Influence Of Moisture Content, Storage Condition And Seed Dimension On Seed Germination Of *Solanum Nigrum* Linn .

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Abstract
Medicinal plants cure many common diseases and are considered essential home treatments in various regions. *Solanum nigrum, known* for its medicinal properties, necessitates the development of effective seed germination methods to ensure consistent and improved yields. The objective of this study was to evaluate the effects of moisture content, storage conditions, and seed dimensions on the germination of *Solanum nigrum* over 4, 8, 12, 18, and 24 months. The seed germination percentage of *Solanum nigrum* Linn. gradually declined as storage time increased from 4 to 24 months. At 10°C storage, 45% of seeds germinated after 4 months, dropping to 22.2% beyond that period. At 40 (±2) °C, the germination rate was 8.9%. Notably, at 10°C, seed germination decreased from 45% to 27.2% over 24 months. Moisture content was maintained for up to 18 months using three storage methods: polythene bags, gunny bags, and cloth bags. Polythene bags preserved maximum moisture for up to 24 months, followed by gunny and cloth bags. A positive correlation was observed between seed weight and germination percentage. This study proposes a seed germination method to produce numerous *Solanum nigrum* plants quickly, aiding in the conservation and utilization of this medicinally valuable species.
Keywords: *Solanum nigrum* Linn . , moisture content, storage condition, seed dimension, seed germination.

1. Introduction

Plants have indeed been fundamental to human survival and development throughout history. Their importance is well-documented in numerous scholarly works. The pivotal role of medicinal plants in traditional healthcare systems and their continued relevance in modern therapeutics (Balemie and Kelbessa, 2006). The bioactive compounds present in medicinal plants and their potential pharmacological applications (Farnsworth, 2001). Medicinal plants play a crucial role in therapeutics, with knowledge about them being passed down through generations. With the rising costs of allopathic medicines, there is an increasing interest in cultivating medicinal plants, which are known for their minimal or no side effects and economic benefits. These plants are a valuable source of compounds used in medicine and are effective in treating various common ailments. The cultivation of medicinal plants is both safe and economically attractive, offering a rich reservoir of medicinal ingredients.

Image 1: Plant of *Solanum nigrum*

Image 2 : Plant of *Solanum nigrum*

Solanum nigrum (Solanaceae family) , also known as black nightshade, is of great medicinal value and has been widely used in traditional medicine worldwide. Its therapeutic versatility is well-documented across various cultures. Its traditional applications are for treating ulcers, wounds, skin diseases, inflammation, and liver disorders

(Gajalakshmi et al.,2016). Additionally, the pharmacological potential of *Solanum nigrum* in addressing respiratory issues, fever, and pain. The plant is renowned for its significant anti-inflammatory, antioxidant, and hepatoprotective properties, which contribute to its broad recognition in traditional medicine systems (Patel et al.,2012; Padalia et al., 2016).The entire *S. nigrum* plant is effective in dispersing blood stasis, reducing swelling, clearing heat, and detoxifying. It has been widely used for thousands of years to treat canker sores, skin eczema, urinary tract infections, bacterial dysentery, prostate issues, and chronic bronchitis (Gao et al., 2021).

The earliest known record describing the medicinal use of *S. nigrum* was found in *Yao Xing Lun*

Tang Dynasty) (Editorial Committee of State Administration of Traditional Chinese Medicine, 1999) . Additionally, in contemporary clinical practice, *S. nigrum* is often used in combination with other medications to treat various cancers, including lung, cervical, breast, esophageal, stomach, liver, and bladder cancers. In other Asian countries such as Japan and India, it is also noted for its use in tumor treatment. The ripe berries of *S. nigrum,* which are sweet and salty, were reportedly used as a famine food in China during the 15th century. In India, the leaves and berries of this plant are commonly eaten as food or vegetables after being cooked (Wang, 2007; Zhao, 2010; Wang et al., 2017).

The sustainable cultivation and preservation of *Solanum nigrum* seeds are imperative to ensure a consistent supply of this valuable medicinal plant. This necessity underscores the significance of maintaining high-quality seeds characterized by optimal viability, vigor, and purity. Achieving uniform seeds is pivotal for enhancing field performance, often necessitating sorting procedures based on seed size utilizing specialized equipment like a seed grader. However, the challenge lies in preserving seed quality over time, as it tends to deteriorate with prolonged storage. This study, inspired by the work of researchers such as Khan et al. (2015) and Singh et al. (2019), delves into the intricate interplay of environmental factors impacting the longevity of *Solanum nigrum* seeds. Key variables under investigation include relative humidity, temperature fluctuations, and initial moisture content. Through a comprehensive understanding of these factors, the research aims to devise effective strategies for optimizing and sustaining seed germination rates during prolonged storage durations. Such insights are crucial for supporting the continued cultivation and utilization of *Solanum nigrum* for its medicinal attributes.

2. Materials and Methods

2.1 Seed Collection and Storage

The seeds of *Solanum nigrum* were collected from Damoh district, m.p India. To minimize the risk of fungal growth, the seeds were surface sterilized by soaking them in warm water at 50°C for 20 minutes. After sterilization, the seeds were placed in cold distilled water to chill them. The seeds were then spread on germination paper and dried overnight at 20°C. For storage, the seeds were kept in sealed polythene bags at various temperatures: 10 (±1)°C, 15 (±1)°C, 28 (±1)°C, 40 (±1) °C, with 90 (±1) % relative humidity at room temperature. Special care was taken to maintain the seed quality during storage, considering factors such as initial seed moisture content, packing method, airtight container usage, and storage conditions with low temperature and humidity (Jain et al., 2021; Jain et al., 2022; Jain et al., 2023).

2.2 Seed Size and Weight

To ensure precise measurements, the weight of *Solanum nigrum* seeds was recorded with an accuracy of 0.01 mg using a screw gauge. For germination, seeds were placed in a seed germinator with two moistened, sterilized filter papers at 30 (±2)°C. The seeds were organized by size and weight, with 24 seeds per type placed in petri dishes. Germination was monitored daily, and newly germinated seeds were recorded. Germination was defined as the emergence of the radicle.

2.3 Moisture

The moisture content of the seeds was measured in triplicate using three independently collected samples, each consisting of 10 grams of seeds. The seeds were placed in paper bags and baked for 24 hours at 95°C. After baking, they were cooled in a desiccator and reweighed. Moisture content was calculated and expressed using the following formula:

Moisture Content (%) = (Fresh Weight- Oven dry weight)/Fresh weight × 100

This procedure was applied to seeds ranging in age from newly sown to 24 months old to measure their moisture content over time.

3. Results and Discussion

It is widely acknowledged that numerous factors influence the germination of seeds and the establishment of seedlings. This study endeavors to explore key discoveries related to seed germination in valuable plant species, examining the impact of various factors such as seed collection methods, seed size, storage conditions, imbibition, seed viability, and environmental factors(Jain et al ., 2020).

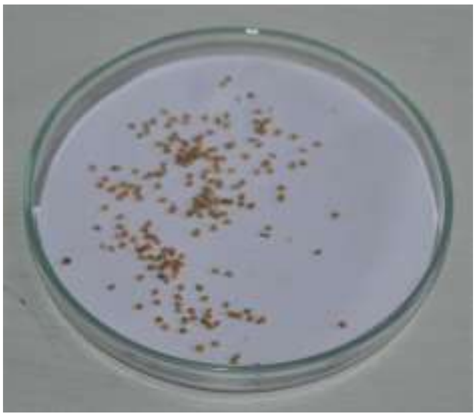


Image 3: Seeds of *Solanum nigrum* Image 4: Germinated Seeds of *Solanum nigrum*

Table 1 Effect of different storage conditions and periods on seed germination of *Solanum nigrum*.

Storage conditions	**Storage period in months**											
	Fresh seed		**4**		**8**		**12**		**18**		**24**	
	A	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**
Room temp.	59	55	52.00	50.20	51.00	44.00	45.30	40.40	32.20	28.00	30.20	27.50
10 (+ 1)°c	-	-	26.30	22.00	21.00	18.10	16.20	14.30	12.00	17.20	08.00	5.22
15 (+ 1)°c	-	-	40.00	25.50	20.30	17.30	30.00	28.20	24.50	23.10	20.20	19.30
28 (+ 1)°c	-	-	54.20	52.20	49.30	45.30	42.2	40.1	35.1	30.1	20.2	18.10
							0	0	0	0	0	
40 (+ 1)°c	-	-	12.30	8.50	6.20	4.00	3.00	1.00	-	-	-	-
90(+ 1) % Relative humidity	-	-	15.20	13.10	12.10	11.70	7.60	5.70	-	-	-	-
Partial vacuum	-	-	50.90	48.20	45.10	42.30	28.20	22.30	20.70	33.20	20.10	22.50

A. Represent germination percent, B represents plant percent

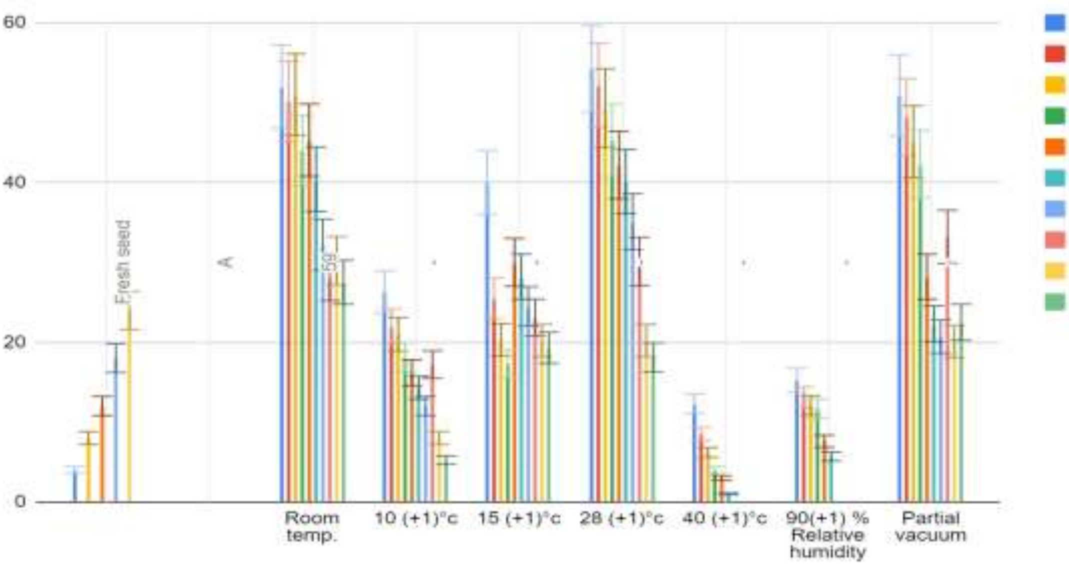

Fig. 1. Effect of different storage conditions and periods on seed germination of *Solanum nigrum*.

In *S. nigrum* (Table 1.1 and Figure 1.1) reduction in germination percent at room temperature with storage was decreased from 59% in fresh seed to 30.20% after 24 month period of storage, germination decline was comparatively less at lower and higher temperatures (10± 1) ℃ and (40± 1) ℃ . At (10± 1) ℃ Seed germination was 26.30% at (40± 1) ℃ seed germination was 12.30%. However, the germination percent of seeds stored at (10± 1) ℃ decreased up to 8 months of storage, and after that gradual decrease up to 24 months was observed in storage temperatures at (10± 1) ℃ , (15± 1) ℃ , (28± 1) ℃ and (40± 1) ℃ shows a decrease in germination percent up to 24 months. When the seeds were stored at (90 ± 1) % relative humidity at a constant temperature of 30 ℃ the seed lost its viability quickly.

Better results have been observed under partial vacuum conditions, with a 50.90% germination rate. This improvement is attributed to a reduction in the rate of aerobic respiration, which decreases the oxygen levels surrounding the seeds. According to Thompson et al., (1977) , even a temperature fluctuation of 1℃ can promote germination in some species.

Germination rates of *Solanum nigrum* increased at room temperature. At lower temperatures, the decline in germination was comparatively less with prolonged storage, similar to *Solanum nigrum* . However, at higher temperatures, the loss in germination was more significant.

The study on *Solanum nigrum* seed germination provides valuable insights into the effects of storage duration and temperature on seed viability. The findings, presented in Table 1.1 and Figure 1.1, demonstrate a clear decline in germination percentage over a 24-month storage period at room temperature, dropping significantly from 59 % in fresh seeds to 30.20 % after two years. This indicates that prolonged storage under ambient conditions adversely affects seed viability.

Interestingly, the decline in germination was less pronounced at both lower and higher temperatures. At 10℃, the germination rate was recorded at 26.30%, while at 40℃, it was 12.30%. This suggests that extreme temperatures, whether lower or higher, may slow down the deterioration processes compared to room temperature storage.

A closer look at the seeds stored at 10℃ reveals an initial decrease in germination rate up to 8 months, followed by a more gradual decline up to 24 months. This trend might indicate an initial adaptation phase where the seeds experience a reduction in metabolic activity, which then stabilizes over time. Similarly, storage at other temperatures (15℃, 28℃, and 40℃) showed a continuous decline in germination rates over the 24-month period, emphasizing that temperature plays a crucial role in maintaining seed viability over extended storage periods.

Moreover, when seeds were stored at a relative humidity of 90% and a constant temperature of 30℃, the viability was lost rapidly. High humidity likely exacerbates seed degradation through increased fungal growth and higher rates of biochemical reactions that lead to seed aging and loss of germination capacity.

In contrast, seeds stored under partial vacuum conditions exhibited better germination rates, with a notable 50.90 % germination. This improvement can be attributed to the reduction in aerobic respiration due to lower oxygen levels, which slows down metabolic processes that contribute to seed deterioration. This aligns with Thompson et al., (1977), who noted that even small temperature fluctuations could promote germination in some species, suggesting that controlled environmental conditions significantly affect seed longevity.

Table 2 Effect of seed dimension and weight on germination percent of fresh *Solanum nigrum*

Seed Weight (mg)	G%	Diameter (mm)	G%
0-5	80	0-1	75
5-10	85	1-1.2	78
10-15	90	1.2-1.4	80
15-20	92	1.4-1.6	82
20-25	93	1.6-1.8	85
25-30	94	1.8-2	87

G%=Germination Percent

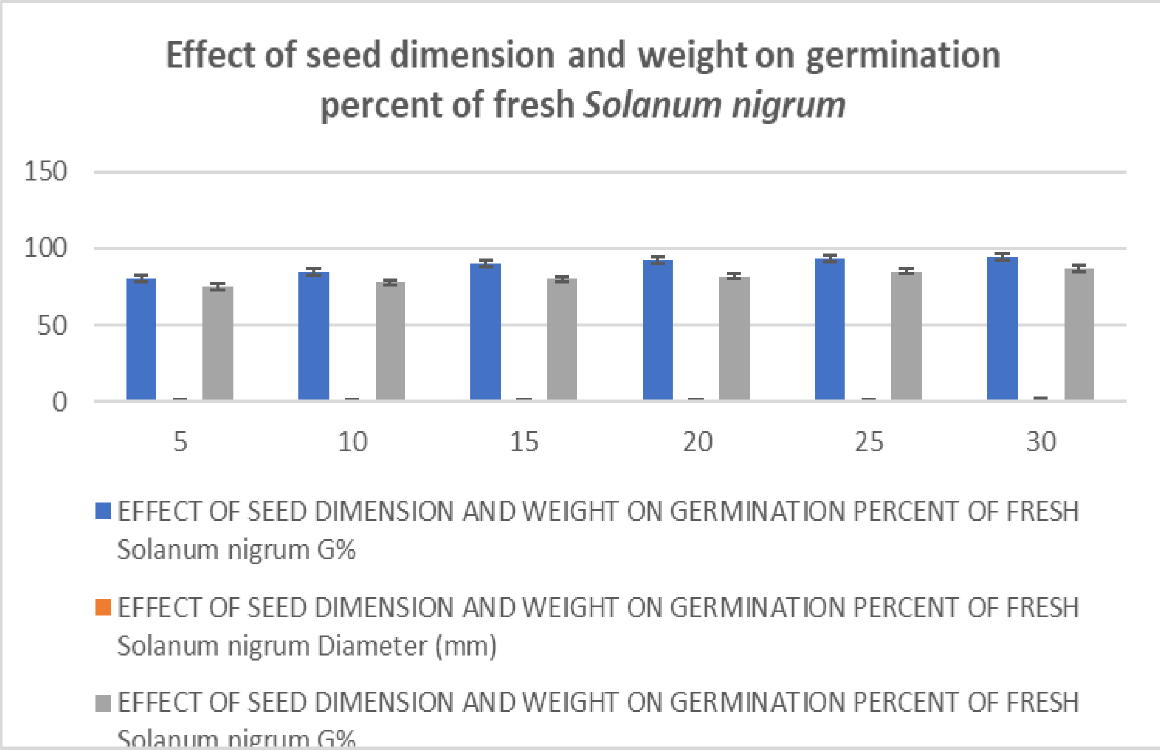

Fig. 1 Effect of seed dimension and weight on germination percent of fresh *Solanum nigrum*

The data presented in Table 2 highlights a clear correlation between seed dimensions and weight with percentage germination. There is a notable positive relationship observed: heavier or healthier seeds tend to exhibit higher percentages of germination. This trend extends to seed width as well, with narrower and wrinkled seeds demonstrating lower germination percentages.
Jain et al., 2020 also found *Andrographis paniculata* (burm.f.) needs.

3.3 Conclusion

The study on the germination behavior of *Solanum nigrum* seeds under various storage conditions reveals crucial insights for their preservation and utilization. Over a 24-month storage period, germination percentages were significantly influenced by temperature and humidity. Room temperature storage showed a moderate reduction in germination, while seeds stored at 10°C and 40°C experienced more pronounced declines. Seeds stored at 90% relative humidity and 30°C rapidly lost viability, whereas partial vacuum conditions improved germination rates by reducing aerobic respiration. These findings emphasize the importance of optimizing storage parameters to maintain the viability of *Solanum nigrum* seeds effectively.

Given the numerous medicinal properties of *Solanum nigrum,* enhancing its germination power could significantly amplify its therapeutic potential. *Solanum nigrum* , commonly known as black nightshade, is renowned for its diverse pharmacological activities, including anti-inflammatory, antioxidant, anticancer, and hepatoprotective effects. By increasing its germination efficiency, we can ensure a more robust and consistent supply of this valuable medicinal plant, facilitating more extensive research and broader applications in herbal medicine.

Improving germination power can be achieved through several methods such as seed priming, which involves treating the seeds with specific substances to enhance their germination rate and vigor. Additionally, optimizing growing conditions like soil quality, moisture levels, and temperature can contribute to better germination and growth outcomes. Advanced techniques like genetic modification or selective breeding may also be employed to develop strains with superior germination and growth characteristics.

Ultimately, by focusing on increasing the germination power of *Solanum nigrum* , we can maximize its availability and effectiveness as a natural remedy, thereby expanding its role in traditional and modern medicine. This approach not only supports sustainable cultivation practices but also paves the way for discovering new therapeutic applications of this versatile plant.

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