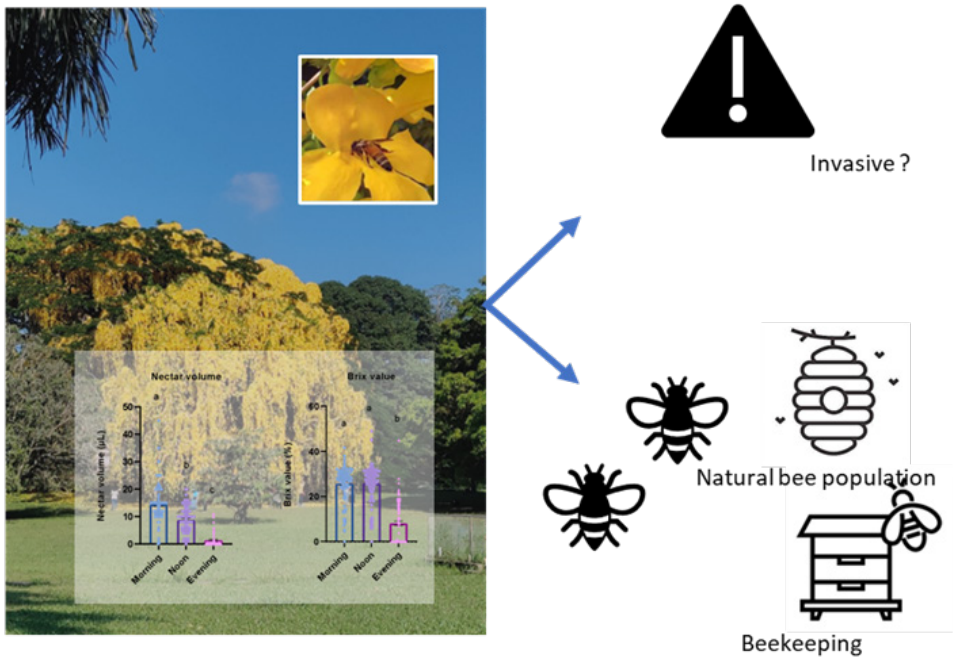
SHORT COMMUNICATION

Dolichandra unguis-cati, a friend or a foe? A study on honey production potential

K. P. T. Silva and W. H. Jayasinghe*



Highlights

- *Dolichandra. unguis-cati* is a major feeding source for foraging bees.
- Estimated honey production potential at the study location was between 77 - 125 kg per season.

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SHORT COMMUNICATION

Dolichandra unguis-cati, a friend or a foe? A study on honey production potential

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Abstract: The University of Peradeniya's grounds are home to the famous *Dolichandra unguis-cati* (L.) L.G. Lohmann; cat's claw vine, which blooms primarily from March through May. The vine has received a lot of attention mostly for its showy flowers. Being an invasive species, *D. unguis-cati* can pose a threat to the native flora and fauna. Yet, the vine also has positive impacts. Therefore, we looked at nectar production dimensions, the average brix value of nectar, honey production potential (HPP) and the honeybee colony carrying capacity (HCCC) of the vine specific to the garden of the University of Peradeniya, which reveals that it is a significant source of food for foraging bees. A vine had an average flower density of 154,700 per vine and 324 per m^2. Each blossom produced nectar for at least four days. The average sugar content per blossom was 6.3 mg and an average of 3.94 kg of sugar was thought to be generated by each plant. The HPP per plant in the experiment was 4.58 kg, whereas the estimated HPP at the study site was between 77 - 125 kg. This gave an HCCC rating between 15 and 25. As a result, *D. unguis-cati* serves as a safe haven for honeybees and a vital food supply for insects, which are crucial in ecology. This study only considered the honey production potential; any other impact on the local flora and fauna has not been considered.

Keywords**:** *Dolichandra unguis-cati; Nectar volume; honey potential*

INTRODUCTION

Dolichandra unguis-cati commonly known as Cat's claw ivy is a woody vine with tendrils that belongs to the Bignoniaceae family (Correll & Correll, 1982; Batianoff & Butler, 2003). Introduced as an ornamental plant in several countries including Sri Lanka, it has become naturalized and has been reported to be invasive in many countries (Oviedo-Prieto & González-Oliva, 2015) but so far not in Sri Lanka. *Dolichandra unguis-cati* is native to the tropical dry forests in Central America, South America (from Mexico to Brazil to northern Argentina) and the West Indies (Acevedo-Rodríguez, 2005). This species has been commercialized as an ornamental plant due to its showy flowers, and as a result now be found in Asia, Africa, Europe, Australia and many islands in the Pacific Ocean (King & Dhileepan, 2009).

Dolichandra unguis-cati creeper often invades forested and riparian plant communities and makes those habitats much more vulnerable to be invaded by other species of weed (PPQ, 2019). Though invasive in nature and being enlisted as an invasive species in many countries, *D. unguis-cati* has ecological importance as it is a nectar source for many pollinators. The flowers are visited and pollinated by insects (Acevedo-Rodríguez, 2005). One of the major pollinators are honeybees. Bees are often attracted to open or flat tubular flowers that contain significant amounts of pollen and nectar. The fragrance of flowers along with the bright colors may lure bees in (Downey & Turnbull, 2007). To our knowledge, no study has been conducted related to the honey production prospects of *D. unguis-cati* and further its positive impact on pollinators as a food source.

The nectar within a flower will differ from species to species. However, a variation can also be seen among flowers of the same species. Even within the same species the quality and quantity of nectar secreted can vary according to the age of the flower, length of the season, precipitation, temperature, and the duration of the day. Therefore, it is important to note the temperature when collecting nectar samples from bee plants. The honey production potential is based on the nectar secretion dynamics of a flower (Crane et al., 1984). Determination of the honey production potential of bee plants is very important to estimate the honeybee colony carrying capacity of a given site (Al-Ghamdi et al., 2016), which can be used as an indicator to show the positive impact on pollinators.

MATERIALS AND METHODS

Study area and blooming pattern

The experiment was carried out in the mid country wet zone, Sri Lanka (7.2549° N, 80.5974°E) in the garden of the University of Peradeniya. The survey area was approximately 784,619 m^2 (193 acres) The study was conducted from March to April 2023 to cover the major blooming season of *D. unguis-cati* in Sri Lanka.

Estimation of number of flowers per plant

The mean blossom density was estimated using digital photographs and Photoshop following the pixel counting method as proposed by Dogan et. al. (2018) with modification.

Collection of flowers

Flowers were collected from the same vine on which visiting of pollinators were prominent. Several other vines were observed to analyze the bloom and development

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stages of the flowers. The flowers were covered with a fine mesh to prevent visitors and were collected over three separate time durations to observe the fluctuation of nectar secretion throughout the day. Accordingly, flowers were collected during the following time periods; morning (8.30-9.30am), afternoon (12.30-1.30pm) and evening (3.30-4.30pm). In each time period more than 100 flower samples were collected randomly. Flowers were plucked in such a way that the sepals were intact with the flower. Flowers were collected in the blooming period in March 2023 at three time periods.

Nectar extraction

The sepals of the flowers were removed, and the petals were cut off as nectar glands were present in the bottom of the flower to prepare the flower samples for nectar extraction, The flower was placed within the 1.5ml tube in such a way that the nectar glands were facing the bottom of the tube. A mesh was then placed to hold back the flower from soaking in the nectar during the centrifuging process. Samples were then centrifuged at 1000rpm for 1 minute at room temperature.

Quantification of nectar and brix value

After centrifuging, the collected nectar was quantified using a micropipette (p10; Nichipet) (Layek et. al., 2020.) and stored at -80°C until further studies. Samples were taken to determine the brix value using the digital refractometer to measure the refractive index of the solution to calculate the soluble solid concentration.

Estimation of sugar level

Pry-Jones & Corbet's (1987) equation was used to convert sucrose concentration to density, and Dafni's (1992) equation was used to compute the amount of sugar based on the nectar's volume, concentration, and sucrose density. Most refractometer values are provided as milligrams of sugar per 100 mg of solution and are stated as sucrose equivalents. By converting the observed sucrose equivalent to g/liter and multiplying this value by the nectar volume, they were transformed into milligrams of sugar per flower (Bolten et al., 1979).

Estimating the honey production potential (HPP) and optimum honeybee colony carrying capacity (HCCC)

The honey production potential of a given plant was assessed using the following equation which was modified from Bareke and Addi, 2022. Typical moisture content and sugar in honey are 18% and 82% for 1 kg (Bareke and Addi, 2022) and those were used to convert the average amount of sugar delivered per area per flowering season into honey. Thus, the sugar was used to estimate the amount of honey that can be produced by a given plant.

Average sugar amount per plant = Average amount of flower heads per plant × average amount of sugar per flower×Nectar secretion duration (in days)

Bareke et al., (2021) showed that HCCC for different management practices in beekeeping can be calculated. Since our intention was to find the natural HCCC we modified the same equation as follow.

HCCC= Expected potential honey yield per area ÷ Average honey yield of a natural hive

To measure the HCCC of modern movable hives as a potential in migratory beekeeping, the same equation was used with the assumption that the 8 kg honey yield can be obtained from a modern movable beehive maintained in mid country area in Sri Lanka. It was also assumed that for every 1 kg of harvestable honey, bee colonies may consume 1 kg of honey to fulfill nutrient requirements of maintenance and reproduction (Al-Ghamdi et al., 2016).

Data analysis

The collected data was analyzed using descriptive statistic and one-way ANOVA in Prisam Graphpad 8. Turkey test was used for mean separation among the treatments

RESULTS AND DISCUSSION

Characterization of *D. unguis-cati* flower

In mature plants, leaves are opposite along the plants, each with two pamphlets, oval shaped and 5-15 cm long (Figure 1). The yellow flowers can grow singly or in groups of two or three, and their diameter ranges from 4 to 5 cm. The bloom was observed for a course of five days. Their narrow, trumpet-shaped calyx is one to two centimeters long. They also have tubular corollas that range in length from 4 to 10 cm (Figure 2). The corolla's five lobes are all different sizes.

Nectar volume and brix value

The highest nectar volume and concentration were significantly different (ANOVA, $p<0.0001$) at different times of the day. The highest mean nectar volume (14.48 µl) was observed during the morning hours (8.30-9.30 am) followed by noon (12.30 pm) and evening (3.30 pm) (Figure 3 a). The mean brix value of the nectar collected in the evening was significantly lower than the nectar collected in the morning and noon (Figure 3 b).

For the majority of plant species, the nectar volume takes noteworthy values during the early hours of the day due to the high moisture and low temperature of the surrounding area. Nevertheless, due to the differences in flower morphology, for some plant species high nectar volumes can be observed at maximum humidity and temperature as well. Nectar volume and solute concentration can also be influenced by the weather conditions of the environment. Therefore, we measured the temperature and RH related to flower collection (Table 1).

Honey production potential (HPP) and optimum honeybee colony carrying capacity (HCCC)

The mean blossom density per square meter was 324 and 154,700 per vine. Each flower was observed to provide nectar for at least four days. The mean amount of sugar per flower was 6.3 mg (ranging from 0.1-10.3 mg). The average mass of sugar produced per plant was estimated to be 3.94 kg. Given the stranded moisture content of 18% (wt/wt), the mean mass of honey produced by a single tree in a season can be calculated as 4.58 kg. Therefore, under the conditions of the experiment conducted the HPP per

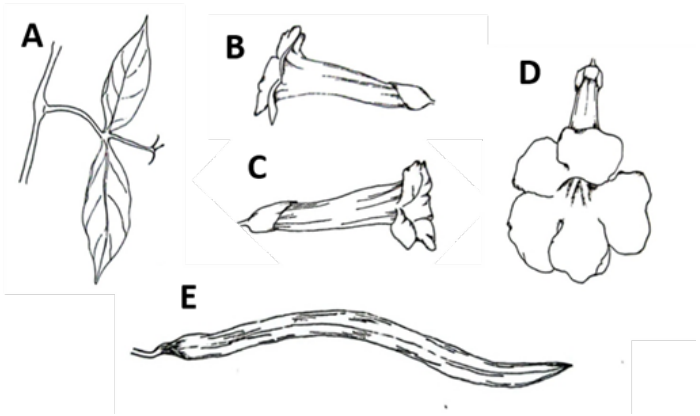


Figure 1: Different parts of the *Dolichanra unguis-cati* flower. A. Leaflets and tendrils of *Dolichandra unguis-cati*. B. Side view of flower. C. Side view of flower. D. Top view of flower. E. Fruit.

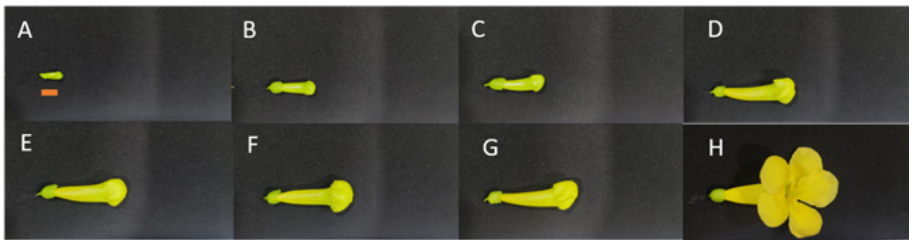


Figure 2: Development stages of Dolichandra unguis-cati flower. Flowers were collected to denote the floral development stages in 8 levels from bud to flower. Considering the increase in length (l) of the flower during development; l A=1.5cm, l B=3.3cm, l C= 3.4cm, l D=5.3cm, l E=5.4cm, l F=5.7cm, l G=5.8cm, l H= 8.7cm. The diameter of the fully grown flower ranges from 4 - 5 cm whereas the diameter of the bud ranges from 1 -2 cm. (The orange line denotes 1cm).

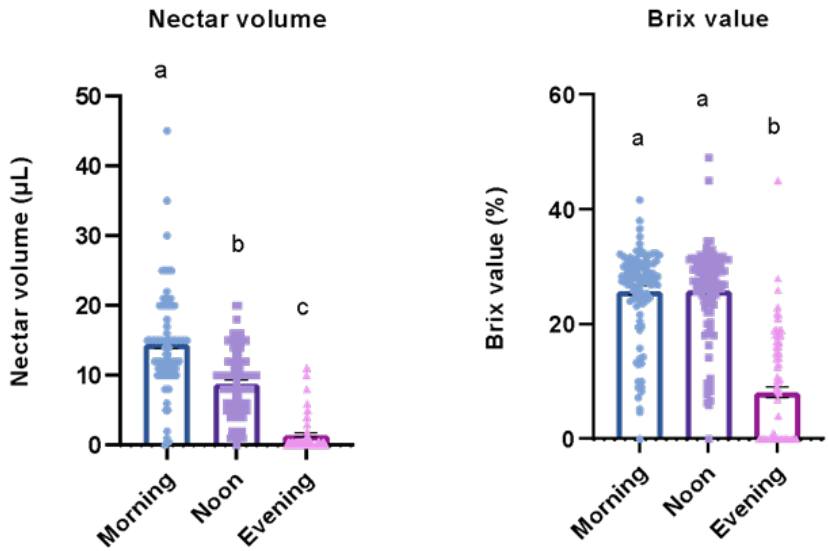


Figure 3: Quantification of nectar and estimation of Brix value of *D. unguis-cati* a) Nectar was quantified in 1.5ml tubes using micropipettes whereas Brix value was determined using the digital refractometer. A significant difference can be seen in the nectar volumes throughout the day (ANOVA, $p<0.0001$). b) However, the brix values for the flowers during morning and noon time periods are similar to each other (ANOVA, $p<0.0001$). Mean separation was done using Turkey's test.

Table 1: Mean nectar volume (µl) and concentration (Brix) per each collecting time. Temperature (°C) and relative humidity (RH as a %) at different collecting times also provided in the table.

Time	Temperature (°C)	RH (%)	Volume (µl)	Mean concentration (Brix)
8.30 am	27.0	79%	14.48	25.78
12.30 pm	28.5	75%	8.810	25.90
3.30 pm	28.0	76%	1.450	8.051

plant was 4.58 kg while the estimated HPP at the studied location (University of Peradeniya) would be between 77 – 125 kg. This provided a HCCC value of 15 – 25. Based on the maximum HPP of the area, the optimum number of honeybee colonies to be introduced during the flowering period can be eight modern movable hives.

DISCUSSION

To our knowledge, this is the first attempt to understand the nectar secretion potential of the plant *D. unguis-cati.* During the flowering season, we observed high bee visitation to this plant in the studied area. The average sugar production per flower was 6.3 mg and the average mass of sugar produced per plant was 2.96 kg. Since the *D. unguis-cati* plants were scattered in the garden, it was not possible to measure the sugar and honey production potential per given area. Therefore, we measured the total potential sugar production in the experiment sit (garden of University of Peradeniya) based on the physical survey of *D. unguis-cati* plants during 27th to 31 March 2023 in area of around 193 acres. The total number of *D. unguis-cati* plants was considered to be 27 by rounding up different sized plants to one reference plant (a vine with around 154,700 blossoms).

We characterized the floral morphology and the nectar secretion of *D. unguis-cati* to understand the nectar secretion potential of the plant. *D. unguis-cati* is a seasonal plant that shows a bloom from spring to summer (March -April) producing a bright yellow color, funnel shaped flower with 5 petals (Henderson, 2001). Flowers can grow alone or in 2 or 3 groups. The fully bloomed flower has a diameter of 4-5 centimeters. The calyx is green and about 1-2 centimeters long. Corolla is tubular with a length of 4 to 10 centimeters and of a brilliant yellow color. Fruits are brown, flattened 25-centimeter-long, woody capsules with two membranous wings where 100 -200 seeds are contained in each. Leaves are opposite, 2 foliate, with a terminal tendril generally of short duration. (Acevedo-Rodríguez, 2005).

The HCCC values for the natural honeybee colonies were 15-25. Which indicates that in the given period in the given area a massive number of honeybees could have survived. The availability of plenty of nectar during the period could open an avenue for migratory beekeeping. Migratory beekeeping refers to locating beehives in different parts of the country depending on food availability. This can maximize the honey production. Eight modern movable hives could be introduced to the said area and the expected harvestable honey yield from eight hives would be 64 kg. Given the market price of honey (Rs 2000-3000 per kg), this indicates how much this plant is economically valuable in terms of honey production.

CONCLUSION

Dolichanra unguis-cati is an iconic flowering vine at the gardens of the University of Peradeniya, which mostly blooms in March-May. The vine is heavily criticized as an invasive plant with a threat to the local fauna and flora. We studied the honey production potential (HPP) as well as the Honeybee Colony Carrying Capacity (HCCC) which shows that the heavily criticized plant is in fact a major feeding source for foraging bees. Therefore, *D. unguis-cati* provides a safe ground for honeybees that play an important role in maintaining biodiversity. This study solely focused on the nectar and honey production potential and any other effects on local fauna and flora have not been evaluated.

ACKNOWLEDGEMENT

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DECLARATION OF CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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