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The Blooming Flowers of Tea Plants and Their Honey

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Tea (*Camellia sinensis L*.) leaves provide beneficial effects for human health, and the functions of the main components of their leaves have been widely studied. Recently several physiological functions of tea flowers have been reported, and the flowers have received attention as a natural healthy material for food and cosmetics. It is not well known that the fragrant tea flowers have sweet nectar. The tea nectar may be attractive to honeybees. However, the honey from tea flowers has not been studied, even though in autumn, many tea fields are filled with blooming flowers in almost all the tea production areas around the world. In addition, honey from tea flowers has not been seen on the market. It was unclear whether tea honey is available. The study used honeybees (*Apis mellifera L*.) and took a small amount of honey from the blooming flowers of tea plants, which contained theanine (L-glutamic acid γ-ethylamide), a specific amino acid of tea plants. The theanine concentration of the nectar of the tea flowers exceeded that of the honey. Theanine is an extremely rare amino acid in nature, and it has psychoactive properties. This result is evidence that this honey is derived from tea flowers. Furthermore, the concentration of caffeine in the tea nectar might affect the honeybee's brain to improve memory, suggesting that honeybees prefer to collect the nectar and produce honey. This study aims to prove that tea flower honey can be harvested and further proposes a unique tea sightseeing where visitors can taste the honey of tea flowers in the gorgeous scenery and fragrance of flower tea gardens.

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1. INTRODUCTION

Green tea (*Camellia sinensis*) leaves provide positive health benefits, and the functions of its main components (including catechin, theanine, and the caffeine in their leaves) have been widely studied [1,2]. Recently several physiological functions (e.g., antioxidant, antimicrobial, immunomodulatory, and antitumor activities) of tea flowers have been reported [3,4,5]. Fragrant tea flowers produce sweet nectar. During hydroponic research on tea plants, It was learned that the nectar of tea flowers has a sweet taste. Although honeybees are tempted by tea nectar, the nectar and honey from tea flowers have not been studied, and their honey has never been marketed. Japanese tea flowers usually bloom for two to three months from June to the end of August. In warmer areas around the world, the blooming period is even longer. During this period, honeybees are seen visiting tea flowers. One study of the bee pollen collected from the flowers of tea plants suggests that honeybees like the pollen of tea leaves (*Camellia sinensis*) [6]. My search suggests two reasons why pure honey has never made from tea flowers. The first is that tea farmers dislike tea flowers. Their blooming suggests poorly nourished tea plants whose roots are weak and lack vitality. If the quality of the tea leaves is low, then the tea farm is being poorly managed. Therefore, tea growers apply fertilizer to prevent blooming. Alternatively, after the final harvest, the tea plants are pruned to avoid nutrient consumption. In addition to this management decision, after first picking the tea leaves, a large amount of fertilizer must be applied to ensure healthy growth for subsequent harvests. Excessive fertilization prevents tea flowers from blooming, which also explains why flowers aren't in full bloom in tea gardens [7]. In fact, it seems logical that abandoned tea gardens have many flowers.

The second reason is a vague belief persists that tea flowers are toxic to honeybees, which might reflect a toxicity study published over 30 years ago [8]. However, the issue of toxicity remains unresolved. Honeybees are most active in spring, and the tea's flowering season is autumn, so their peaks do not match. Beekeepers might not be very busy in the fall due to a lack of nectar plants. However, the relationship between tea flowers and honeybees has not been scrutinized. The study explores the issue of the incompatibility of tea flowers and honeybees by harvesting honey from them. This paper demonstrates the knowledge and findings regarding tea flower honey, which grew out of my inquisitiveness and attraction to the previously unknown area of tea flower nectar. This study proposes a novel tea sightseeing opportunity where the honey of tea flowers can be enjoyed in a blooming tea garden. The aroma from the tea garden where the flowers are in full bloom is exceptional. Fresh green leaves are beautiful in tea gardens; their flowers are even more majestic.

2. BEEKEEPING

Both western (*Apis mellifera L.*) and Japanese honeybees (*Apis cerana japonica*) are cultivated in Japan. Considering the availability of honeybees and the amount of honey that they can produce, western honeybees are more suitable for beekeeping. They are also more convenient for the daily checking of honey due to their honeycomb frame structure. In the current study, western honeybees and standard beekeeping were used [9]. In March in Japan, flowers begin to bloom, and honeybees start to work. They collect a large amount of nectar and change it into honey. However, honeybees are weakened by the summer heat. Collecting honey might be inefficient since autumn is uncomfortable for honeybees. However, honeybees, especially *Apis mellifera L*., tend to collect the nectar of a single species of flower, such as acacia or lotus. I placed the beehives in the middle of a vast expanse of a tea garden from September to November in Shizuoka, Japan, and employed standard beekeeping equipment.

3. ANALYSES

To confirm whether the honey was derived from the nectar of tea flowers, a High Performance Liquid Chromatography (HPLC) was used to analyse its theanine content [10]. Other main components, the catechin and caffeine content of the honey, were also detected by HPLC. Furthermore, the theanine, catechin, and caffeine of the nectar from tea flowers were analysed to compare with the honey from the tea plant flowers cultured hydroponically.

Data are expressed as the mean ± standard error of the mean (SEM). Statistical analysessis

of variance (ANOVA). All statistical analyses were performed in a statistical analysis program, JMP ver.13 (SAS Institute Inc., Cary, NC USA).

4. RESULTS AND DISCUSSION

4.1 Evidence of Honey from Tea Flowers

The honeybees collected the nectar of tea flowers. In the autumn, many honeybees visited the flowers in the tea garden, and the condition of the honeybees and the state of the honey storage weekly were checked. A small amount of honey in the honeycombs was eventually found and carefully collected. The following is a breakdown of its quality: 80.3% sugar content, 18% water content, and pH of 3.9. These values have the same quality as the standard natural honey in the world. In this study, we developed a beekeeping procedure for obtaining the honey of tea flowers, even for a short period.

Even though honey was harvested from the tea gardens, it is not sure that the honey was derived from the tea flowers. The fact that the honeybees were sitting on the tea flowers did not necessarily mean that they were gathering nectar. They might have been collecting pollen. Thus, theanine content in the honey was analysed to establish that the honey was from the nectar of tea flowers. Theanine, which is one of the main components that provide the *umami* taste in tea, has been attracting attention in recent years for its relaxing effect [11,12]. It is a rare amino acid that is naturally found only in several *camellia* species and in one inedible mushroom (*Bay bolete; Boletus badius*) [13]. Detecting theanine provides strong evidence that the honey is derived from tea. My results showed theanine in the honey and in the nectar, signifying genuine tea flower honey (Table 1). Even if the honeybees had the ability to collect nectar from flowers in a 3-km area, no plant other than tea has flowers that contain theanine. We successfully harvested honey from the tea flowers in tea gardens and proved that honey can be obtained from tea flowers.

4.2 Connection of Caffeine between Tea Flowers and Honeybees

Since caffeine in the pollen of tea flowers has generally been deemed harmful to honeybees, beekeepers have struggled to keep their bees away from tea gardens and intentionally avoided making honey from tea flowers. Recently, [9] argued that caffeine might have a secondary advantage that attracts honeybees and enhances their long-term memory [14], suggesting that they learn to seek the nectar of flowers that has caffeine. They concluded that 0.1 mM (0.019 mg/mL) of caffeine activated honeybee brains, supporting the data in Table 1 showing that the tea nectar had about 0.02 mg/mL of caffeine [15]. Such definite evidence showed the interdependence between honeybees and flowers through caffeine and suggested that they might collect nectar from tea plants. Caffeine tastes bitter to mammals and in high doses is toxic and repellent to pollinators; however, honeybees are attracted to tea nectar, which includes a low amount of caffeine.

4.3 Sightseeing Involving the Blooming Tea Flowers in Tea Garden

This study proved that actual honey can be obtained from tea flowers. Since autumn may be unsuitable for honeybee activity in Japan, harvesting enough honey for tasting requires strategies. To enable tourists to enjoy tea honey while gazing at tea flowers in a tea garden, I address the following aspects:

1. Honeybee colony strength:

In a single colony, numerous honeybees collect more nectar more efficiently to produce honey, as in conventional beekeeping.

2. Selection of tea gardens:

Numerous flowers in bloom are required in vast tea gardens. Otherwise, the honeybees will move to other flowers that are blooming more.

3. Environment around the tea garden:

A tea garden's environment is critical because bees are sensitive organisms. Noise, vibrations, odours, chemicals, etc., must be removed [16,17].

4. Weather/climate:

Honeybees cannot visit flowers in the rain. Nor do they work in temperatures of 15℃ or less [9]. In other words, honeybees are active during nice, warm weather. If these conditions are met, tea flower honey can be harvested worldwide.

Table 1. Concentration of main ingredients of the tea nectar and the obtained honey

	Theanine (mg/mL)	Catechins (mg/mL)	Caffeine (mg/mL)
Honey	0.0747±0.0177（n=6）	ND	0.00657±0.0032 (n=6)
Nectar	0.0990±0.0616（n=4）	ND	0.023±0.00675 (n=4)

ND: Not Detected

To create successful sightseeing situations in tea gardens that feature blooming tea flowers, the most important factor is that the tea flower blossoms must be everywhere in a vast tea garden. The landscape of flowering tea gardens is valuable. More tea blossoms can be seen in abandoned tea gardens because less nutritious tea gardens allow the flowers to bloom [4]. Recently, since many tea farmers are retiring or leaving the tea business, especially in mountainous areas, more tea gardens are being abandoned not only in Japan but around the world. After flowering, the tea plants bear seeds. Tea seed oil has recently become popular for its unique taste and physiological effects. Some companies that own tea gardens are reviving abandoned tea gardens to harvest the tea seeds to manufacture high-quality tea seed oil [18,19]. Therefore, the recent increase of abandoned tea gardens could lead to a rebirth where the tea gardens are revived and improved as blooming tea flower gardens that display beautiful tea blossoms and produce tea seeds.

In a tea garden where the tea flowers are in full bloom, the flowers can be enjoyed even though just a small amount of tea flower honey will be produced. Most people have probably never experienced the scent of tea flowers, whose faint sweetness evokes jasmine. We were exposed to the elegant aroma of tea flowers during my research of tea plants that were hydroponically cultured in a phytotron. When its door was opened, a sweet scent diffused. We experienced the same sweet scent of tea flowers when we visited tea gardens to collect tea honey. The tea flowers in bloom throughout the garden emitted a very elegant, impressive scent. Apart from the scenery and elegant scent of tea gardens, one only needs the honey from tea flowers to enjoy the flowers in bloom. When drinking green tea at such places, adding a little honey to the edge of the cup enhances the tea's aroma and taste. This is the most impressive way to taste the blooming flowers of tea plants and their honey. We believe that a new type of tea tourism, which focuses on the marvellous flowering of tea plants and their honey, will become popular and soon help tea to become even more attractive to consumers.

5. CONCLUSION

This study showed that honeybees produced honey from the flowers of tea plants. The obtained honey and the nectar of tea flowers contained a very rare amino acid, theanine, showing that the honey was derived from the tea flowers. The nectar of tea flowers contained a low concentration of caffeine that was attractive to honeybees. This study proposes a new type of tea tourism focusing on the wonderful flowering of tea plants and their honey.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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