



An Evaluation of Recycled Papers as Storage and Germination Medium of Vegetable Seeds

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An innovative approach to storing and germinating seeds can be achieved by embedding seeds in recycled papers. This quantitative study was conducted to evaluate the viability and germination of vegetable seeds in recycled paper compared to soil. Pechay (*Brassica rapa*), mustard (*Brassica juncea*), spinach (*Spinacia oleracea*), and saluyot (*Corchorus olitorius*) were seed samples

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examined in both media. Daily monitoring of seedlings' height and germination count was conducted using a counting method and rulers, as well as water sprays. As a result, viability varied among seeds, with pechay (100%) and mustard (96.30%) showing higher rates in recycled paper than spinach (25.93%) and saluyot (44.44%). The viability of pechay (96.30%), mustard (96.30%), spinach (96.30%), and saluyot (70.37%) was generally higher in soil. Germination rates differed across seed types and media. Pechay and mustard grew consistently in both media, while spinach and saluyot had different growth patterns and showed slower growth. Statistical analysis using the Fisher Exact Test and T-test showed no significant difference in viability between recycled paper and soil ($P = 0.214$). Soil remains preferred, but recycled paper can serve as an alternative starting medium. Long-term growth assessment and matching media to more plant species are recommended to enhance germination practices and sustainable agriculture.

Keywords: Germination rate; recycled paper; soil; vegetable seeds; viability.

1. INTRODUCTION

Significant quantities of paper waste have been accumulated in recent years due to environmental concerns, highlighting the need for reuse and recycling, much like the varying lifespans of seeds, which depend greatly on species despite identical treatment and storage conditions [1,2]. Meanwhile, with wasted paper and paper products constituting for over a third of landfill waste, the paper industry generates significant quantities of waste, contributing to landfill overflow [3,4]. However, recycled paper fibers offer a sustainable solution by binding the soil particles together, preventing them from being washed away by water or blown away by wind [5,6,7,8].

Seed germination and storage methods are crucial for optimal plant growth and sustainable agriculture [9]. While soil and peat have traditionally been used, there is a growing need for ecological alternatives. Recycling paper offers sustainability benefits, including saving trees and water while reducing manufacturing costs. It is biodegradable and environmentally friendly [10,11]. Including various vegetable seeds like pechay, saluyot, spinach, and mustard greens expands the study's scope.

In the agricultural landscape, leafy greens like pechay in the Philippines provide a valuable source of income for farmers, with their rapid 30-45 day harvesting cycle [12]. There are studies that examine methods like organic foliar fertilization to optimize pechay yield. Additionally [13], crops like spinach are gaining global popularity due to their nutritional benefits, despite potential health concerns like nitrate-induced methemoglobinemia [14,15]. Meanwhile, mustard, rich in phytochemicals and nutrients, contributes to the diverse array of crops cultivated worldwide [16]. Jute cultivation showcases versatility, thriving in various

intermediate soils, except for extreme sand or clay compositions. [17,18]

The study investigated the viability and germination rates of four vegetable seeds in recycled paper versus soil, aiming to highlight differences in germination mediums. This study could empower urban dwellers to engage in sustainable living, bridging everyday actions with environmental responsibility. Additionally, it contributes to resource efficiency discussions, advocating for creative material reuse.

2. METHODOLOGY

This study employed an experimental research design that aimed to investigate the viability and germination rate of recycled papers derived from seed calendars as opposed to soil. The testing and comparison of the germination rates and viability of vegetable seeds (pechay, mustard, saluyot, and spinach) in each medium took a total of 10 days. This study's parameters included seeds' height, sprouting days, and germination count. These were monitored by counting and measuring by using calibrated rulers every afternoon for 10 days. Each medium received 30 water sprays, which were evenly distributed. Additionally, a T-test for two independent means and a Fisher's exact test were applied to assess whether there is a significant difference between the viability and germination rates of vegetable seeds in recycled papers and soil.

3. RESULTS AND DISCUSSION

3.1 The Viability of Four (4) Vegetable Seeds Using Recycled Paper and Soil as Germination Medium

The analysis revealed that recycled paper had greater viability for both pechay and mustard

seeds than soil. Contrary to spinach and saluyot, which both show a preference for soil. This highlights the significant influence of the germination medium on seed viability, suggesting different preferences among the seeds.

3.2 The Germination Rate of Four (4) Vegetable Seeds Using Recycled Paper and Soil as Germination Medium

According to the analysis, mustard seeds were found to have the highest germination rates in both recycled paper and soil, followed by pechay, spinach, and saluyot. However, since this study solely focused on vegetable seeds, further exploration with diverse seed varieties is warranted, indicating that mustard seeds' have superior adaptability for germination in various mediums. Overall, plants in soil consistently exhibit taller heights, indicating healthier growth compared to those in

recycled [19]. The adoption of sustainable practices is likely to help achieve more resilient and productive food systems and enable sustainable production, which would serve to reduce poverty and advance food security [20].

3.3 The Difference in Viability and Germination Rate of Four (4) Kinds of Vegetable Seeds Using Recycled Paper and soil as germination medium

The analysis revealed using Fisher's exact test that there was no significant difference in viability between the two media, with ($P = 0.21$), which is above the level of significance 0.05. Both recycled paper and soil are equally effective in supporting the germination and growth of the seeds tested. The different types of seeds showed similar viability rates across both media.

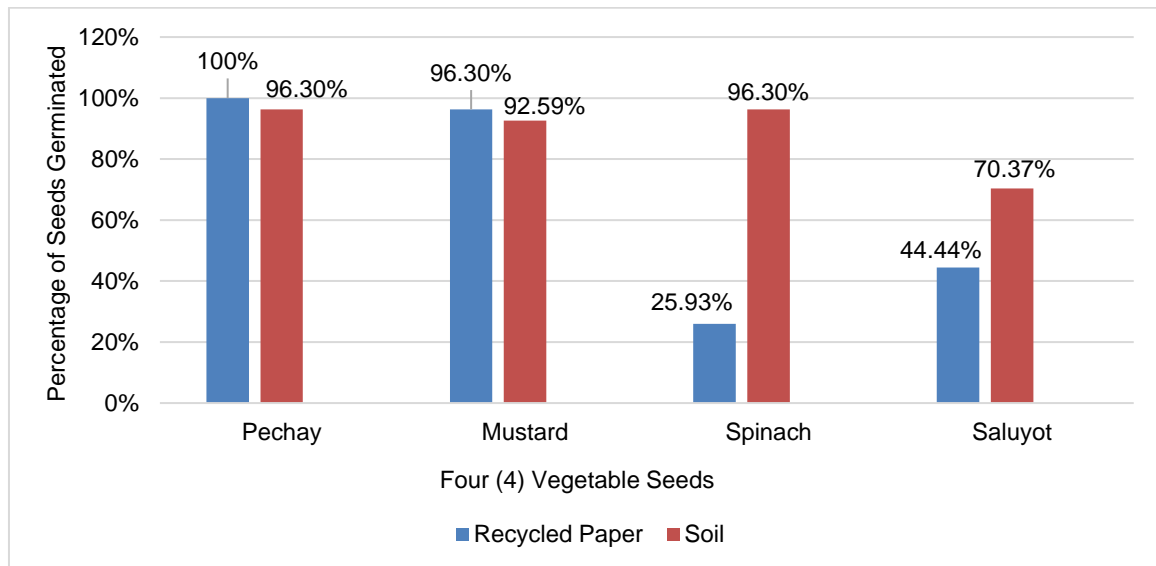


Fig. 1. The percentage distribution of the viability of four (4) vegetable seeds

Table 1. Difference in growth between recycled paper and soil as germination medium

Difference	Medium	Mean (cm)	SD	Mean Difference	t-value	p-value	Remarks
Pechay	Soil	2.83	1.37	1.07	3.73	0.001	Significant
	Paper	1.76	0.91				
Mustard	Soil	3.27	1.61	0.76	1.953	0.057	Not Significant
	Paper	2.51	1.13				
Spinach	Soil	2.28	0.83	0.46	1.304	0.202	Not Significant
	Paper	1.83	0.77				
Saluyot	Soil	1.67	0.50	1.18	7.573	0.0001	Significant
	Paper	0.49	0.23				

With 0.05 level of significance

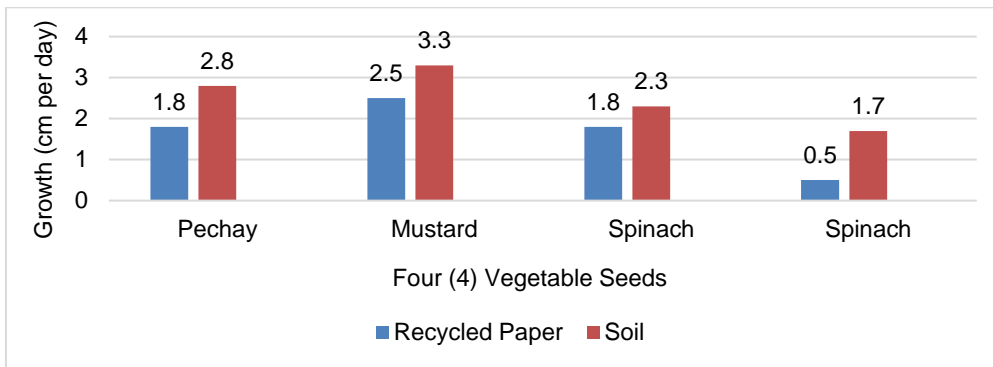


Fig. 2. The germination rate of four (4) vegetable seeds using recycled paper and soil as germination medium

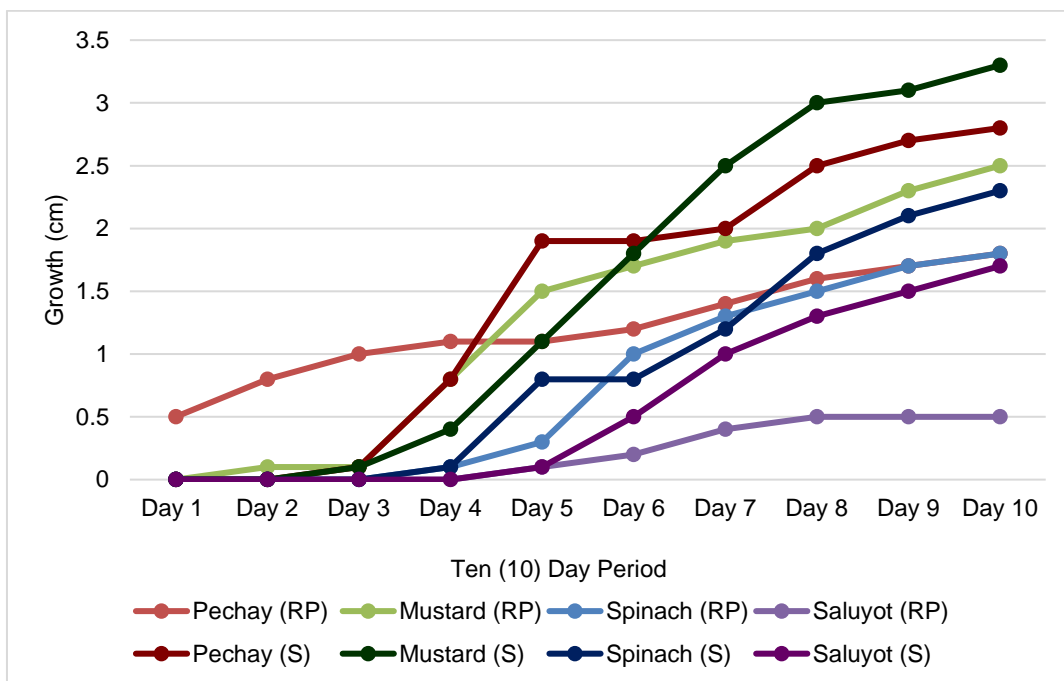


Fig. 3. The growth of plants from day 1-10 using recycled paper and soil

The germination rates varied depending on the medium. For pechay and saluyot, growth differences were statistically significant ($P = 0.001$) and ($P = 0.0001$). Pechay thrived better in soil, while saluyot showed superior growth in recycled paper. Conversely, for mustard and spinach, the differences were not statistically significant ($P = 0.057$) and ($P = 0.202$), suggesting that the choice of medium does not notably affect their growth.

4. CONCLUSION

The four plant types showed distinct preferences between soil and recycled paper for germination. Pechay and mustard seeds thrived on recycled paper with germination rates of 100.00% and

96.30% respectively, surpassing those on soil. In contrast, spinach and saluyot seeds preferred soil, exhibiting higher viability rates of 96.30% and 70.37% respectively. Despite recycled paper's limitations, it emerges as a promising alternative for seed germination, suggesting its potential for waste reduction and environmental conservation. While germination rates vary, the growth outcomes indicate the comparable viability of recycled paper as a sustainable planting medium.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image

generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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