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Ethnomedicinal Properties of *Gnetum gnemon* L. in Mizoram, Northeast India, and the Contribution of Regeneration Studies for Future Ethnobotanical Resources.

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Abstract

Gnetum gnemon L. (Gnetaceae), locally known as Pelh in Mizoram, Northeast India is a traditional ethnobotanical plant used by local for food and to treat various ailments, including fever, inflammation, joint pain, and digestive disorders. Its seeds, leaves, and roots contain pharmacologically active compounds such as resveratrol, flavonoids, and stilbenoids with documented antioxidant, anti-inflammatory, antimicrobial, and anticancer properties. However, the natural regeneration status of this species in protected areas of Mizoram is uncertain for the long-term sustainability. Natural regeneration of *G. gnemon was* studied for two consecutive years (2020–2021) in a reserved forest of Serchhip District, Mizoram. Ten permanent 1 m² quadrats were established, and all saplings were followed bimonthly for survival, recruitment, height growth, and diameter growth.

The species was present in only one quadrat (10% frequency). Of the initial six saplings, four survived 18 months (66.7% survival). Only two new recruits appeared during the entire study, and one died. Height of surviving individuals increased significantly ($p = 0.028$), but diameter did not, and the height–diameter correlation was weak ($r = 0.48$, $p = 0.009$), indicating suboptimal microsite conditions. The population of *G. gnemon* in a Mizoram reserved forest has low regeneration, with insufficient recruitment to balance mortality. This directly threatens the long-term availability of its ethnomedicinal resources. Active conservation measures are immediately needed to preserve this valuable medicinal plant for future generations.

Keywords: *Gnetum gnemon*, ethnomedicine, natural regeneration, Mizoram, conservation.

Introduction

Gnetum gnemon L. (Gnetaceae) is a dioecious evergreen tree native to tropical Asia, valued for its edible nuts, leaves, and timber [4]. In Northeast India, particularly in Mizoram, the species is locally known as Pelh and is integral to traditional livelihoods. Despite its cultural and economic significance, wild populations are declining due to habitat fragmentation and poor natural regeneration. *G. gnemon* has considerable pharmacological interest [5]. The seeds are particularly rich in trans-resveratrol and its oligomers (gnetins), which exhibit strong antioxidant, anti-inflammatory, and anticancer activities [2].

Natural regeneration in protected areas is a key indicator of forest health. However, baseline data on regeneration dynamics of *G. gnemon* are scarce, especially from reserved forests of Mizoram.

Understanding recruitment, survival, and growth patterns is essential for conservation planning [7]. This study aimed to:

1. quantify the frequency and density of *G. gnemon* regeneration in Sakhisih Reserved Forest,
2. estimate survival and recruitment over two years,
3. analyse height and diameter growth, and
4. assess height–diameter allometry as a substitution for regeneration vigour.

Methodology

2.1. Study area

The study was conducted in Sakhisih Reserved Forest (approx. 23°N, 93°E), Serchhip District, Mizoram, Northeast India. Sakhisih Reserved Area is 152.35 hectare approximately in size and the area receives an average annual rainfall of ~2000 mm, with a distinct monsoon from June to September. Vegetation is tropical moist evergreen forest. The site is a protected area with no anthropogenic disturbance -grazing, logging, or fire during the study period.

2.2. Sampling Data collection

Ten permanent quadrats of 1 m × 1 m (1 m²) were laid randomly within a 2-hectare forest patch known to contain adult *G. gnemon* trees. All quadrats were georeferenced and marked with rope for repeat sampling. Monitoring was conducted at bimonthly intervals: March, May, June, September, November (2020), and January, May, September (2021) – a total of 8 sampling events. Within each quadrat all *G. gnemon* seedlings/saplings (height < 2 m) were tagged with numbered aluminium tags. The height (cm) was measured from ground level to apical bud using a graduated ruler. The diameter (cm)was measured at the base (0 cm above ground) using digital callipers. The survival was recorded as alive or dead (NT = "No Tree"). Recruitment was recorded when a new individual appeared in a quadrat which are previously absent.

All dead individuals were left in place. Cause of death was natural as there were no signs of herbivory or human interference.

2.3. Data analysis

i. Regeneration frequency = (number of quadrats with *G. gnemon* / total quadrats) × 100.
ii. Density = individuals per quadrat (since area = 1 m²).
iii. Survival rate = (number alive at final census / number initially present) for initial cohort; exact binomial 95% confidence interval (CI) calculated.
iv. Growth was analysed using paired t-tests (March 2020 vs. September 2021 for height; March 2020 vs. May 2021 for diameter due to missing September 2021 diameter data).
v. Height–diameter relationship assessed by Pearson's correlation coefficient using all paired measurements (n = 28).
vi. Statistical significance set at $\alpha = 0.05$. Analyses performed in R version 4.1.2 (R Core Team, 2021).

2.4. Ethnomedicinal Use

A systematic collection of ethnomedicinal data was conducted through structured and semi-structured interviews with local informants, aiming to document traditional knowledge regarding the therapeutic uses of the plant species.

Results

3.1. Ethnomedicinal Use

In Mizoram, the plant *Gnetum gnemon* is used for a variety of therapeutic purposes. Documented ethnomedicinal uses include:

Leaves: Pounded and applied as a poultice for fever, headache, and skin infections; decoction taken for dysentery and stomach ache.

Seeds (nuts): Roasted or boiled seeds are consumed as a tonic and to improve vitality; also used for post-partum recovery in women.

Roots: Decoction used for joint pain, inflammation, and as an antidote for certain poisons.

3.2. Regeneration frequency and density

Out of 10 quadrats, only one (Quadrat 5) contained *G. gnemon* individuals. Regeneration frequency = 10%. Density in Quadrat 5 varied over time (Table 1).

Table 1. Population census of *Gnetum gnemon* in Quadrat 5 (1 m²) from March 2020 to September 2021

Date	Individuals	New recruits	Deaths
Mar 2020	6	–	–
May 2020	6	0	0
Jun 2020	6	0	0
Sep 2020	6	0	0
Nov 2020	8	2	0
Jan 2021	8	0	0
May 2021	8	0	0
Sep 2021	5	0	3

3.3. Survival and ingrowth

i. Initial cohort (March 2020, n = 6): 4 individuals survived to September 2021 → 18-month survival = 66.7% (exact binomial 95% CI: 22.3–95.7%).

ii. Recruits (November 2020, n = 2): 1 survived to September 2021 → survival = 50% (95% CI: 1.3–98.7%).

iii. Net change: 6 → 5 individuals (−1) over 18 months.

Only one recruitment event occurred which is at post-monsoon 2020; no new individuals appeared in 2021.

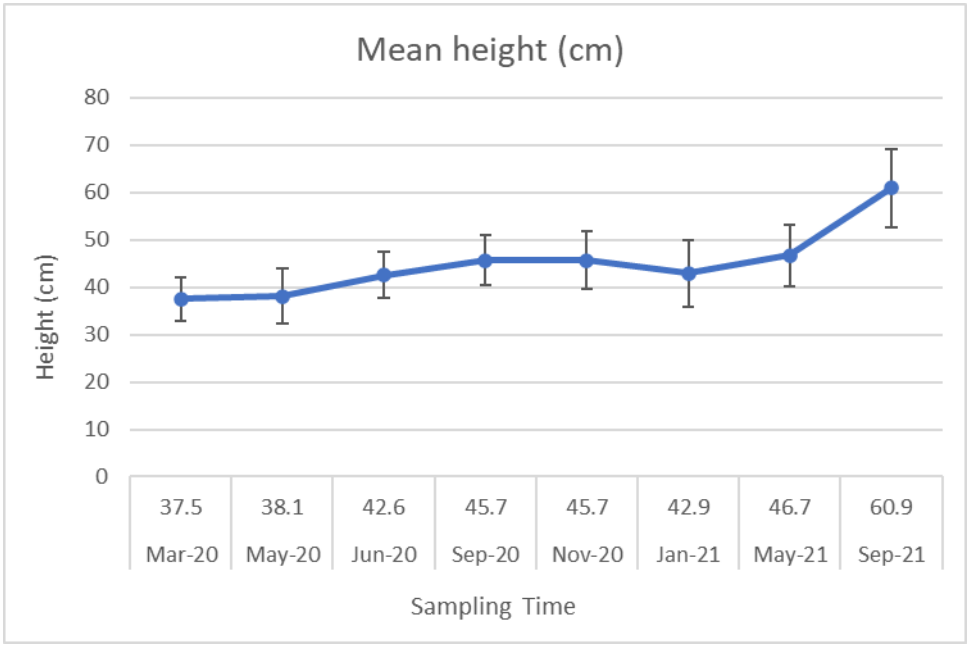

Figure 1. Mean height (± SE) of surviving *Gnetum gnemon* saplings (n=4) from March 2020 to September 2021. Height increased significantly over 18 months (paired t-test, p = 0.028).

3.4. Growth of surviving individuals

i. Height growth (cm): Mean height increased from 37.5 cm (SE 4.7) in March 2020 to 60.9 cm (SE 8.2) in September 2021. Paired t-test: mean increase = 23.4 cm, t (3) = 3.98, p = 0.028 → significant.

ii. Diameter growth (cm): Mean diameter was 0.73 cm (SE 0.16) in March 2020 and 0.78 cm (SE 0.17) in May 2021 (last complete set). Paired t-test: mean change = +0.05 cm, t (3) = 0.29, p = 0.79 → not significant.

3.5. Height–diameter correlation

Pearson's correlation coefficient: r = 0.48 (p = 0.009). Coefficient of determination $r^2 = 0.23$ – only 23% of height variation explained by diameter. The relationship is weak but statistically significant.

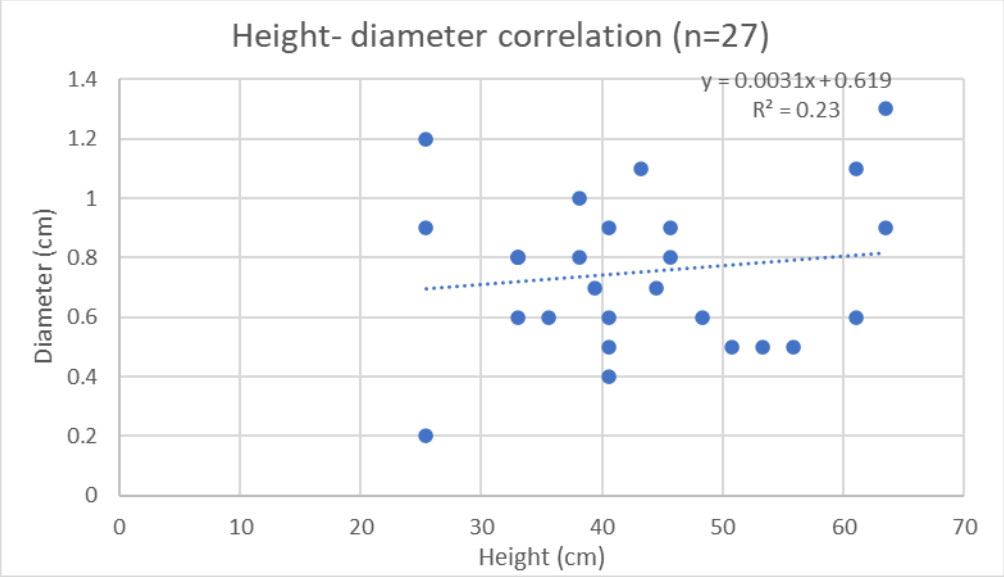

Figure 2. Relationship between height and diameter of *Gnetum gnemon* saplings (n = 27 paired measurements). Pearson's correlation r = 0.48 (p = 0.009). The regression line shows weak positive allometry.

Discussion

4.1. Regeneration frequency

G. gnemon regenerates in only 10% of sampled quadrats despite being present in the forest environment. This pattern showed a seed limitation either low seed production, poor seed dispersal, or high seed predation. Similar results have been reported for other non-timber forest products in disturbed tropical forests [3].

4.2. Survival and recruitment

The 66.7% survival of the initial cohort is moderate, but the ingrowth rate is critically low (only 2 recruits in two years, with 50% mortality). The only recruitment occurred in November 2020, immediately after the monsoon. This shows that *G. gnemon* seeds germinate only within a fine post-monsoon period, and that microclimate conditions like light, moisture, litter depth may be suitable [1] only in that one quadrat. The absence of recruitment in 2021 suggests a failed seed year or unsuitable conditions.

4.3. Growth

Significant height gain without corresponding diameter growth is typical of plants under shade stress [5]. In dense forest understorey, saplings elongate to reach light but do not thicken. The weak height–diameter correlation (r = 0.48) further supports the idea of etiolated growth, indicating that the current microsite in Quadrat 5 may be suboptimal for vigorous regeneration.

Regeneration densities of *Gnetum* species in Southeast Asian forests range from 0.2 to 2.5 individuals/m² [4]. Our maximum density of 8 individuals/m² is within that range, but the spatial restriction to one quadrat is unusual. Our study entirely within a reserved forest likely represents the species' intrinsic regeneration capacity without human aid.

4.5. Conservation implications

The population in Sakhisih Reserved Forest appears demographically unstable. With only 5 individuals remaining and no consistent recruitment, local extinction is possible within a few decades. Although the area is protected, natural regeneration is insufficient. Canopy gap creation to improve light conditions and promote diameter growth is essential. Seedling transplanting from nursery to increase population size. This study demonstrates that ethnomedicinal plants are not automatically protected by forest reserves. For many wild-harvested medicinal plants, particularly slow-growing tropical species, regeneration failure may be widespread but undetected due to lack of monitoring.

5. Conclusion

This two-year study provides the first quantitative assessment of natural regeneration of *Gnetum gnemon* in Sakhisih Reserved Forest, Mizoram. The species shows extremely low occupancy (10% of quadrats), a single recruitment over two years, and etiolated growth i.e., height increase without diameter gain. The weak height–diameter correlation ($r = 0.48$) indicates suboptimal microsite conditions. Unless active conservation measures are implemented, this population is likely to decline further. Long-term monitoring (>5 years) and experimental seed addition trials are immediately needed.

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