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Some Ecological Aspects of Little Honeybee (*Apis florea* F.) and Type of Sugar Contents in Honey in Northeast Thailand

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Abstract: This research was carried out at Khon Kaen and Maha Sarakham Provinces in northeastern region of Thailand. The work designed to investigate ecological locations and types of sugar in honey of Little Honeybee (*Apis florea* F.). The results showed that there were four types of ecological locations found, i.e. cropland and degradation forest, orchard farm, villages, and housing area of government's official. Five types of sugar contents in honey were found with majority of fructose followed by glucose, lactose, maltose, and least with sucrose. The highest amounts of sugar in honey were highest in June followed by February, December, January, March, September, April, October and November. All types of sugar had no effect on egg rate, worker, and drone cells except fructose where it had highly significant effect on number of queen cells. A range of 1-1.05 (g ml⁻¹) of total sugar had highly significant effect on number of queen cells, but with higher range number of queen cells was declined.

Key words: Little honeybee (*Apis florea* F.), fructose, glucose, lactose, maltose, sucrose, queen cell, worker cell, and drone cell.

INTRODUCTION

Little Honeybee (*Apis florea* F.) is well recognised as an important type of natural insect for honey production in most regions of Thailand. Villagers in most regions of Thailand have been using honey for their dietary food and markets for a number of years^[1,2]. It has been advocated that many people around the globe have been using honey of different species of bees as a source of medicinal sugar^[3], since honey contains different types of sugar, e.g., glucose, fructose, and sucrose. These types of sugar have been recognised as majority types of sugar in most of honey production. Some types of honey may contain a small amount of galactose, mannose, maltose and raffinose^[4]. Slansky and Rodriguez^[5] reported that honey can be classified into four categories based on sucrose/hexose value, i.e. if the value is smaller than 0.1 then this type of honey is classified into a hexose-dominant, if the value is ranged from 0.1-0.499 then it is classified as a hexose-rich, and a range of 0.5-0.999 for sucrose-rich. If the value is greater than 0.999 then it is classified as a sucrose-dominant. Wakhle and Desai^[6] reported that generally honey contains a certain amount of inhibin, a substance being produced from mandibular gland of honeybee. Inhibin has an important property in retarding growth of microorganisms such as bacteria and fungi.

The different types of sugar content in honey depended most on plant species and ecological

environments where bee colonies have inhabited^[7-9]. Honey production of Little Honeybee is relatively small compared with other types of bees such as *Apis mellifera*, *Apis cerana* and *Apis dorsata*^[10]. Although Little Honeybee (*Apis florea* F.) is familiar to villagers in most tropical and sub-tropical regions but data on this type of insect, particularly types of sugar and their ecological environments seem limited. Therefore, it is of important value to carry out research work on this particular type of honeybees for a better understanding and also for some economic values.

MATERIALS AND METHODS

This research work was carried out at Khon Kaen and Maha Sarakham Provinces, Northeast Thailand in 2000-2002 to search for some ecological information and types of sugar in honey of Little Honeybee (*Apis florea* F.) in relation to ecological environments. Four ecological environments were used, i.e. 1) cropping areas and degraded forests, 2) orchard farms, 3) village residences, and 4) government's residential areas. These four environments were the sites of Little Honeybee where they have built their combs and they are located in Khon Kaen and Maha Sarakham Provinces, Northeast Thailand. Most of the combs were attached to branches of mango trees followed by bamboo bushes, and trees of dipterocarp forest. The search for combs was carried out

by a survey through different locations with the use of species-area curves method and a blue print method for the determinations of individual comb area^[11,12]. High Pressure Liquid Chromatography was used to determine different types and contents of sugar^[13,14]. The obtained data were statistically analysed using a SPSS Computer Programme^[15].

RESULTS

Ecological sites and types of sugar in honey: There were four different ecological sites of little honeybee (*Apis florea* F.) found in Khon Kaen and Maha Sarakham Provinces, Northeast Thailand. They are: (1) Cropland and degradation forest, (2) Orchard farm, (3) Village, and (4) Housing area of Government's official. The highest number of samples was found at orchard farm (N=20) followed by village (N=17), housing area of Government's official (N=12) and cropland and degradation forest (N=10). Honeybee combs were attached to branches of mango trees, bamboo bushes, and trees of dipterocarp forest. The majority number of samples were highest in February (N=16) followed by January (N=14), December and March (N=8), April and October (N=2), June and September (N = 1) and nil for July and August (Table 1). There were five types of sugar content in honey found, i.e. fructose, glucose, lactose, maltose, and sucrose with average values of 0.97, 0.56, 0.20, 0.16, and 0.16 g ml⁻¹, respectively. Total sugar contents ranged from 1.18 to 2.01 g ml⁻¹ for Orchard and Village area, respectively. Of all types of sugar content, the highest value of total sugar content was found in the month of June followed by the months of February, December, January, March, September, April, October, and November with mean values of 3.42, 2.81, 1.73, 1.67, 1.59, 1.27, 1.17, 1.10, and 0.51 g ml⁻¹, respectively. Little Honeybee did not provide any sugar in the months of May, July, and August. Within a year, average mean values of different types of sugar were highest for fructose followed by glucose, lactose, maltose and sucrose with average values of 0.66, 0.41, 0.11, 0.11 and 0.07 g ml⁻¹, respectively.

Types of sugar on egg rate, queen cells, worker cells, and drone cells: The results on correlation coefficient (r) showed that different types of sugar contents in honey had no effect on egg rate of queen, worker cells and drone cells but fructose had highly significant effect on queen cells, whilst other types of sugar had no significant effect on egg rate, worker cell, and drone cell (Table 2).

Total sugar ranges on egg rate, queen cells, worker cells, and drone cells: The results showed that all ranges of sugar contents had no significant effect on egg rate,

worker cell, and drone cell except that of queen cell where a range of 1.00-1.051 g ml⁻¹ gave highly significant number of queen cell, which is greater than a range between 1.051-2.00 g ml⁻¹ but this range gave significantly greater number of queen cell than a range > 2.00 (Table 3).

Main sugar on egg rate, queen cell, worker cell and drone cell: Fructose and glucose, two main sugar contents in honey had no significant effect on egg rate,

Table 1: Different types of sugar content in *Apis florea* F. honey (g./ml.) as affected by locations and months of harvests, collected from Khon Kaen and Maha Sarakham Provinces, Northeast Thailand

Locations and months of harvest	Type of sugar content					Totalsugar (g ml ⁻¹)
	Fructose (g ml ⁻¹)	Glucose (g ml ⁻¹)	Lactose (g ml ⁻¹)	Maltose (g ml ⁻¹)	Sucrose (g ml ⁻¹)	
Cropland and degradation forest (N=5)	0.88	0.22	0.18	0.00	0.09	1.24
Orchard (N=20)	0.97	0.86	0.19	0.23	0.13	1.81
Village (N=17)	1.18	0.67	0.26	0.23	0.23	2.01
Housing area (N=12)	0.84	0.49	0.18	0.18	0.18	1.52
Average	0.97	0.56	0.20	0.16	0.16	1.49
January (N=14)	1.03	0.48	0.25	0.13	0.17	1.67
February (N=16)	1.18	0.97	0.14	0.30	0.26	2.18
March (N=8)	0.80	0.76	0.35	0.15	0.16	1.59
April (N=2)	0.70	0.33	0.12	0.08	0.01	1.17
May (N=0)	-	-	-	-	-	-
June (N=1)	1.18	1.10	-	0.32	-	3.42
July (N=0)	-	-	-	-	-	-
August (N=0)	-	-	-	-	-	-
September (N=1)	0.95	0.26	0.16	-	-	1.27
October (N=2)	0.80	0.29	0.11	-	-	1.10
November (N=2)	0.21	0.20	-	0.09	0.06	0.51
December (N=8)	1.03	0.53	0.14	0.23	0.15	1.73
Average	0.66	0.41	0.11	0.11	0.07	1.22

Table 2: Correlation coefficient (r) between egg rate and types of sugar, number of queen cells and types of sugar, number of workers and types of sugar, and number of drone cells and types of sugar of Little Honeybee (*Apis florea* F)

Items	Fructose	Glucose	Lactose	Maltose	Sucrose	Total sugar
						(egg/day)
Egg rate of queen	0.064	0.203	-0.043	-0.022	-0.044	-0.045
Queen cell number	-0.697**	0.374	0.231	0.277	0.009	-0.705**
Worker cell number	-0.060	0.227	-0.125	0.025	-0.081	-0.256
Drone cell number	-0.086	0.432	-0.062	-0.023	0.083	-0.054

Remarks: ** P = 0.01

Table 3: Ranges of total sugar on egg rate of queen, queen cells number, worker cells number and drone cells number of Little Honeybee (*Apis florea* L.)

Total sugar (g ml ⁻¹)	N	Egg rate of queen (egg/day)	N	Queen cell number		Worker cell number		Drone cell number	
				N	N	N	N	N	N
< 1.00	8	196.88	4	8.00a	8	3866.00	4	518.50	
1.00-1.05	18	251.06	9	7.11a	22	4302.64	12	688.00	
1.051-2.00	8	163.38	4	5.25b	8	2700.50	5	532.00	
> 2.00	14	214.00	3	4.00c	16	2795.25	7	546.00	
F-test		1.401		5.584**		1.482		1.482	

Remarks: Letters of the same column indicate significant levels of Multiple's Range Test. N = Number of samples, ** P = 0.01

Table 4: Ranges of main sugar on egg rate, number of queen cells, number of worker cells and number of drone cells of Little Honeybee (*Apis florea* F.)

Main sugar	Egg rate of queen		Number of queen cells		Number of worker cells		Number of drone cells	
	N	(eggs/day)	N		N		N	
Fructose (g./ml.)								
< 0.450	8	187.25	3	8.00a	8	3538.25	3	520.67
0.451-0.900	9	233.22	4	7.50a	11	3686.91	5	682.40
0.901-1.350	13	240.46	9	6.22a	16	4181.86	11	641.09
> 1.350	16	210.56	4	3.50b	16	2988.63	9	510.44
F-test		0.472		6.847**		0.855		0.405
Glucose (g. ml ⁻¹)								
< 0.200	22	229.36	11	5.64	23	3630.25	15	501.60
0.201-0.800	14	191.79	8	7.63	16	3917.25	8	769.75
0.801-1.600	4	229.25	1	6.00	5	2726.00	1	888.00
> 1.600	9	220.22	1	3.00	10	3097.80	5	512.40
F-test		0.367		3.110		0.568		1.671

Remarks: Letters of the same column indicate significant levels of Multiple's Range Test. N = Number of samples, ** P = 0.01

Table 5: Ranges of minor sugar on egg rate, number of queen cells, number of worker cells and number of drone cells of Little Honeybee

Minor sugars	Egg rate		Queen cell		Worker cell		Drone cell	
	N	(eggs/day)	N	number	N	number	N	number
Lactose (g./ml.)								
< 0.030	10	180.10	7	5.86	11	3262.18	7	507.71
0.031-0.060	9	253.00	1	9.00	10	4079.80	3	626.67
> 0.060	9	228.11	6	7.17	11	4454.00	7	794.57
F-test		1.275		2.135		0.820		1.619
Maltose (g./ml.)								
< 0.100	36	219.47	18	6.28	40	3850.93	23	623.74
0.101-0.200	3	176.67	2	8.00	3	3809.33	2	661.00
> 0.200	10	219.90	1	3.00	11	2281.27	4	366.00
F-test		0.222		2.220		2.579		1.130
Sucrose (g./ml.)								
< 0.100	37	222.70	15	6.67	42	3604.51	21	612.48
0.101-0.200	4	249.00	1	8.00	4	4375.00	2	619.00
> 0.200	8	174.25	5	4.80	8	2739.50	6	505.33
F-test		0.877		2.134		0.910		0.247

work cell and drone cell of honeybee (*Apis florea* F.) except that of queen cell where fructose at a range between 0.45 to 1.35 g ml⁻¹ gave much greater number of queen cell than that of a value greater than 1.35 g ml⁻¹. The differences were large and highly significant. Glucose had no significant effect in all these tested parameters (Table 4).

Minor sugar contents on egg rate, queen cell, worker cell and drone cell: Lactose, maltose, and sucrose, the three minor sugar contents in honey had no effect on the production of egg cell, queen cell, worker cell and drone cell of Little Honeybee (*Apis florea* F.) found at Knon Kaen and Maha Sarakham Provinces, Northeast Thailand (Table 5).

DISCUSSION

Little honeybee (*Apis florea* F.) is an important insect for honey production apart from other species of bees such as *Apis cerana*, *Apis mellifera* and *Apis dorsata*. *Apis florea* F. can be found in most areas in tropical and sub-tropical regions, however, it is well justified that there is only a small amount of published work on this type of little honeybee, particularly on its inhabitation and types of sugar. It was evidently found that in Northeast Thailand especially at Khon Kaen and Maha Sarakham areas, ecological sites of this type of honeybee are classified into four different locations. They are: (1) Cropland and degradation forest, (2) Orchard farm, (3) Villages and (4) Housing area of government's official. The results indicated that *Apis florea* F. had its preferential selections to build up their combs nearby residential areas of man. This may be due to some reasons, e.g. water availability and food supply. It was found that the majority of honeybees were found with orchard farm followed by villages, government's residential areas and cropland and degradation forest. This may be due to plentiful of availability of food when orchard trees start to flower in mostly from cool to early hot seasons. Nevertheless, when food supply is inadequate, Little Honeybee colony obviously moves away to a better site. Therefore, its location depended most on water and food supply.

Little Honeybee (*Apis florea* F.) found with this work collected five types of sugar contents, i.e. with majority of fructose followed by glucose, lactose, maltose and sucrose. Fructose and glucose are considered as main sugars, whilst other types of sugars are of minor sugars^[4]. The highest amounts of sugar content were found in June followed by February, December, January, March, September, April, October and November. However, Abrol^[10] in India reported that the highest collected honey weights were obtained from February to May. This may be due to different types of plant species with high amounts of hexose in their flowers. In Thailand they include plant species of *Brassica* spp., *Tridax procambens*, *Cosmos sulphureus*, *Muntingia calabura* and *Eucalyptus citriodora*.

With respect to type of sugar on egg rate, queen cells, worker cells and drone cells, the results indicated that only fructose had highly significant effect on number of queen cells, whilst other types of sugar had no effect. Therefore, to increase number of colony, fructose could possibly be one of the other important factors for

honeybee populations. Number of queen cells also affected by ranges of total sugar, i.e. a range between 1-1.05 gave highly significant number of queen cells yet with a range greater than this it gave a smaller number of queen cells, particularly with a range greater than 2.00. The results also revealed that fructose, the main sugar content in honey, gave highly significant number of queen cells but not glucose. Whilst other minor sugars such as lactose, maltose and sucrose had no significant effect on egg rate, queen cells, worker cells and drone cells. Therefore, fructose alone could be considered as the most important sugar in honey for honeybee populations.

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