carrot extracts did not significantly affect seed germination percentage. However, it enhanced seed vigor, as indicated by higher germination index, seedling growth rate, and seedling development compared with the unsoaked control. Among the treatments, soaking seeds in 20% cucumber extract produced the highest germination percentage and seed vigor, surpassing those soaked in distilled water or other extract concentrations.

Table 1 Effects of cucumber aqueous extracts and carrot aqueous extracts on germination of rice seed RD49 variety

Soaking Treatments	Germination (%)
no soaking	97 ab
soaking in distilled water	98 ab
10% cucumber aqueous extract	95 b
20% cucumber aqueous extract	98 ab
30% cucumber aqueous extract	95 b
10% carrot aqueous extract	99 a
20% carrot aqueous extract	99 a
30% carrot aqueous extract	100 a
F-test	*
C.V.(%)	2.1

Means within the same column followed by the same letters indicate no significant differences among treatment using by DMRT, * Significant different at 0.05 (P=0.019)

Table 2 Effects of cucumber aqueous extracts and carrot aqueous extracts on germination index and seedling growth rate of rice seed RD49 variety

Soaking Treatment	Germination Index	Seedling Growth Rate (SGR) (mg per plant)
no soaking	25.95 e	7.25 c
soaking in distilled water	38.00 bc	7.35 c
10% cucumber aqueous extract	39.08 ab	9.23 a
20% cucumber aqueous extract	37.67 bc	8.83 ab
30% cucumber aqueous extract	30.42 de	8.75 ab
10% carrot aqueous extract	32.00 cd	8.40 ab
20% carrot aqueous extract	44.67 a	8.20 b
30% carrot aqueous extract	33.82 bcd	8.78 ab
F-test	**	**
C.V.(%)	11.1	6.9

Means within the same column followed by the same letters indicate no significant differences among treatment using by DMRT, ** Significant different at 0.01 (P=<0.001)

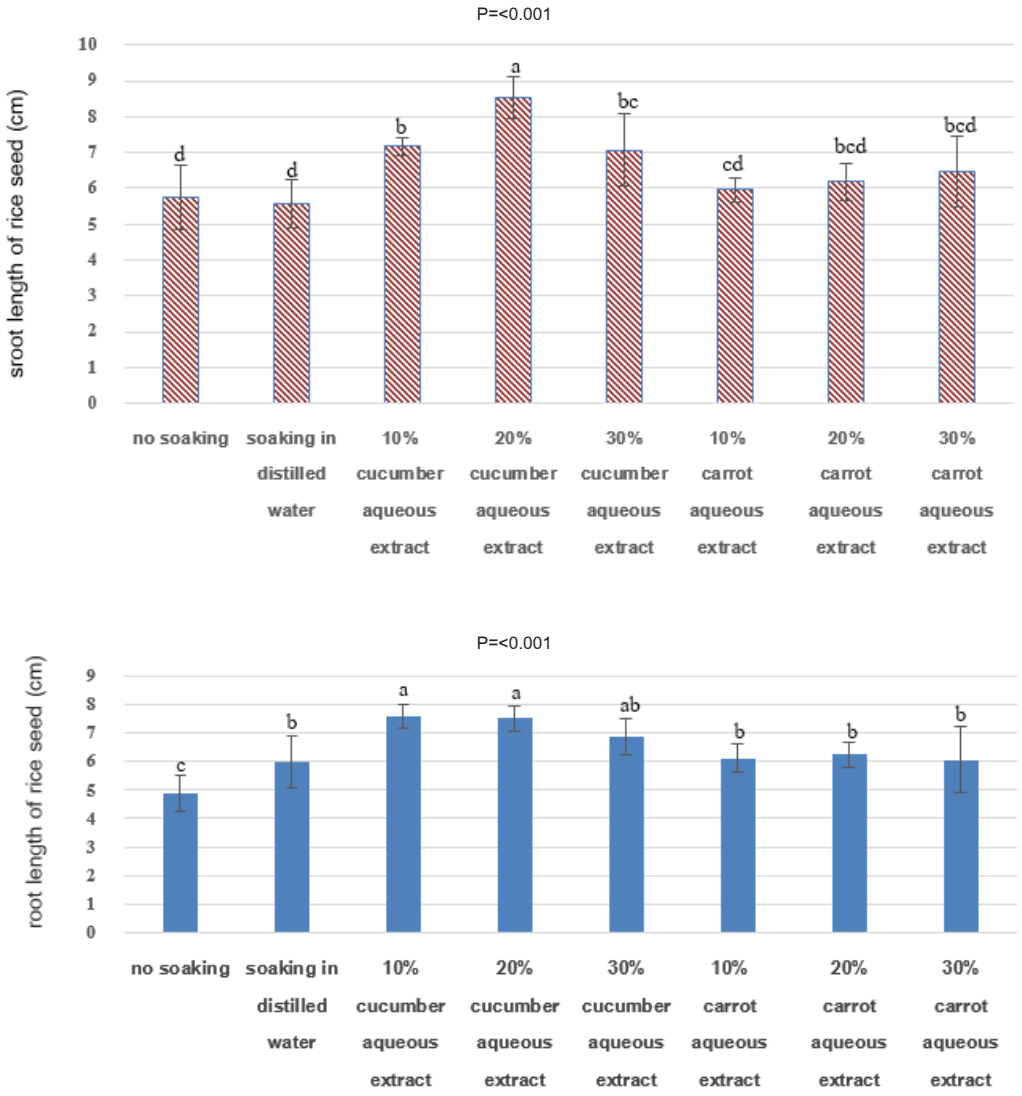

Figure 1 Effects of cucumber aqueous extracts and carrot aqueous extracts on shoot length and root length of rice seed RD49variety (Means within the same label bar followed by the same letters indicate no significant differences among treatment using by DMRT, ** Significant different at 0.01

This finding is consistent with U-sungnoen *et al*. (2012), who reported that soaking rice seeds in diluted pig manure extract (1:20 ratio) did not affect seed germination percentage but improved seed vigor and seedling quality. However, higher extract concentrations reduced rice seedling growth.

Furthermore, Yunusa *et al*. (2018) found that aqueous cucumber extracts contained total phenolic compounds (TPC) of 10.02 mg GAE/g. Phenolic compounds play an important role in regulating metabolic processes related to protein synthesis and the production of antioxidant-related enzymes. These antioxidants scavenge free radicals generated within cells during seed germination (Hayat *et al*., 2010). The presence of antioxidant compounds helps maintain the integrity of cellular membranes, thereby enhancing photosynthesis and metabolic efficiency in rice seedlings. In addition, cucumbers contain approximately 20 mg of vitamin C per 100 g of edible portion, while carrots contain about 3 mg per 100 g (Department of Health, 2018). Vitamin C is a small-molecule antioxidant derived from dietary sources (Sawadsitung, 2025). It acts as a free radical scavenger, preventing oxidative damage to cellular components within the seed, thereby reducing seed deterioration (Siri, 2015). When seed deterioration occurs, structural, physiological, and biochemical changes take place within the seeds, including damage to cell membranes, reduction of enzymatic activity, decrease respiration rate, increase free fatty acid content. The afore-mentioned effects, in turn, course the reduction of germination rate, storability, and seedling vigor (Duangpatra, 1986) and, therefore, minimizing seed deterioration helps preserve seed quality, maintaining high germination and vigor.

4. Conclusion

The results of this study indicate that soaking rice seeds in cucumber and carrot extracts influenced seed vigor. Soaking seeds in 20% cucumber extract produced the highest seed vigor, particularly in terms of seedling growth, compared with the unsoaked control, soaking in distilled water, soaking in carrot extract, and other concentrations of cucumber extract. In addition, the seedling growth rate of seeds soaked in 20% cucumber extract was higher than that of seeds soaked in distilled water or those that were not soaked.

5. Recommendations

Further studies should include additional concentrations of the extracts, such as 5%, 15%, and 25%, to determine the optimal level for promoting seed vigor and seedling growth. Moreover, it is recommended to extend the experiment to other rice varieties or different plant species to evaluate whether soaking seeds in these extracts produces similar improvements in seed quality and vigor. In addition, field experiments should be conducted to investigate the effects of seed soaking with the extracts on plant growth, yield quantity, and crop quality before applying this novel practice.

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