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# Studies on Indian Prickly Ash (*Zanthoxylum rhetsa* (Roxb.) DC) Collections from Goa, India

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## Abstract

Seven collections of *Zanthoxylum rhetsa* (Roxb.) DC from different locations of Goa were studied for tree and fruit morphological traits, essential oil content and oleoresin content in fruit skin. Variations were noticed in parameters *viz*. tree height (15 to 24 m), number of main branches (3-5), number of prickles/10 $cm^2$ on main stem (5.25 to 7.25), number of prickles at terminal branch (22.2 to 25.0) and number of leaflets per terminal branch (228.6 to 273.4). Essential oil content in dried fruit skin ranged between 6.0% (Tisal-07) and 8.4% (Tisal-06). Oleoresin content was determined using acetone as a solvent, which revealed as high as 12.22% oleoresins in Tisal-04, while 8.86% was obtained in Tisal-01.

**Key words:** *Essential oil, morphological parameters, oleoresin, pericarp*

## Introduction

Indian Prickly Ash or Tisal belonging to the family Rutaceae is found growing in wild form in the forests of Goa, the Western Ghats and the North East Himalaya. The tree has vast traditional significance and has potential for commercial utilization. The tree wood is termite resistant (Boer et al., 1998) and could be used for preparation of furniture and handicrafts. Forest dwellers use the dried branches as firewood. Branches have thick sharp prickles and hence, are used for fencing to keep away the wild cattle. The shoots are consumed as vegetables by *Adi* tribe of East Siang District of Arunachal Pradesh (Payum et al., 2013). Fresh and dried fruits have been traditionally used in culinary items in many parts of India. In Goa, dried fruit pericarp is used in culinary items *viz*. fish curry, *solkadhi*, biryani, pumpkin dish *etc*. (Karanjalker et al., 2021). Fruit powder is reported to be effective against rancidity in peanut (Antony et al., 2019). Locals of Goa use the raw fruits for preservation of raw mango (Karanjalker and Karanjalker, 2021).

Tisal fruits have multiple pharmaceutical values and have been traditionally used against manifold human ailments. For example, leaves are being used for de-worming by Naga tribes of North East India (Yadav and Tangpu, 2009) and prickles for breast pain by *Kanikkar* tribes of Tamil Nadu (Medhi et al., 2013). It is used against toothache, dizziness and bloating in Thailand (Duangyod et al., 2020). It also helps in increasing lactation in nursing mothers (Lalitharani et al., 2010). It is reported to be have anti-cancerous (Theeramunkong and Utsintong, 2018), antibacterial (Pooja et al., 2012), anti-diabetic, anti-spasmodic, anti-inflammatory, anti-nociceptive and anti-diarrheal properties (Pai et al., 2009; Duangyod et al., 2020).

Botanical description of the species has been given by the earlier researchers. Plant attained height of 25–30 m (Shankaracharya, 1994; Brophy et al., 2000), hard- conical shaped spines (Lalitharani et al., 2013), compound-imparipinnate leaves, terminal cymose (20 cm length) flowers and simple follicle fruits. However, information on characterisation of individual trees of tisal for variability in morphological traits and essential oil content is scarce and hence, the present study was undertaken.

## Materials and Methods

The plants were identified from different locations of Goa as per the information provided by the locals where the marketing and consumption of fruits are observed. The collections were done from Hankane (Tisal-01),

Sangolda (Tisal-02), Sakorda (Tisal-03), Madkaim (Tisal-04), Velguem (Tisal-05), Dongrim (Tisal-06) and Cudnem (Tisal-07). The plants were of different unknown age and no cultivation practices were followed. The morphological parameters *viz*. plant height, number of main branches, number of leaves per terminal end, number of fruits per cluster, number of prickles at 1.3 m height (breast height), number of prickles at terminal branch, fresh fruit diameter (mm), seed length (mm), seed width (mm), seed thickness (mm) and 100 seed weight (g) were recorded. All values were subjected to statistical analysis using Web Agri Statistical Package (WASP v. 2.0) software (ICAR-CCARI, Ela, Goa, India).

Fresh matured fruits were harvested and sun dried for five days. Pericarp was separated from seed and packed in air tight bags till further analysis. Oleoresin and essential oil content in the pericarp were determined using Soxhlet apparatus and Clevenger's apparatus, respectively. The content was expressed as percentage.

## Results and discussion

### Tree morphological characters

The plant height amongst the collections varied from 15 m in Tisal-03 to 24 m in Tisal-06 (Table 1), which closely resembled with the height range (25–30 m) reported by Shankaracharya (1994) and Brophy et al. (2000). In all the collections, trunk was observed to be upright, corky and straight. The number of main branches varied from 3-5. Trunk and branches of *Z. rhetsa* are characterized with prickles all over the surface (Lalitharani et al., 2013). The conical prickles on branches were sparse and thick on the main trunk, while those were thin and pointed at the terminal end of the stem. Number of prickles per 10 $cm^2$ area at 1.3 m varied from 5.3 ± 0.70 (Tisal-03) to 7.3 ± 0.70 (Tisal-05), while at terminal end, it varied from 22.2 ± 0.70 (Tisal-03) to 25.0 ± 3.53 (Tisal-05). Leaves were compound- imparipinnate and were mostly present at the terminal ends of the branches. Number of leaves per terminal branch significantly varied from 14.0 (Tisal-01) to 27.5 (Tisal-05).

**Table 1. Tree morphological parameters of Tisal collections from Goa, India**

| Collection code | Tree height (m) | No. of main branches | No. of prickles at breast height per 10$cm^2$ area | No. of prickles at Terminal branch | No. of leaves per terminal end | No. of fruits per cluster |
|---|---|---|---|---|---|---|
| Tisal-01 | 17 | 4 | 6.0 ± 0.70 | 23.0 ± 1.41 | 14.0c | 237.2 ± 45.97 |
| Tisal-02 | 19 | 3 | 5.8 ± 0.70 | 23.5 ± 2.82 | 25.0a | 273.4 ± 25.97 |
| Tisal-03 | 15 | 5 | 5.3 ± 0.70 | 22.2 ± 0.70 | 24.3a | 228.6 ± 47.97 |
| Tisal-04 | 19 | 4 | 6.0 ± 2.12 | 23.8 ± 0.70 | 14.5bc | 249.6 ± 22.02 |
| Tisal-05 | 22 | 4 | 7.3 ± 0.70 | 25.0 ± 3.53 | 27.5ab | 256.5 ± 17.51 |
| Tisal-06 | 24 | 3 | 6.5 ± 1.41 | 23.3 ± 3.50 | 12.1abc | 261.1 ± 40.24 |
| Tisal-07 | 23 | 5 | 7.0 ± 1.70 | 24.5 ± 0.70 | 19.7c | 241.6 ± 34.08 |

*Values followed by similar alphabet in a column do not differ significantly at 5% level ofsignificance using least significant difference

Very few studies on systematic characterisation of tree diversity in *Z. rhetsa* are available in the literatures. Plant is deciduous or evergreen in nature (Yadav and Tangpu, 2009, Hartley, 2013). Flowers are borne terminally in cymose (20 cm long) and both male and female flowers are evident on the panicle. Male flowers have 3 mm long stamens and are of disc or conical shape, lobed or grooved along with rudimentary gynoecium, whereas female flowers are of disc or columnar shaped, 1.5 mm long with single/double carpelled gynoecium, excentric style and flattened stigma (Hartley, 2013).

## Fruit and Seed morphological parameters

Fruits of tisal are borne in cluster and number of fruits per cluster varied between 228.6 (Tisal-03) and 273.4 (Tisal-02). However, the difference among the collections were not significant. Diameter of fresh fruits varied from 5.48 mm (Tisal 01) to 6.55 mm (Tisal 03) in present study (Table 2). Seeds were globose, hard with smooth and black surface. Morphological characterization of seven collections from various parts of Goa suggested distinct variations for seed morphology (Table 2). Significant differences were noticed for seed length, which varied between 5.535 mm (Tisal-02) and 6.525 mm (Tisal-06), while seed width varied from 4.835 mm (Tisal-05) to 6.376 mm (Tisal-01). Thickest seeds of 5.385 mm were noticed in collection Tisal-01, while it was the lowest in Tisal-07. Weight of 100 seeds varied between 8.403 g (Tisal-03) and 14.773 g (Tisal-07) among the collections studied.

**Table 2. Fruit and seed morphological parameters of Tisal collections from Goa, India**

| Collection code | Diameter fresh (mm) | Seed length (mm) | Seed width (mm) | Seed thickness (mm) | 100 seed weight (g) |
|---|---|---|---|---|---|
| **Tisal-01** | 5.48 d | 6.111 b | 6.376 a | 5.385 a | 11.883 c |
| **Tisal-02** | 5.81 cd | 5.535 c | 5.825 c | 5.207 ab | 9.630 e |
| **Tisal-03** | 6.55 a | 5.656 c | 5.725 c | 5.119 bc | 8.403 f |
| **Tisal-04** | 6.36 ab | 6.250 b | 5.678 c | 5.154 b | 13.410 b |
| **Tisal-05** | 6.23 ab | 6.145 b | 4.835 d | 4.955 cd | 10.340 d |
| **Tisal-06** | 6.47 a | 6.525 a | 6.066 b | 5.130 bc | 13.896 b |
| **Tisal-07** | 6.06 bc | 6.495 a | 6.085 b | 4.845 d | 14.773 a |

*Values followed by similar alphabet in a column do not differ significantly at 5% level ofsignificance using least significant difference

## Essential oil and oleoresin content

Fruits are highly aromatic that smell like lemon skin (Duangyod et al., 2020) and hence, essential oil and oleoresin contents were determined in different collections. Essential oil content in dried fruit skin ranged between 6.0% (Tisal-07) and 8.4% (Tisal-06). Oleoresin content was determined using acetone as solvent, which revealed as high as 12.22% oleoresins in Tisal-04, while 8.86% was obtained in Tisal-01. The recovered oleoresin varied in terms of colour as well.

As synthesis and accumulation of essential oils in a species is governed by several internal and external factors, variations in this trait could be expected. Theeramunkong and Utsintong (2018) observed volatile oil yield of 8.1 to 13.6% (v/w) from fresh fruit skin, while it was 13.17 to 15.33% (v/w) in skin from dried fruits collected from Thailand (Northern Nan, Southern Nan, Phayao and Chiang Rai). Volatile oil recovery of 2.3% (v/w) has been reported by Duangyod et al. (2020) in dry fruits collected from Thailand, while mere 1.94% essential oil was recovered in a study by Rana and Blazquez (2010), who obtained the dry seed coats from Imphal, Northeast India. Visual colour of oleoresin was 'Golden yellow to light green' in four collections (Tisal-01, Tisal-02, Tisal-03, Tisal-05), while it was 'dark green to blackish' in remaining three collections (Tisal-04, Tisal-06 and Tisal-07). Such variations indicate presence of diversity, which needs to be systematically exploited. Identification of genotypes with higher content of essential oil and oleoresins is a pre-requisite for promotion of small scale extraction units.

Vegetative and reproductive parts of plants of tisal possess pleasant flavour. As the aroma is akin to lemon, fruit skin oil could be used as a substitute for the citrus oil. Essential oils extracted from various parts of plants and fruits could be used in manifold commercial products like perfumes, preservatives, cosmetic natural sunscreen, anti-ageing cosmetic, antiseptics *etc*. (Shantanu et al., 2011; Reddy and Beena, 2011; Antony et al., 2019; Santhanam et al., 2013).

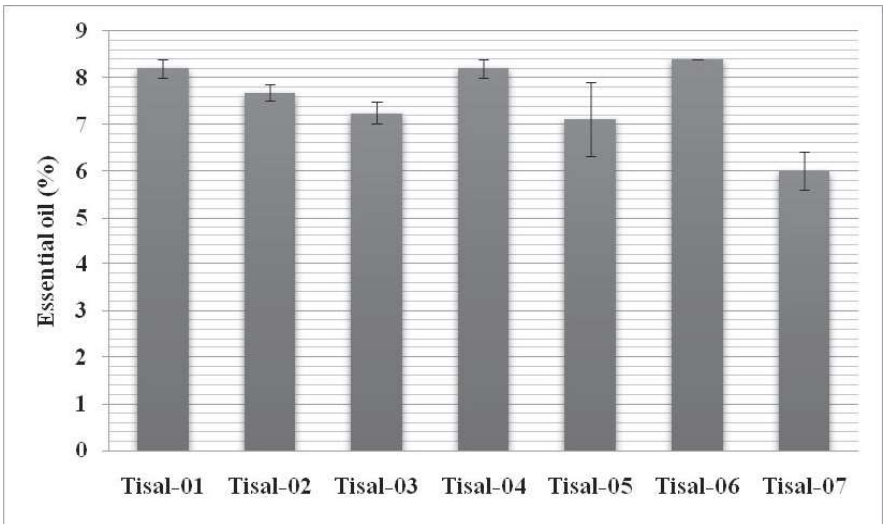


**Fig. 1. Variability in essential oil content among tisal collections from Goa, India**

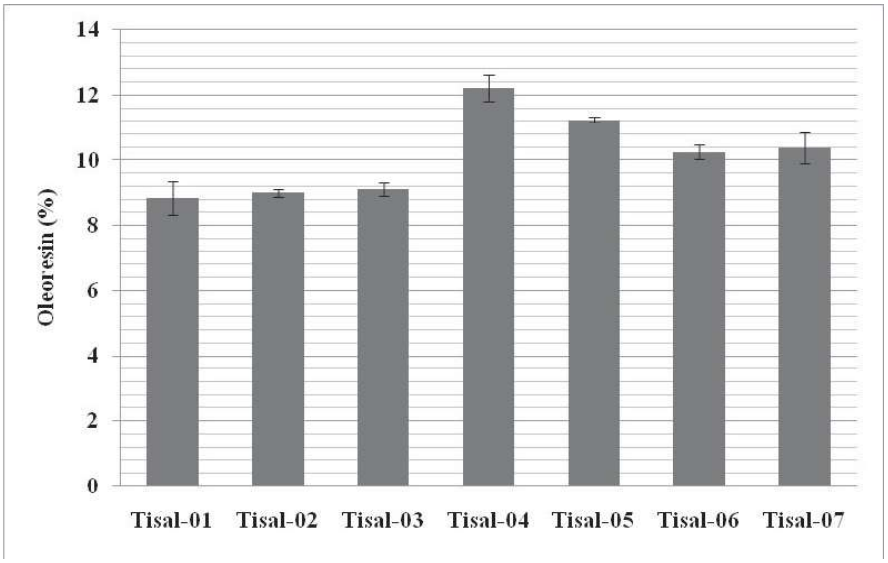


**Fig. 2. Variability in oleoresin content among tisal collections from Goa, India**

## Conclusion

In the present study, seven collections of an underutilized but traditionally valued spice 'tisal' from different locations of Goa were studied. Variations were observed for tree, fruits and seed morphological parameters. Further, collections showed variability for volatile oil content and oleoresin content, which indicated scope for identification of superior germplasm for further utilization in aroma based industries.

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