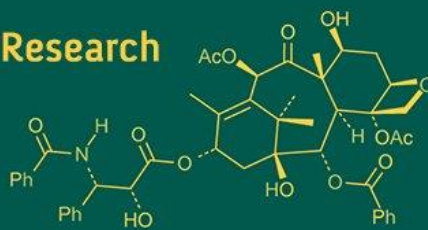


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Comparative efficiency of organic priming (Cow urine and slurry) vs. synthetic chemical treatments on seed dormancy breaking in *Tamarindus indica* L.: A review

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Abstract

Tamarindus indica L. is an economically significant and versatile tree species widely integrated into agroforestry systems due to its medicinal, dietary, and timber value. However, its mass propagation in nurseries is severely obstructed by physical seed dormancy, primarily caused by a tough, impermeable hard seed coat that restricts water absorption and delays germination. This review paper systematically compares two different treatment process to break harder and outer layer of a seeds. Synthetic chemical treatments such as GA₃, KNO₃, and H₂SO₄ against to the organic priming methods including cow urine, cow dung slurry, and bio fertilizers in overcoming seed dormancy. The extensive analysis of existing literature shows that chemical treatments (GA₃ at 200 ppm) effectively accelerate to the water uptake and ensure the earliest and high germination percentage. But they are relatively expensive and have environmental concerns. On the other hand, organic stimulants like cow urine (20-30% concentration) and cow dung slurry are very cost effective and eco-friendly alternatives. With the use of these organic agents seed germination may be slightly slower but they greatly increase seedlings vigor, establishment and environmental sustainability. The review concludes that although organic priming provides late germination and may provide less germination compared to chemical treatment, but organic priming is eco-friendly, low-cost effective and does not cause any harm to the environment.

Keywords: Seed dormancy, organic priming, germination, cow urine, synthetic chemicals

Introduction

This study incorporates only those investigations that specifically examined the physical dormancy of tamarind, and for which quantitative data were generated or provided regarding the effects of mechanical scarification, artificial chemical applications. Tamarind is botanically known as *Tamarindus indica* L. and belongs to the family Fabaceae (Caesalpiniaceae). Tamarind is however originated from dry savanna region of tropical Africa. India is the highest producer, exporter and consumer of tamarind in India. In southern part of India, tamarind is a basic ingredient in diet and different recipes. In India it is known as imli. It is frequently utilized in tropical nations due to its laxative and aphrodisiac attributes (Havinga *et al.*, 2010) [13]. It is called Indian date because of the colour of its dry pulp. It is a major crop for agroforestry system in India. The best part of the fruit tree is that it can grow and sustain even in harsh semi-arid climate. It can grow in barren land as well. It is a diploid dicotyledonous species, constituting the third biggest family of flowering plants, comprising 727 genera and 19,327 species possessing a chromosomal number of 2n = 24 (Purseglove, 1987) [22]. The *Tamarindus indica*, an evergreen tree, may reach heights of 30 meters and features a wide, spreading crown with a circumference of up to 12 meters (Orwa *et al.*, 2009) [19]. The compound leaves, consisting of several small leaflets arranged in pairs along a central axis, measure between 6 and 15 cm in length and typically fold at night (Shah 2014). Emerging in pendulous clusters, its 2.5 cm diameter, pale yellow or pinkish flowers have reddish streaks (Orwa *et al.*, 2009) [19]. The fruit typically measures 4 to 20 cm in length and is characterized by a distinctive, indehiscent pod featuring a scurfy brown exterior and a soft, acidic pulp that surrounds multiple firm, dark brown seeds (Gupta *et al.*, 2025) [12].

Tamarind is known to possess several importance because of which it is widely utilized all over the world Kumar and Bhattacharya (2008) [15]. It can perfectly fit into agroforestry system as it is leguminous in nature. *T. indica* exhibits extensive antibacterial properties and is a potential source of novel antibiotic classes that may be beneficial for the treatment and management of infectious diseases (Doughari *et al.*, 2006) [9]. Timber is used for making furniture and tool handles. Wood is also used for preparation of charcoal, oil mills, rice pounders and fuel wood. In traditional medicine, it is utilized for wound healing, abdominal pain, diarrhea, dysentery, parasite infections, fever, malaria, and respiratory issues (Bhadoriya *et al.*, 2011) [6].

The fruit is known to possess several desirable medicinal properties. Anti-asthmatic property was reported by (Rifaatul & Khairunnisak, 2017). These are used in some Thai food recipes because of their sourness and specific aroma (Coronel *et al.*, 1991) [7]. Tamarind is used for souring curries, sauces, chutneys and certain beverages. The product prepared from tamarind flowers, leaves, roots, fruits and seeds have been extensively used in the traditional medicines in India and Africa. Processed seed powder is used in confectionery (Patel *et al.*, 2008) [23].

The pulp of tamarind fruit possesses a sweet and acidic flavor resulting from elevated levels of tartaric acid and reducing sugars (Caluwe *et al.*, 2010) [8]. The commercially available dried tamarind pulp has 8 to 18% tartaric acid (2, 3-dihydroxybutanedioic acid C₄H₆O₆, a dihydroxy carboxylic acid) and 25 to 45% reducing sugars, with glucose constituting 70% and fructose 30% (EI-Siddig, 2006) [10]. It has been recommended for use as a stabilizer in ice-cream, mayonnaise, and cheese and as an ingredient or agent in a number of pharmaceutical products, and the seed oil is said to be palatable and of culinary quality (Morton 1987) [16].

The germination of (*Tamarindus indica*) is often difficult because of its tough seed coat, which leads to physical dormancy (Agbogidi *et al.* 2007) [1]. This hard outer shell prevents water from entering the seed, making it hard for the plant to grow on its own. To fix this, treatments like mechanical scarification, acid soaking, and hot water are used to break the seed coat (Baskin 2003). These methods help in softening the seed, allowing for better and more uniform germination in the nursery (Ajiboye 2010) [2].

Tamarindus indica is a moderately large, evergreen tree, reaching larger heights of the tree and girths of 7 meters. It is a substantial evergreen tree characterized by an incredibly attractive spreading crown, planted across nearly the entire country, excluding the Himalayas and arid western parts

(Muhammad and Amusa 2003) [17]. Leaves are alternately arranged, compound, consisting of 10-18 pairs of opposing leaflets; leaflets are narrowly oblong, measuring 12-32×3-11 mm, with a finely hairy petiole and rachis, and the midrib and net venation are somewhat prominent on both surfaces. The fruit is a pod, indehiscent, sub cylindrical, about 10-18 × 4 cm, either straight or curved, with a velvety, rusty-brown exterior; the pod's shell is fragile, and the seeds are encased in a sticky, delicious pulp (Gupta *et al.*, 2025) [12].

Botanical Description and Taxonomy

Tamarindus indica is a member of the Fabaceae family and the Caesalpinioideae subfamily. It comprises 58 tribes based on its morphology.

(Sources: Wikipedia and Scientific Classification of Fruits):

Tamarind (*Tamarindus indica*) is a versatile tree that is spread over a wide geographical areas. As a result of that the local people gave it different names, which resulted in a great variety of its names. Although at the international level it is referred to as 'Indian date' in English, its names in Indian languages differ to a large extent for example, in Hindi and Punjabi it is known as 'Imli', in Telugu as 'Chinta', and in Tamil and Malayalam as 'Puli'. The various local names of the plant such as 'Tentuli' in Odia and 'Chinch' in Marathi indicate the establishing the plant in the regional cultures and the traditional dishes of the area.

Methodology

Seed dormancy in *Tamarindus indica* L. significantly affects seed germination, so breaking the seed dormancy becomes very important, which affects seed germination percentage or germination DAS. A systematic literature review has been conducted to evaluate this. (As illustrated in the systematic flow Figure 2).

Search Strategy

To conduct a scientific and deep study, many academic databases including Google Scholar, Web of Science, and Research Gate. Paper published between (1987 to 2026) were selected.

Inclusion and Exclusion Criteria

Or biological treatments. Studies focusing on medicinal properties or fruit production which did not address seed dormancy have been excluded from this comparative analysis.

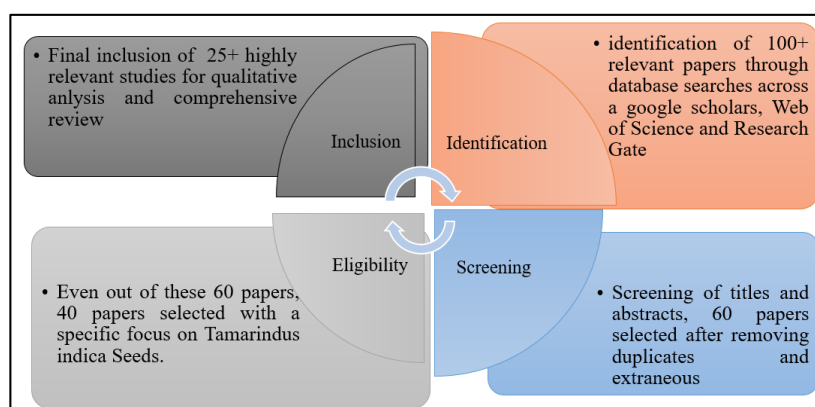


Fig 1: Systematic flow of the literature selection process for the review study.

Data Extraction

The selected literature was categorized into two main domains:

1. Treatments addressing specific physical dormancy problems (e.g., slow water absorption and hard seed coat).

2. Comparative performance of organic growth stimulants versus synthetic chemicals on germination parameters.

The extracted data was then systematically tabulated to facilitate a comparative discussion.

Table 1: Comparative Analysis of Seed Dormancy Breaking Treatments and Major Research Findings in *Tamarindus indica*.

S. No.	Organic Treatment		Chemical Treatment		Result	Economic benefits	Author
	Treatment	Effect	Treatment	Effect			
1.	Soaked in cow urine 20-30%	Enhanced metabolic activity, improved seedling vigour and germination percentage	GA ₃ 200 ppm	Accelerated water uptake, activated enzymatic activity and promoted early seed germination and seedling growth in tamarind.	Chemical treatment GA ₃ 200 ppm recorded the earliest and highest germination.	Organic Treatment (cow urine) is cost-effective and eco-friendly alternative than buying expensive chemical GA ₃ .	Nishad <i>et al.</i> , (2025) ^[18]
2.	soaked in cow dung slurry 20-30%	Improved germination as compared to untreated seeds.	KNO ₃ 1-2% and HCl 0.5-1%	Chemical treatments helped in breaking seed dormancy, and promote earliest germination.	Chemical treatments showed faster germination, whereas cow dung slurry.	Eliminates the financial burden of expensive chemical fluids like KNO ₃ and HCL	Sahu <i>et al.</i> , (2025) ^[25]
3.	Seeds were soaked in cow urine 5% and distilled water as control for sixteen hours.	Improved germination as compared to normal treatment.	Seeds were treated in GA ₃ (200 and 300 ppm), NAA (200 and 300 ppm), KNO ₃ Biofertilizers.	germination percentage (97.78%), rate of germination (2.12) and decrease in number of days taken (5.33 days)	Chemical treatments resulted in earlier and more vigorous germination. and decrease number of days of germination	Economical biofertilizers that is avoid heavy expenditure on expensive and synthetic chemical hormones.	Vasanth <i>et al.</i> , (2014) ^[29]
4.	Seed were soaked in cow's urine 50/50 v/v	The leaf area was maximised by cow's urine.	The growth stimulants evaluated were IBA 100 ppm, IAA 100 ppm, ZnSO ₄ 2%, succinic acid 1%, KCl 1%, KH ₂ PO ₄ 3%	Soaking in IBA 100 ppm improved the shoot and root lengths and dry weight better than the other treatments.	Chemical treatments, germination was quicker and fast growth.	Cow urine and cow dung slurry is a cheap organic options and avoids buying expensive commercial growth chemicals ZnSO ₄ , IAA, and IBA	Vanangamudi, (2022) ^[28] Fallick <i>et al.</i> (1989) ^[11]
5.	Cow urine 5%, Cow Urine 10%, Cow Urine 20%, Cow Dung Slurry for 24 hr.	The organic treatment whereas the untreated seeds showed no improvement.	GA ₃ , NAA and thiourea.	Showed fast germination (5.27 DAS), survival percentage of seedlings after 150 days (94.67%).	Chemical treatments showed earlier germination and cow urine treatment is showed late germination.	Cow urine is budget-friendly and replaces expensive chemical regulators GA ₃ , NAA and thaourea with economical inputs.	Tandon <i>et al.</i> , (2019) ^[14]

Table 2: Comparative Performance of Organic Growth Stimulants versus Synthetic Chemical Treatments on Seed Germination Parameters.

S. No.	Issue	Identified Reasons	Experiment	Findings	Authors
1.	Seed Dormancy	Hard Seed Coat (Tough outer layer, restrict water permeability)	Heat treated (50 °C for 30 min 50 °C for 60 min 100 °C for 30 min 100 °C for 60 min) Chemical treatment (49% H ₂ SO ₄ for 30 min 49% H ₂ SO ₄ for 60 min 98% H ₂ SO ₄ for 30 min 98% H ₂ SO ₄ for 60 min) and scarification.	Improve water absorption and permeability of seed Heat treated (enhanced germination) Mechanically processed (improved seed germination) Highest germination percentage (78.8%) (49% sulphuric acid)	Muhammad & Amusa (2003) ^[17]
2.	Seed Dormancy	Hard, water-impermeable seed coat causing physical dormancy and restricting water uptake (imbibition).	Control (untreated) Bottom cutting (BC) Both side cutting (BSC) Bottom + both side cutting (BC + BSC) 98% H ₂ SO ₄ for 25 min 98% H ₂ SO ₄ for 50 min 98% H ₂ SO ₄ for 75 min 98% H ₂ SO ₄ for 100 min 98% H ₂ SO ₄ for 125 min	Highest germination to lowest germination 98% H ₂ SO ₄ , 25 min-92.5% (3 DAS) BC + BSC-92.5% (3 DAS) BSC-87.5% (3 DAS) BC-85.0% (3 DAS) Control-55.0% (8DAS) 98% H ₂ SO ₄ , 125 min-27.5%	Ayala-Silva <i>et al.</i> , (2013) ^[4]
3.	Mechanical scarification	Hard seed coat, restricts rapid water uptake, Poor water imbibition delays.	Control (no soaking, no PGR) Different soaking periods GA ₃ treatments Soaking + GA ₃ combinations	Germination started-24 h soaking + GA ₃ 200 ppm (6.9 DAS) Control (17.8 DAS) Germination Percentage-24 h soaking + GA ₃ 200 ppm (95%) Control (Lowest) 24 h soaking + GA ₃ @ 200 ppm was the best treatment.	Tiwari <i>et al.</i> (2025) ^[27]
4.	Seed coat removal	Hard seed coat, restricts water	Control (untreated seeds) Mechanical Scarification(MS) at	Initial germination-mechanical scarification (5 DAS), H ₂ SO ₄ 60%, 10 min (5DAS), control	Oyebamiji & Babalola

		entry, Water reach in embryo, seed coat is damaged.	micropyle H ₂ SO ₄ (60%) for 10 minutes (A10) Water soaking for 24 hours (S24h) S1 = Top soil S2 = River sand S3 = Top soil + River sand + Manure Treatment combination S1MS, S2MS, S3MS S1A10, S2A10, S3A10	(9DAS) Germination Percentage-H ₂ SO ₄ 60%, 10 min (100%), Untreated Control ((65%) 24 h soaking + GA ₃ @ 200 ppm was the best treatment.	(2019) ^[20]
5.	H ₂ SO ₄	Hard, water-impermeable seed coat causing physical dormancy and restricting water uptake (imbibition).	Control Cold, water soaking 24 h, 48 h, 72 h, Hot water soaking 5 min, 10 min, 15 min, Sulphuric acid (H ₂ SO ₄) Concentrated acid (~98%) mein 5, 10 aur 15 mi, Mechanical scarification manually scratch/nick	Germination Percentage-Mechanical scarification 83%, H ₂ SO ₄ 10 min (78-80%) Hot water 10 min (65-70%), Cold water soaking (45-60%), Control (43%) Initial germination-H ₂ SO ₄ (10 min) (8-10DAS), Mechanical scarification (9-11DAS), Hot water treatment (11-13 DAS), Control (15-18DAS)	Rajamanickam <i>et al.</i> (2002) ^[24]
6.	H ₂ SO ₄ treatment	Dormancy caused by hard impermeable seed coat.	commercial sulphuric (H ₂ SO ₄) acid @ 200 ml kg ⁻¹ 10-15-20 min	Maximum germination obtained with H ₂ SO ₄ treatment and hard seed percentage minimum.	Parameswari <i>et al.</i> , (2001) ^[21]
7.	Cow urine	Hard Seed Coat (Tough outer layer, seed coat, wataer absorption, restricts water permeability).	Control (distilled water) GA ₃ @ 100 ppm GA ₃ @ 200 ppm GA ₃ @ 300 ppm NAA @ 100 ppm NAA @ 200 ppm NAA @ 300 ppm HCl 10% (acid scarification) Cow urine 5% Cow urine 10% Cow urine 20% Cow dung slurry (24 h soaking)	GA ₃ @ 200 ppm: Initial germination 5.27 DAS, germination 86.67%, survival 94.67%. GA ₃ @ 300 ppm: Initial germination 5.67 DAS, 50% germination 15.67 DAS, germination 83.33%, survival 92.00%. Cow urine @ 20%: Germination 76.67%, survival 88.00%. Cow urine @ 10%: Germination 73.33%, survival 86.67%. Cow urine @ 5%: Germination 70.00%, survival 84.00%. Cow dung slurry: Germination 66.67%, survival 82.67%. Control: Initial germination 11.67 DAS, germination 53.33%, survival 73.33%.	Tandon <i>et al.</i> , (2019) ^[14] Tiware <i>et al.</i> (2025) ^[27]
8.	Cow Dung Slurry	Dense Impermeable Testa (Thick pericarp barrier, seed coat, wataer absorption, delays internal moisture imbibition).	Control: Distilled water Chemical Treatment (GA ₃): GA ₃ @ 100 200 300 ppm Chemical Treatment (GA ₃): Treatment (NAA): NAA @ 100 200 300 ppm. Chemical Acid Scarification: HCl 10%, Organic Treatment (Cow Urine): Cow urine 5% 10% 20% (Cow Dung): Cow dung slurry (24 h soaking)	GA ₃ @ 200 ppm: Initial germination 5.27 DAS, germination 86.67%, survival 94.67%. GA ₃ @ 300 ppm: Initial germination 5.67 DAS, 50% germination 15.67 DAS, germination 83.33%, survival 92.00%. Cow urine @ 20%: Germination 76.67%, survival 88.00%. Cow urine @ 10%: Germination 73.33%, survival 86.67%. Cow urine @ 5%: Germination 70.00%, survival 84.00%. Cow dung slurry: Germination 66.67%, survival 82.67%. Control: Initial germination 11.67 DAS, germination 53.33%, survival 73.33%.	Sahu <i>et al.</i> , (2025) ^[25] Tiware <i>et al.</i> (2025) ^[27]
9.	Biofertilizers	Rigid Cellular Seed Envelope (Stony exterior shell, seed coat, wataer absorption, blocks immediate hydration.)	Control: Distilled water Chemical Treatment GA ₃ GA ₃ @ 100 ppm, GA ₃ @ 200 ppm, GA ₃ @ 300 ppm Chemical Treatment NAA NAA @ 100 ppm, NAA @ 200 ppm, NAA @ 300 ppm Acid Scarification HCl 10% Organic Treatment (Cow Urine) Cow urine 5%, Cow urine 10%, Cow urine 20% Organic Treatment (Bio-waste) Cow dung slurry (24 h soaking)	GA ₃ @ 200 ppm: Initial germination 5.27 DAS, germination 86.67%, survival 94.67%. GA ₃ @ 300 ppm: Initial germination 5.67 DAS, 50% germination 15.67 DAS, germination 83.33%, survival 92.00%. Cow urine @ 20%: Germination 76.67%, survival 88.00%. Cow urine @ 10%: Germination 73.33%, survival 86.67%. Cow urine @ 5%: Germination 70.00%, survival 84.00%. Cow dung slurry: Germination 66.67%, survival 82.67%. Control: Initial germination 11.67 DAS, germination 53.33%, survival 73.33%.	Yadav <i>et al.</i> , (2025) ^[30]

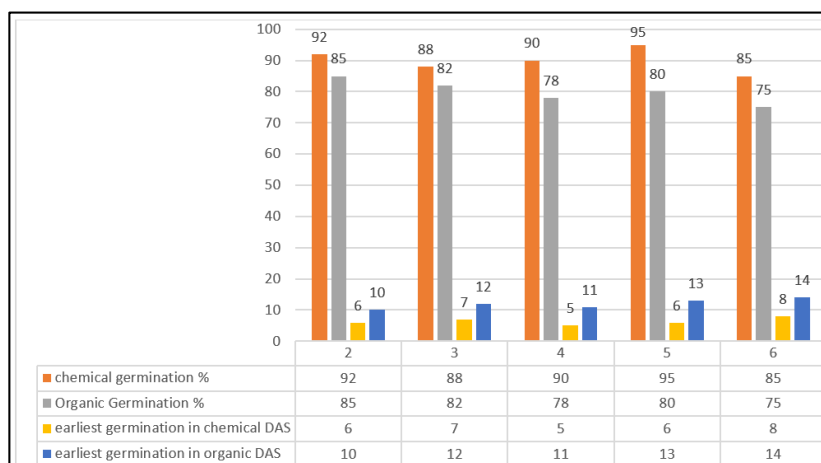


Fig 2: Impact of Synthetic Chemicals and Organic Priming on Days taken for Seed Germination in *Tamarindus indica* L.

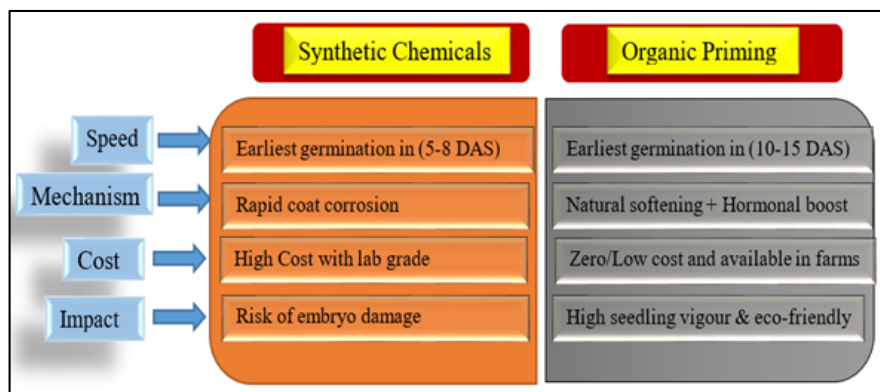


Fig 3: Comparative Effect of Chemical vs. Organic Treatments on Seed Germination Percentage of *Tamarindus indica* L.

Conclusion

The outer layer of the tamarind seed, known as the seed coat, is very hard and impermeable. The problem of seed dormancy is still a major challenge in the raising seedlings process in the nurseries. This comparative challenge unveils a critical dichotomy, where synthetic chemical treatments (GA_3 , KNO_3 and H_2SO_4) are highly effective in rapidly softening the outer layer of the seed and increasing germination rates, but have many drawbacks. These chemicals can cause significant environmental harm, are too expensive for many to afford, and have many other associated risks. This is in stark contrast to organic priming techniques, namely 20%, 30% and 40% solutions of cow urine and cow dung as well as bio-fertilizers, which have been found to be highly effective, eco-friendly and economically viable options. These approaches are accessible to everyone and can frequently be acquired at minimal expense or even for free. Reviews of numerous studies suggest that while seed germination might occur at a slightly slower pace when using these organic agents, they consistently produce seedlings of higher quality and promote environmental sustainability. Since they do not harm the environment in any way, it is highly advised to prioritize organic treatments over synthetic chemicals to support the extensive and sustainable agroforestry development of *Tamarindus indica*.

Future Scope

In the future objective of research should focus on determining the precise quantities of various organic fertilizers and evaluating different application methods. This is intended to minimize the initial delays often encountered during seed germination. Furthermore, large-scale field trials are essential to evaluate and document the growth performance of perennial plants cultivated under diverse climatic condition.

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