

# The effect of different beehives on the activity of foragers, honey pots number and honey production from stingless bee *Tetragonula* sp.

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## Abstract

*Tetragonula* sp. is one of stingless bee species nesting in bamboos hive and produced honey, bee bread, and propolis. The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume in each pot, and production of honey from stingless bee *Tetragonula* sp. Thirty colonies of stingless bee *Tetragonula* sp. from bamboo hives were divided into two groups: bamboo and box hives, each group consisted of 15 colonies. The colonies were transferred in the night to avoid stress in the bees consisting of a queen bee, foragers, drones, and brood cells. The colonies were beekeeping one-month in Sukadana Bee Village, North Lombok, Indonesia.

The exit activity in the morning and afternoon of foragers from stingless bee *Tetragonula* sp. in the box hives was higher than in bamboos hive. The honey pots number, honey volume in each pot, and honey production (big, medium, and small pots) in box hives were higher than in bamboo hives.

**Keywords:** bamboo hive, box hive, bee village, nectar

## Introduction

The stingless bees include tropical bee groups. In the world, more than 500 species have been identified and possibly more than 100 species unidentified (Michener 2013). In Indonesia, the stingless bees ( *tribe Meliponini*) are at least 46 species (Kahono et al 2018) and mostly found nesting in bamboos, sugar palm stalks, tree trunks or woods, and in the ground (Agussalim et al 2015). One of the stingless bee species that can be found in Indonesia is *Tetragonula* sp. that is nesting in a bamboo (Agus et al 2019a; Agussalim et al 2019). Stingless bee *Tetragonula* sp. can be producing honey, bee bread, and propolis like *Apis mellifera*, but the honey production is generally lower than honey production from all of honeybees from *Apis* genus. In addition, the stingless bees are much more in propolis production. Honey is a natural food made from the nectar collected by worker bees or foragers from plant flowers (floral nectar), extrafloral nectar, and honeydew with adding enzymes (Codex Alimentarius 2001; Sihombing 2005).

In North Lombok, West Nusa Tenggara, Indonesia mostly beekeepers are using box and bamboo as the hive for stingless beekeeping, but the information about the honey production from each beehive is not available. Agussalim et al (2017) reported that honey production from stingless bee from genus of *Tetragonula* that origin from Genggelang North Lombok that domesticated from sugar palm stalks to various sizes of beehives using box hives ranged from 49.2 to 66.6 ml after beekeeping for two months. Although it has been performed a study about honey production of stingless bee *Tetragonula* sp., the different sources of habitat from the stingless bee, different locations for beekeeping, and the type of hive will be influencing the activity of bees and honey production. The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume in each pot, and production of honey from stingless bee *Tetragonula* sp.

## Materials and methods

### Colony transfer

Thirty colonies of stingless bee *Tetragonula* sp. from bamboo hives colonies were adapted for one week in the Sukadana Bee Village, Bayan, North Lombok, Indonesia. The colonies were divided into two groups and each group consisted of 15 colonies. The first group was box hive with size 40 x 20 x 15 cm and the second group was bamboo hive with the length 30 to 40 cm and diameter 7 to 8 cm. Thirty colonies of stingless bee *Tetragonula* sp. from bamboos were transferred to box and bamboo hives were performed in the night to avoid stress in the bees. The colonies were transferred consisted of a queen bee, workers (foragers), drones, brood cells, and then all colonies were beekeeping for one-month in Sukadana Bee Village.



**Figure 1.** The colonies of stingless bee *Tetragonula* sp. from bamboo hives



**Figure 2.** The colonies of stingless bee *Tetragonula* sp. from box hives

### Temperature and humidity environment

The temperature and humidity environment were measured every day for one-month using thermo-hygrometer in the morning (08:00 am) and in the afternoon (4:00 pm).

### Honey production

Honey production of stingless bee *Tetragonula* sp. was measured after beekeeping one month. In brief, honey was harvested from boxes and bamboos with cutting the propolis as the construction in the box walls, then the honey was placed in the plastic bottles. Furthermore, honey was squeezed using hand to separate honey from cerumen or propolis, then honey was measured by graduated cylinders. The predominant plant types as the source of nectar to produce honey also were identified at a maximum distance of 200 meters.

### Daily activity of foragers

The daily activity of the foragers was counted every day for one month i.e. the exit activity from hives was counted using hand counter check. The exit number of foragers from hives was counted by standing in front of the hive entrance at a distance 1 meter for 5 minutes each hive and was performed in the morning (08:00 am) and in the afternoon (4:00 pm).

### Honey pots number

The pots number was counted after beekeeping one month and were divided into three categories: big pots (diameter mean was 1.1 cm), medium pots (diameter mean was 0.7 cm), and small pots (diameter mean

was 0.4 cm). The boxes and bamboos hives were opened and then the number of honey pots was counted in the night equipped with lighting. In addition, the production of honey from each honey pot was aspirated using a syringe 1 ml and the honey volume in each pot was measured.

## Statistical analysis

The data of honey production, exit activity of foragers, honey pots number, and honey volume each pot from stingless bee *Tetragonula* sp. were analyzed by T-test, and the temperature and humidity environment were analyzed by descriptive analysis using SPSS statistics version 23.

## Results and discussion

### Temperature and humidity environment

The results showed that the environment temperature in the Sukadana Bee Village, North Lombok ranged from 25.0 to 26.1°C in the morning, while in the afternoon was ranged from 28.6 to 30.4°C. The environment humidity ranged from 68.0 to 74.4% in the morning, while in the afternoon was ranged from 57.9 to 64.9% (Table 1). The temperature and humidity environment in the Sukadana Bee Village, North Lombok was including the normal temperature and humidity required by stingless bees for optimal productivity.

**Table 1.** The mean of temperature and humidity environment every week in the Sukadana Bee Village, North Lombok

Weeks	Temperature (°C)		Humidity (%)	
	Morning	Afternoon	Morning	Afternoon
First	25.1	28.6	74.7	63.9
Second	25.7	30.4	68.0	61.3
Third	26.1	29.1	68.4	64.9
Fourth	25.0	30.1	69.9	57.9

The environment temperature required by the bees to collect food was ranged from 5 to 45°C and if under or above it, decrease the activities of honeybees and even until death (Abrol 2011). The elevated temperatures and the concomitant lack of water during dry periods can be induced absconding in stingless bees (Maia-Silva et al 2015). Heard and Hendrikz (1993) explained that the temperature was a significant effect on the flight activity of stingless bee *Trigona carbonaria*, but not consistent on relative humidity. The temperature threshold to activity was ranged from 18 to 19°C. The peak activity of *T. carbonaria* was ranged from 26.1 to 29.8°C with humidity relative 35 to 90%. The temperature and humidity in the study was differ from those previously reported (Agussalim et al 2015) for *Trigona* sp. (*Tetragonula* sp.) and Heard and Hendrikz (1993) for *T. carbonaria*.

### Daily activity of foragers

The results showed that the exit activity from hives by foragers in box hive in the morning was higher than the exit activity in bamboo hive (50.1 versus 36.6 heads/5 minutes) and in the afternoon (29.3 versus 25.3 heads/5 minutes) (Table 2). In addition, the exit activity from hives by foragers in the morning was higher than in the afternoon for bamboos hive (36.6 versus 25.3 heads/5 minutes) and boxes hives (50.1 versus 29.3 heads/5 minutes) (Table 2). That the exit activity from boxes hives was higher than bamboos hives might be the foragers in the boxes must gather more materials to build the nest and be creating comfort conditions than bamboos hives. In addition, it also might be affected by the foragers and brood cells number, and the productivity of the queen bee, but in our study this was not measured.

**Table 2.** The mean of exit activity of foragers stingless bee *Tetragonula* sp. from bamboos and boxes hives

Observation time	Bamboos hive (heads/5 minutes)	Boxes hive (heads/5 minutes)	SEM	<i>p</i>
Morning (08:00 am)	36.6 <sup>bx</sup>	50.1 <sup>ax</sup>	0.47	<0.001
Afternoon (4:00 pm)	25.3 <sup>by</sup>	29.3 <sup>ay</sup>	0.22	<0.001

<sup>a,b</sup> Different superscripts within rows indicate differences at  $p < 0.05$

<sup>x,y</sup> Different superscripts within column indicate differences at  $p < 0.05$

The exit activity of foragers stingless bee *Tetragonula* sp. in the morning was higher than in the afternoon because in the morning very abundant blooming flowers as the food source like nectar (raw material to produce honey) and pollen (raw material to produce bee-pollen or bee bread), and resin (raw material to produce propolis or cerumen or geopropolis). The exit activity from stingless bee *Tetragonula* sp. in this study was different from those previously for stingless bee *Tetragonula laeviceps*, *Heterotrigona itama*, and *Lepidotrigona terminata* (Atmowidi et al 2018), for *T. laeviceps* (Agus et al 2019b; Gadhiya and Pastagia 2019), and for *Trigona* sp. (*Tetragonula* sp.) (Agussalim et al 2015). The different daily activity from each stingless bee was affected by the different stingless bee species, geographical origin (related to temperature, humidity, light intensity, wind velocity), foragers and brood cells number.

### Honey production

The results showed that the honey pots number after beekeeping one month from box hive was higher than from bamboo hive for all of the honey pots size 18.1 versus 8.27 pots for big pots, 25.8 versus 16.3 pots for medium pots, and 26.8 versus 17.6 pots for small pots (Table 3). The honey pots number was higher in the box hive and was affected by the good development of colonies from boxes such as brood cells and foragers number that impacted on the higher exit activity from the hive by foragers in box hive than in bamboos hive (Table 3).

**Table 3.** The mean of honey pots number from stingless bee *Tetragonula* sp. after beekeeping one-month

Honey Pots Number	Bamboos hive (pots)	Boxes hive (pots)	SEM	<i>p</i>
Big	8.27 <sup>b</sup>	18.1 <sup>a</sup>	1.11	0.00
Medium	16.3 <sup>b</sup>	25.8 <sup>a</sup>	1.34	0.00
Small	17.6 <sup>b</sup>	26.8 <sup>a</sup>	1.53	0.00

<sup>a,b</sup> Different superscripts within rows indicate differences at  $p < 0.05$

The foragers in the box hive very were active to collect nectar from plant flowers and resin from plants than from bamboo hive was shown by the higher exit activity of foragers (Table 2). In addition, the volume from boxes hive was higher for *Tetragonula* sp. than bamboos hive volume for which was smaller, thus allowing the colonies in box hives to develop properly. The volume each honey pot from box hive was higher than bamboo hive for all of the honey pots sizes: 0.37 versus 0.32 ml for the big pot, 0.28 versus 0.25 ml for the medium pot, and 0.18 versus 0.14 ml for the small pot (Table 4). The higher honey volume each pot from box hive might be related to the ability of workers to produce the big pot and the foragers very active to collect nectar and resin from plants was shown by the higher exit activity of foragers in box hives than in bamboos hive (Table 2).

**Table 4.** The mean of honey volume each pot from bamboos and boxes hives by stingless bee *Tetragonula* sp

Honey volume (mL)	Bamboo hive	Box hive	SEM	<i>p</i>
Big pot	0.32 <sup>b</sup>	0.37 <sup>a</sup>	0.01	0.01
Medium pot	0.25 <sup>b</sup>	0.28 <sup>a</sup>	0.01	0.02
Small pot	0.14 <sup>b</sup>	0.18 <sup>a</sup>	0.01	0.01

<sup>a,b</sup> Different superscripts within rows indicate differences at  $p < 0.05$

The honey production of stingless bee *Tetragonula* sp. from boxes hive was higher than from bamboo hive for all of the honey pots were 6.68 versus 2.65 ml for the big honey pot, 7.22 versus 4.07 ml for the medium honey pot, and 4.82 versus 2.46 ml for the small honey pot (Table 5). The honey production in Sukadana Bee Village was supported by plants as the source of nectar were longan, banana, mango, cashew, sunflowers, start fruit, bilimbi, coconut, calliandra, Jamaica cherry, papaya, and cassava. The plants have different times for flowering and blooming, but they support each other.

**Table 5.** Honey production of stingless bee *Tetragonula* sp. for one-month beekeeping in Sukadana Bee Village, North Lombok

Honey production (mL)	Bamboos hive	Boxes hive	SEM	<i>p</i>
Big pot	2.65 <sup>b</sup>	6.68 <sup>a</sup>	0.43	0.00
Medium pot	4.07 <sup>b</sup>	7.22 <sup>a</sup>	0.39	0.00
Small pot	2.46 <sup>b</sup>	4.82 <sup>a</sup>	0.29	0.00

<sup>a,b</sup> Different superscripts within rows indicate differences at  $p < 0.05$

The higher honey production in box hive than bamboo hive was affected by the higher exit activity of foragers in the box hive than bamboo hive in the morning and afternoon (Table 2) that impacted on much more nectar and resin has been collected by foragers to produce honey and propolis. Furthermore, the nectar and resin much more will impact the increase of honey pots number (Table 3).

Production of honey from stingless bee *Tetragonula* sp. in this study (Table 5) was differ from reported by Agussalim et al (2017) for stingless bee *Trigona* sp. (*Tetragonula* sp.). The difference of honey production with this study was affected by the plant types as the food source, the bee species which involved in honey production, the daily activities of foragers especially when collecting nectar, and resin from plants and also foragers number. In addition, in Sukadana Bee Village was the center for research, development, empowerment, and community service to poverty alleviation and livelihood security of communities, especially beekeepers in North Lombok Regency, West Nusa Tenggara Province, Indonesia. Thus, in the future is required advanced study about the roles of stingless bee keeping on the income of beekeepers and poverty alleviation in communities.

## Conclusions

- The exit activity of hives from stingless bee *Tetragonula* sp. foragers in the box hives was ranged from 29.3 to 50.1 heads/5 minutes and ranged from 25.3 to 36.6 heads/5 minutes for bamboo hive
- The honey pots number from stingless bee *Tetragonula* sp. in box hive after beekeeping one-month were 18.1 pots (big pot), 25.8 pots (medium pot), 26.8 pots (small pot), and 8.27 pots (big pot), 16.3 (medium pot), and 17.6 pots (small pot) for bamboos hive
- The honey volume of stingless bee *Tetragonula* sp. from box hive in each pot were 0.37 ml (big pot), 0.28 ml (medium pot), 0.18 ml (small pot), and 0.32 ml (big pot), 0.25 ml (medium pot), and 0.14 ml (small pot) for bamboos hive
- The honey production of stingless bee *Tetragonula* sp. after beekeeping one-month in box hive were 6.68 ml (big pot), 7.22 ml (medium pot), 4.82 ml (small pot) and 2.65 ml (big pot), 4.07 ml (medium pot), and 2.46 ml (small pot) for bamboos hive

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