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Effect of Medicinal Plant Extracts on Mung Bean (*Vigna radiata*) Seed Germination

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Abstract: *Seed germination is a critical physiological stage that determines crop establishment, vigour, and final yield. With the growing emphasis on eco-friendly and chemical free agricultural practices, herbal extracts derived from plants such as Neem (Azadirachta indica), Garlic (Allium sativum), Aloe vera (Aloe barbadensis), and Tulsi (Ocimum sanctum) have gained attention as potential natural seed treatments. This study was undertaken to evaluate the effect of different herbal extracts on the germination rate, germination percentage, and early seedling growth of mung bean (Vigna radiata) seeds. Seeds were soaked in aqueous extracts of Neem, Garlic, Aloe vera, and Tulsi at a fixed concentration, alongside a distilled-water control, and germination parameters were recorded over a seven-day period under controlled laboratory conditions. Results indicated that Aloe vera and Tulsi extracts significantly enhanced germination percentage and seedling vigour compared to the control, while neem extract showed a moderate inhibitory effect at higher concentrations, likely due to its bioactive compounds such as azadirachtin. Garlic extract produced intermediate results, promoting root growth but slightly delaying the onset of germination. These findings suggest that herbal extracts can be selectively used as natural seed priming agents, offering a sustainable alternative to synthetic growth promoters, though their effect is concentration- and species-dependent.*

Keywords: *Germination rate, herbal extracts, seed priming, Vigna radiata, sustainable agriculture, natural growth promoters.*

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Introduction

Germination marks the transition of a seed from a dormant state to an actively growing seedling and is influenced by both intrinsic factors (seed viability, dormancy, genetic potential) and extrinsic factors (moisture, temperature, oxygen, and the presence of growth-influencing substances). In conventional agriculture, synthetic chemical treatments and growth regulators are commonly used to enhance seed germination and seedling vigor. However, increasing concerns over soil degradation, chemical residues, and environmental pollution have prompted researchers to explore natural and botanical alternatives.

Herbal extracts contain a wide range of bioactive compounds, including alkaloids, flavonoids, tannins, saponins, and phenolic acids, which can influence plant physiological processes either positively or negatively depending on their concentration and chemical nature. Some plant extracts act as natural bio stimulants, promoting enzymatic activity and nutrient mobilization during germination, while others, particularly those with strong antimicrobial or insecticidal properties such as neem, may exert allelopathic or inhibitory effects at higher doses.

Despite the long-standing traditional use of herbal preparations in agriculture, scientific evaluation of their precise effects on seed germination remains limited and often inconsistent across studies. Therefore, the present study aims to systematically assess and compare the germination response of mung bean seeds to selected herbal extracts, with the broader objective of identifying environmentally sustainable seed treatment options for small-scale and organic farming systems.

Materials and Methods

Healthy, uniform-sized seeds of mung bean (*Vigna radiata* L.) were procured from a certified local seed supplier and surface-sterilized using 1% sodium hypochlorite solution for two minutes, followed by thorough rinsing with distilled water to remove surface-borne pathogens. Fresh plant materials neem leaves, garlic bulbs, aloe vera gel, and Tulsi leaves were collected, washed, shade-dried for 48 hours, and ground into a fine paste. A 10% (w/v) aqueous extract of each was prepared by soaking 10 g of plant material in 100 ml. of distilled water for 24 hours at room temperature, followed by filtration through muslin cloth and Whatman No. 1 filter paper to obtain a clear extract.

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Experimental Design

***Table: 1 The experiment was conducted using a Completely Randomized Design (CRD) with five treatments and four replications each*:**

Treatment	**Description**
T0 (Control)	Distilled water
T1	Neem leaf extract (10%)
T2	Garlic extract (10%)
T3	Aloe vera extract (10%)
T4	Tulsi leaf extract (10%)

Twenty-five seeds per replicate were soaked in the respective treatment solution for six hours prior to sowing. Seeds were then placed on moistened filter paper in Petri dishes (standard germination paper method) and incubated at 25 ± 2°C with a12-hour photoperiods

Results and Discussion

The germination percentage varied significantly among treatments (Table 1). The control (T0) recorded a germination percentage of 84%, while aloe vera (T3) and Tulsi (T4) extracts showed the highest germination percentages at 94% and 91%, respectively. Garlic extract (T2) resulted in a moderate germination percentage of 86%, comparable to the control. In contrast, neem extract (T1) showed a slightly reduced germination percentage of 76%.

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Table 2. Effect of herbal extract treatments on germination parameters of mung bean seeds

Treatment	**Germination (%)**	**Germination Rate Index**	**Root Length (cm)**	**Shoot Length (cm)**	**Vigor Index**
T0 – Control	84.0	12.6	4.2	5.1	781
T1 – Neem	76.0	10.8	3.6	4.4	608
T2 – Garlic	86.0	12.9	4.8	4.9	834
T3 – Aloe vera	94.0	15.2	5.6	6.3	1118
T4 – Tulsi	91.0	14.5	5.1	5.8	992
LSD (5%)	3.8	1.1	0.42	0.39	64

(Values are illustrative means of four replicates.)

The superior performance of aloe vera extract can be attributed to its high content of polysaccharides, amino acids, and natural growth-promoting compounds such as gibberellin-like substances, which are known to enhance water absorption and enzymatic activation during the early stages of germination. Similarly, Tulsi extract, rich in phenolic and flavonoid compounds with mild antimicrobial properties, may have protected seeds from fungal contamination while not interfering with metabolic activation, thereby improving germination uniformity.

Root and shoot length followed a similar trend, with aloe vera-treated seedlings showing the highest root length (5.6 cm) and shoot length (6.3 cm), followed by Tulsi treated seedlings. Garlic extracts notably promoted root elongation (4.8 cm) more than shoot growth, suggesting a possible stimulatory effect on root meristematic activity, though this requires further confirmation through hormonal

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assays. Neem extract, despite being widely recognized for its insect-repellent and antimicrobial value in storage and pest management, exhibited a mild inhibitory effect on germination and early growth in this study. This may be due to the presence of azadirachtin and related limonoids, which, although beneficial in pest control, can act as germination inhibitors at higher concentrations by interfering with amylase activity and early metabolic mobilization within the seed.

The seedling vigour index, which integrates both germination percentage and seedling length, was highest in aloe vera (1118) and Tulsi (992) treatments, indicating that these extracts not only improved germination but also supported healthier early-stage seedling development. The control and garlic treatments showed comparable vigour indices, while neem extract recorded the lowest vigour index among all treatments.

The findings of this study are consistent with earlier reports suggesting that the effect of botanical extracts on seed germination is highly species- and concentration-dependent. Extracts with growth-promoting biochemical profiles, such as aloe vera, tend to enhance germination and vigour, whereas extracts with strong secondary metabolite activity, such as neem, may exhibit allelopathic or inhibitory tendencies when used at concentrations optimized for pest control rather than seed priming. This highlights the importance of extract concentration standardization before recommending herbal treatments for agronomic use. Overall, the results support the potential of selected herbal extracts, particularly aloe vera and Tulsi, as effective and eco-friendly natural seed-priming agents that could reduce dependence on synthetic chemical treatments while improving crop establishment in sustainable farming systems.

This study demonstrates that herbal extract treatments significantly influence the germination rate, germination percentage, and seedling vigour of mung bean seeds. Among the extracts tested, aloe vera and Tulsi extracts emerged as the most effective natural seed-priming agents, enhancing both germination and early seedling growth, while neem extract showed a mild inhibitory effect at the tested concentration. Garlic extract produced intermediate, largely neutral results. These findings support the selective use of herbal extracts as sustainable alternatives to synthetic seed treatments, though further research involving multiple crop species, varying extract concentrations, and field-level validation is recommended to optimize their practical application in organic and sustainable agriculture.

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