Propolis mixture production and foragers daily activity of stingless bee *Tetragonula* sp. in bamboo and box hives

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Abstract

The objectives of present study were to determine the foragers exit activity, propolis weight, and propolis mixture production from honey pots and bee bread pots of stingless bee *Tetragonula* sp. from different beehives. In this study was used 30 colonies of *Tetragonula* sp. obtained from bamboo hives and divided into 2 groups (each 15 colonies) consisted of box hives with size 40 x 20 x 15 cm and bamboo hives with diameter was 8 cm and length was 50 cm. The colonies were transferred from natural hives to box and bamboo hives were done at night consisted of a queen bee, workers, drones, and brood cells. The variables were measured consisted of the exit activity of foragers, propolis weight, and propolis mixture production from stingless bee *Tetragonula* sp. Afterwards, all the colonies were meliponiculture for thirty days. The present results showed that the exit activity of foragers, propolis weight, and propolis mixture production from honey pots and bee bread pots (big, medium, small, and total production) from stingless bee *Tetragonula* sp. was higher in box hives than in bamboo hives ($p<0.01$).

Keywords: *bamboo hive, box hive, foragers, meliponiculture, nectar*

Introduction

The stingless bees number in the world that have been identified are 500 species and unidentified are minimum 100 species (Michener 2013). The number of stingless bees species in Indonesia are minimum 46 species from the genus (*tribe*: *Meliponini*) *Austroplebeia* Moure, *Geniotrigona* Moure, *Heterotrigona* Schwarz, *Homotrigona* Moure, *Lepidotrigona* Schwarz, *Lisotrigona* Moure, *Papuatrigona* Michener and Sakagami, *Pariotrigona* Moure, *Tetragonula* Moure, and *Wallacetrigona* Engel and Rasmussen (Kahono et al 2018). Stingless bees consist of three castes are a queen, workers, and drones and each caste have a different work i.e. a queen to produce eggs, drones to mating a young queen, and workers to perform all of the tasks inside the hive (building nest construction, caring brood cells, to produce honey, bee bread, propolis). Furthermore, in the outside of hives the tasks of workers such as collecting nectar, water, pollen, resin, and other materials that are required to build a nest (Michener 2013).

Indonesia, especially in North Lombok Regency is mostly found in the stingless bees species create a nest in bamboos, sugar palm stalks, and tree or woods (Erwan et al 2020; Agussalim et al 2015). One of the stingless bee species is *Tetragonula* sp. that can produce honey, bee bread, and propolis. Erwan et al (2020) reported production of honey from stingless bee (*Tetragonula* sp.) in box hives for big, medium, and small pots are 6.68 ml, 7.22 ml, and 4.82 ml, respectively. Furthermore, in bamboo hives is 2.65 ml, 4.07 ml and 2.46 ml for each big, medium, and small pots, respectively after four weeks meliponiculture. In addition, the propolis mixture production from honey pots of stingless bee *Tetragonula* sp. in various beehives ranged from 18.20 to 30.08 g after meliponiculture for two months. Furthermore, production of propolis from stingless bee *Tetragonula laeviceps* is 15.4 to 77.2 g after 4 months meliponiculture (Agussalim et al 2020), but the information of propolis mixture production each pot from honey pots and bee bread pots is lacking. Therefore, the objectives of present study were to determine the foragers exit activity, propolis weight, and propolis mixture production from honey pots and bee bread pots from different beehives.

Materials and methods

Transfer of colony

The stingless bee (*Tetragonula* sp.) as much 30 colonies obtained from bamboos were adapted one week before domesticated and divided into 2 groups each 15 colonies for bamboo and box hives. The bamboo hive volume was 2,514 cm^3 (length was 50 cm and diameter was 8 cm), while the box hive volume was 12,000 cm^3 (length was 40, width was 20, and height was 15 cm). The colonies were transferred to bamboo and box hives were a queen bee, workers, drones, and brood cells and then meliponiculture for thirty days. In addition, the workers number was not counted because very difficult to count them in the night.

Figure 1. The box hive and bamboo hives was used in the study

Foragers daily activity

The daily activity was measured was exit activity of foragers from the hive was counted using hand counter check every day for thirty days. The exit activity of foragers was counted at distance 1.5 meter from the hive entrance (5 minutes/hive) was done in the morning at 08:00 am and in the afternoon at 04:00 pm.

Plant types for resin sources

The plant types as the resin sources as the raw material to produce propolis by workers *Tetragonula* sp. was identified with checking the availability of resin from living plants was characterized by sticky material from wound plants.

Propolis weight

Propolis weight consists of propolis from the honey pot and bee bread pot. The propolis from each pot was divided in three categories were big pot (diameter was ranged from 0.9 to 1.3 cm), medium pot (diameter was ranged from 0.6 to 0.8 cm), and small pot (diameter was ranged from 0.3 to 0.5 cm). Propolis from each honey pot and bee bread pots were taken one pot sample and then weighed using a digital scale.

Propolis mixture production

Production of propolis from the stingless bee *Tetragonula* sp. were propolis from the honey pot and bee bread pot after meliponiculture for thirty days. In brief, propolis from each pot was harvested with cutting the propolis in the base as the nest construction and cleared from honey and bee bread. Afterwards, the clean propolis was placed in plastic and then weighed using a digital scale. The plants as the resin source to produce propolis were identified with checking availability of resin from living plants wound. The describe of colony of stingless bee *Tetragonula* sp. was shown in Figure 2 and 3.

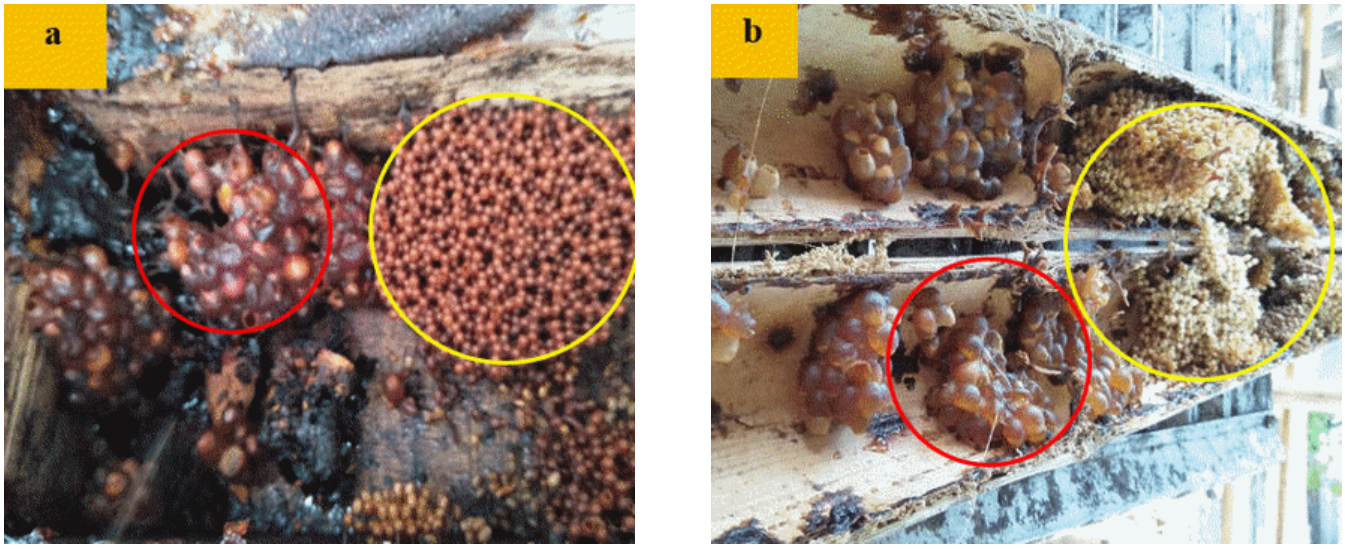

Figure 2. The description of colony from stingless bee *Tetragonula* sp. in each hive
(a. box hive, b. bamboo hive, red circle was honey pots, and yellow circle was brood cells)

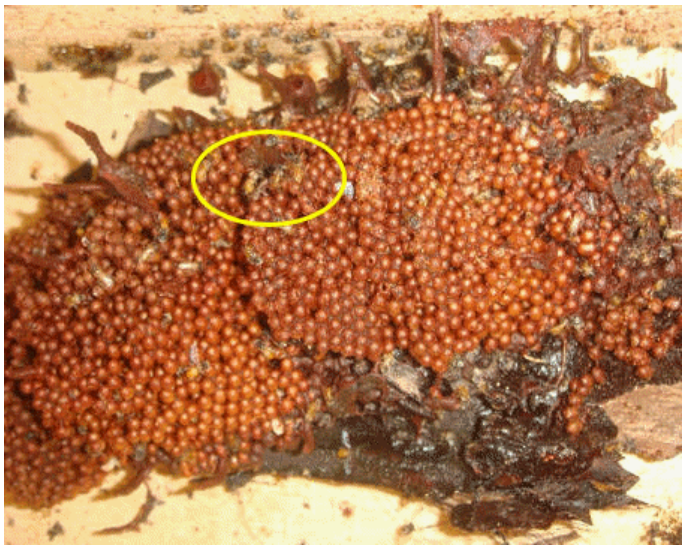

Figure 3. The stingless bee *Tetragonula* sp. was characterized by the abdomen is yellow color (inside yellow circle)

Statistical analysis

The data production of propolis, propolis weight each pot, the foragers exit activity of stingless bee (*Tetragonula* sp.) were analyzed by independent-samples T-test using SPSS statistics version 23.

Results and discussion

Foragers daily activity

The present results showed that the foragers exit activity of stingless bee (*Tetragonula* sp.) in box hives every week was higher than in bamboo hives in the morning and afternoon. The foragers exit activity from box hives in the morning ranged from 49.2 to 51.3 heads in 5 minutes, while in the afternoon it ranged from 29.0 to 29.6 heads in 5 minutes. Furthermore, bamboo hives ranged from 34.7 to 37.5 heads in 5 minutes in the morning and ranged from 24.9 to 25.5 heads in 5 minutes in the afternoon. The foragers exit was higher in the box hives is affected by the workers number or their population in the hive especially foragers in the box hive might be much more than in the bamboo hive and consequently the exit activity of foragers also higher in box hive than in bamboo hive. The higher foragers exit activity in the morning related to the availability of resin from living plants might be much in the morning than in afternoon. In addition, Bankova et al (2000) explained that plants can be secreted substances actively and exuded wounds from plants like materials of lipophilic on leaves, mucilages, gums, resins, and lattices that were collected by foragers to produce propolis.

Table 1. Foragers exit activity from the hive of stingless bee (*Tetragonula* sp.) in bamboo and box hives

Time of observation (weeks)	Exit activity of foragers		SEM	*p*
	Bamboo hives (heads in 5 minutes)	Box hives (heads in 5 minutes)		
Morning at 08:00 am				
First	34.7^{bx}	49.2^{ax}	0.94	0.000
Second	37.3^{bx}	50.2^{ax}	0.91	0.000
Third	36.8^{bx}	51.3^{ax}	0.98	0.000
Fourth	37.5^{bx}	49.8^{ax}	0.93	0.000
Afternoon at 04:00 pm				
First	24.9^{by}	29.6^{ay}	0.46	0.000
Second	25.4^{by}	29.2^{ay}	0.44	0.000
Third	25.5^{by}	29.4^{ay}	0.45	0.000
Fourth	25.2^{by}	29.0^{ay}	0.44	0.000

^{a,b,x,y} *Different superscripts within rows and columns indicate differences at $p<0.05$*

The foragers exit activity of stingless bee (*Tetragonula* sp.) (Table 1) was differ with previous study for the species of stingless bees were *Tetragonula laeviceps* (Agus et al 2019; Gadhiya and Pastagia 2019; Atmowidi et al 2018), *Heterotrigona itama*, and *Lepidotrigona terminata* (Atmowidi et al 2018), *Tetragonula* sp. (Erwan et al 2020; Agussalim et al 2015), and *Trigona carbonaria* (Heard and Hendrikz 1993). The different exit activity from the hive is affected by the different species of stingless bees, environment conditions (temperature, humidity, and light intensity). Furthermore, affected by the number of workers especially the foragers number.

Propolis weight

Propolis is a sticky dark material that collected by honeybees or stingless bees from wound of living plants and then mix with wax to construct their nest (Bankova et al 2000). Propolis is made from resins or balsams is 45 to 55%, waxes and fatty acids is 25 to 35%, essential oils is 10%, pollen is 5%, and other organics and minerals is 5% (Cherbuliez 2013). The present results showed that propolis weight for one-pot from honey pots and bee bread pots in box hives were higher than propolis weight from bamboo hives (Table 2).

Table 2. Propolis weight each pot for one-pot (big, medium, and small pots) from honey pots and bee bread pots of stingless bee *Tetragonula* sp.

Propolis weight	Bamboo hives (g)	Box hives (g)	SEM	*p*
Honey pots				
Big	0.14[b]	0.17[a]	0.006	0.005
Medium	0.08[b]	0.10[a]	0.004	0.003
Small	0.05[b]	0.07[a]	0.003	0.001
Bee bread pots				
Big	0.13[b]	0.17[a]	0.007	0.016
Medium	0.08[b]	0.10[a]	0.003	0.017
Small	0.06[b]	0.08[a]	0.002	0.001

[a,b] *Different superscripts within rows indicate differences at p<0.05*

Propolis weight each pot from honey pots in box hives compared with bamboo hives were 0.17 g versus 0.14 g (big pot), 0.10 g versus 0.08 g (medium pot), and 0.07 g versus 0.05 g (small pot). Furthermore, 0.17 g versus 0.13 g (big pot), 0.10 g versus 0.08 g (medium pot), 0.08 g versus 0.06 g (small pot) for propolis weight from bee bread pots. The higher propolis weight in box hives than bamboo hives might be affected by the workers number in box hives much more than workers number in bamboo hives that impact the number of resins can be collected by foragers is much more. Propolis weight for each pot (big, medium, and small) from honey pots and bee bread pots in the same hives were similar, it might be the same species did not affect the pot size and propolis weight. The size and weight of propolis are affected by the different species of stingless bees, the exit activity from the hives that are involved in collecting resin, and the availability of resin from living plants (Agussalim et al 2015).

Propolis mixture production

The present results showed that production of propolis from honey pots and bee bread pots was higher in the box hives than in bamboo hives. Propolis mixture production from honey pots in box hives compared with bamboo hives was 3.08 g versus 1.08 g of a big pot, 2.52 g versus 1.29 g for a medium pot, 1.80 g versus 0.90 g for a small pot, and total production was 7.40 g versus 3.28 g. In addition, propolis mixture production from bee bread pots in box hives compared with bamboo hives was 1.28 g versus 0.87 g for a big pot (did not differ), 0.92 g versus 0.63 g for a medium pot, 0.97 g versus 0.54 g for a small pot, and total production was 3.16 g versus 2.04 g (Table 3). In addition, our study showed propolis mixture production from stingless bee *Tetragonula* sp. from honey pots much more or higher than in bee bread pots for each pot size.

The propolis mixture production from honey pots and bee bread pots in box hives was higher than bamboo hives because supported by the exit activity of foragers was higher to collect resin from plants living (especially from wound plant) in the morning and afternoon (Table 1). Furthermore, affected by number of workers and the availability of bee bread in the box hives might be much more than in bamboo hives, however in our study not measured. The bee bread is the main source of protein in the hive that required by the workers to produce royal jelly as the queen bee feed and consequently the productivity of queen bee is increases to producing eggs as the workers and propolis mixture production in box hives.

Table 3. Propolis mixture production each pot (big, medium, and small pots) from honey pots and bee bread pots of stingless bee *Tetragonula* sp.

Propolis mixture production	Bamboos hive (g)	Boxes hive (g)	SEM	*p*
Honey pots				
Big	1.08[b]	3.08[a]	0.21	0.000
Medium	1.29[b]	2.52[a]	0.16	0.000
Small	0.90[b]	1.80[a]	0.13	0.000
Total	3.28[b]	7.40[a]	0.45	0.000
Bee bread pots				
Big	0.87	1.28	0.12	0.082
Medium	0.63[b]	0.92[a]	0.07	0.044
Small	0.54[b]	0.97[a]	0.07	0.001
Total	2.04[b]	3.16[a]	0.16	0.000

[a,b] *Different superscripts within rows indicate differences at p<0.05*

This study indicates that *Tetragonula* sp. foragers collect much more resin to made honey pots than bee bread pots and will have an impact on the honey production is higher than bee bread production, however in our study is not measured. In addition, depend on requirement in the hive, for example if in the hive the honey is fulfilled, afterwards the foragers can be collecting pollen, water, and other materials that required to construct the nest or otherwise. Agussalim et al (2015) reported that various box hives with different volume is not affecting propolis mixture production of stingless bee *Tetragonula* sp., but in our study the different volume of hives (box and bamboo hives) is affecting the propolis mixture production might be the number of workers in both box and bamboo hives is different. The plant types as the resin sources were mango, cashew, and banana. Propolis mixture production of stingless bee (*Tetragonula* sp.) from honey pots and bee bread pots (Table 3) was differ from the previous study for stingless bee *Tetragonula* sp. (Agussalim et al 2015) and *Tetragonula laeviceps* (Agussalim et al 2020; Abduh et al 2020). The different propolis mixture production is affected by the different foragers exit activity, resin source from plants wound, the number of workers or foragers in the colony, and environment conditions (temperature, humidity, and light intensity) (Agussalim et al 2020).

Conclusions

- The volume of hives (box and bamboo hives) is affecting the exit activity of *Tetragonula* sp. foragers, propolis weight, and propolis mixture production in the morning and afternoon from the stingless bee *Tetragonula* sp.
- Propolis weight, propolis mixture production, and daily activities in the box hives is higher than in bamboo hives from honey pots and bee bread pots.

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