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Article

Efficiency of Attractive Baits for Social Wasps (Vespidae: Polistinae) and Their Relation to Local Food Resources

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ABSTRACT
The management of social wasp colonies is relevant for their use in biological control in agricultural ecosystems. Therefore, this study investigated the influence of different attractants in traps for sampling social wasps (Vespidae: Polistinae), considering the food resources available in two agricultural areas of IFMG – Bambuí Campus: a guava orchard and a banana plantation. The collections took place between April and May and October and November 2024, during six consecutive weeks in each area, with weekly replacement of the attractants. The traps were made from PET bottles using honey, guava juice, and banana juice. In total, 712 individuals belonging to 21 species were collected. Honey was the most effective, with greater abundance and average species richness in both areas. Guava and banana juices showed similar performance, regardless of the local crop. The results indicate that the efficiency of the attractants is not related to the type of crop and that honey is a more effective alternative for sampling social wasps in agricultural environments.
Keywords: banana; biological control; diversity; guava; honey

Introduction

Social wasps (Hymenoptera: Vespidae) are widely distributed in natural, agricultural, and urban environments (Jacques *et al.*, 2024), where they play important ecological roles, such as predation of other insects (Prezoto *et al.*, 2019) and pollination (Brock *et al.*, 2021).

In agricultural systems, the presence of these wasps has raised increasing interest among the scientific community and producers, mainly due to their effectiveness as natural agents in biological pest control (Ferreira *et al.*, 2024; Palandi *et al.*, 2025). This contributes significantly to integrated pest management practices and to reducing the use of insecticides (Schoeninger *et al.*, 2020; Oliveira *et al.*, 2022).

In this context, understanding the diversity and abundance of social wasps is essential to enable their use as a biological control tool (Silva & Franco-Assis, 2021). To this end, different sampling methods have been employed (Noll & Gomes, 2009; Santos *et al.*, 2020). Active searching, considered one of the most traditional methods (Souza, Prezoto, 2006), consists of directly collecting individuals in flight or in their nests, which, however, requires considerable sampling effort and experience on the part of researchers (Jacques et al., 2018a).

In addition, passive methods have also been widely used. Among them, the Malaise trap stands out, which intercepts flying insects and directs them to a collection container (Souza *et al.* 2015). Although efficient for

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diversity studies, this trap has limitations, such as low selectivity and greater need for maintenance and infrastructure.

In contrast, attractive traps are a simple, low-cost, and highly efficient alternative for capturing social wasps (Jacques *et al*., 2018a). They are produced using PET bottles and different attractants, such as honey, molasses, sardine broth, and different fruit juices, such as passion fruit, guava, and pineapple (Maciel *et al*., 2016; Jacques *et al*., 2018a). The fermentation of fruit juice releases volatile compounds that simulate rotting fruit, which attracts social wasps (Raw, 1998; Elmquist & Landolt, 2018).

Despite its widespread adoption, little is known about the influence of the type of attractant on the food resources available in the sampled environment. In other words, it is still unclear whether attractants prepared with fruits from the same crop present in the study area are more efficient than those made with fruit pulp from other plants.

Thus, the present study aims to test whether attractants prepared from fruits of the local crop result in greater sampling efficiency of social wasps.

Methodology

The research was conducted in two agricultural areas of the Federal Institute of Education, Science, and Technology of Minas Gerais - Bambuí campus (Figure 1A), in different periods of 2024: the first between April and May and the second between October and November. In both stages, collections took place over six consecutive weeks. The first area is characterized by guava cultivation (Figure 1B), with an area of approximately 4,000 m², and is located near campus buildings, such as those used for classes. The second area, used for banana cultivation (Figure 1C), is approximately 5,600 m² and is located near agricultural areas with a predominance of pastures. The two areas are approximately 765 meters apart in a straight line. The crops were chosen based on the distance between them and the possibility of producing attractive juices from their fruits.

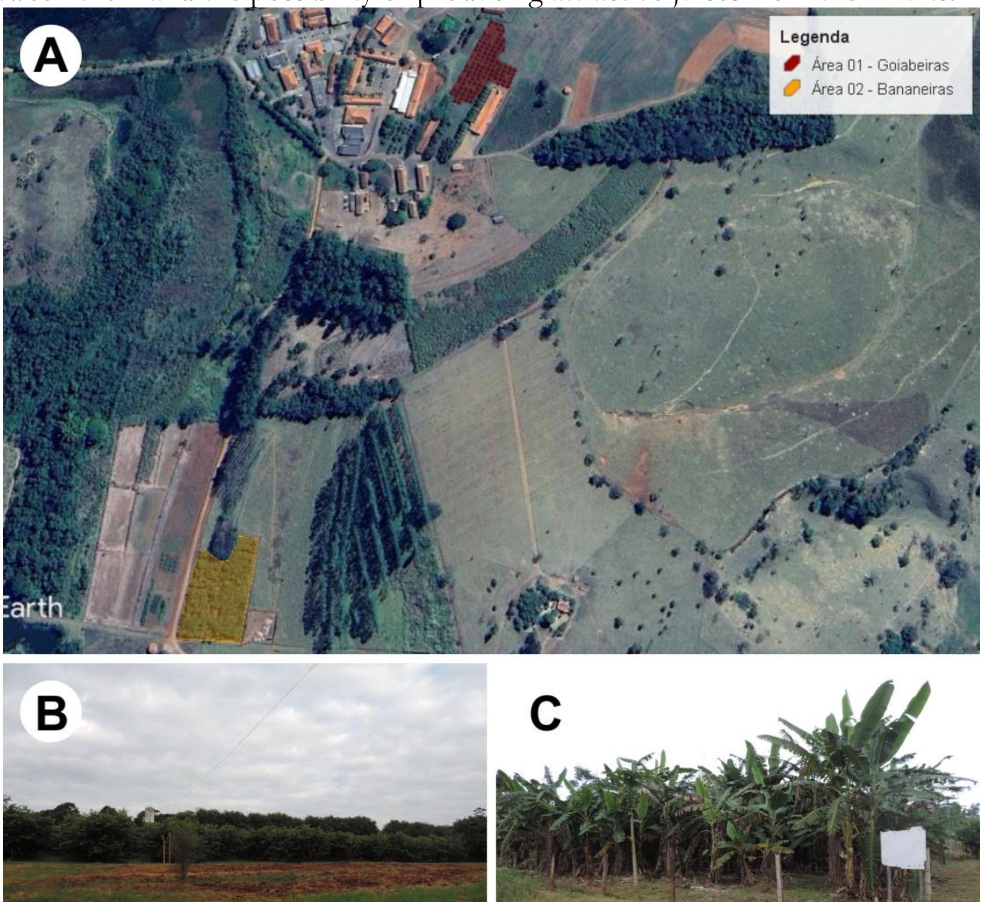

Figure 1: Areas used for collecting social wasps (Vespidae: Polistinae) at the Bambuí Campus of IFMG, Minas Gerais, Brazil: (A) overview of the campus; (B) guava tree area; (C) banana tree area. Source: The authors, 2025.

The wasps were sampled using attractive traps made from 2-liter PET bottles with three triangular openings (2 × 2 × 2 cm) positioned approximately 10 cm from the base (Jacques *et al.* 2018a). Three types of attractants were tested: (1) diluted honey (control), (2) banana, and (3) guava. The honey was diluted in a 1:1 ratio (1 liter of honey to 1 liter of water), while the fruit attractants were prepared using 1 kg of fruit, 250 g of sugar, and enough water to complete the required volume. Diluted honey was chosen because it is the attractant that attracts the greatest diversity and abundance of social wasps (Jacques *et al.* 2018a).

The distribution of the traps followed the methodology proposed by Jacques *et al.* (2018a). In each area, 18 traps were installed, six of each type of attractant, arranged alternately with a spacing of 10 meters between them, organized in three rows (Figure 2), so that all attractants were distributed equally at the edges and in the center of the crops. The volume of attractant added to each trap was 200 mL, with weekly replacement, along with the collection of specimens.

The collected wasps were removed from the traps, and then placed in a plastic container with 70% alcohol. Later, they were identified with the aid of dichotomous keys for genera and species (Richards, 1978; Somavilla *et al.* 2021), in addition to comparison with specimens from the Biological Collection of Social Wasps (CBVS) of IFSULDEMINAS – Inconfidentes Campus, where the specimens were deposited (registration numbers 12546-2024 to 12581-2024).

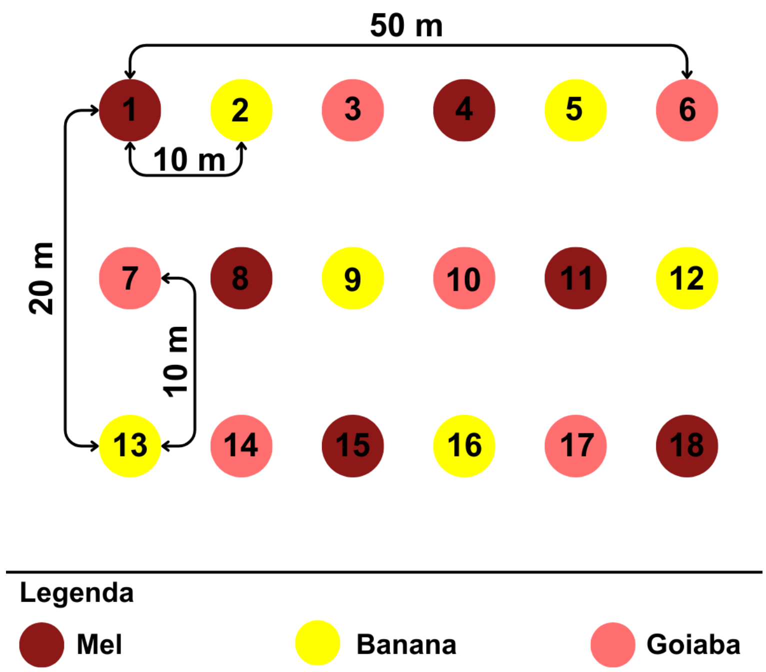

Figure 2: Arrangement of traps in the field using three attractants: honey, banana juice, and guava juice. Source: The authors, 2025.

The Shapiro-Wilk test was applied to verify the normality of the data. In order to evaluate significant differences between the attractants in terms of abundance and species richness, the Kruskal-Wallis (KW) test was used, followed by pair-wise comparisons with the Mann-Whitney U test. The similarity of community composition between the two areas was analyzed using Principal Coordinate Analysis (PCoA), using the Bray-Curtis index, which considers species abundance. To verify whether the observed differences were statistically significant, a PERMANOVA (Permutational Multivariate Analysis of Variance) was performed. All statistical analyses were conducted using PAST 4.03 software (Hammer *et al.*, 2005).

Results and Discussion

A total of 712 individuals of 21 species were collected in both areas (Table 1). Honey, in both areas, was the attractant that collected the highest total abundance and also the highest average abundance per week of collection (p< 0.05; H= 23.17), but it was similar between areas (p> 0.05). The same occurred with species richness, with honey in both areas being more attractive than banana and guava juices in both areas (p< 0.05; H= 26.35) and similar between them (p> 0.05). This result is similar to that found by Jacques *et al.*, 2018a, in which honey, together with molasses, were the best attractants compared to passion fruit juice and sardine broth.

Table 1: Abundance and species richness of social wasps collected with different attractants in guava and banana cultivation areas at IFMG - Bambuí Campus, Minas Gerais, Brazil.

Location	**Guava tree**				**Banana tree**				**Total**
Species/attractant	**Honey**	**Guava**	**Banana**	**Total/area**	**Honey**	**Guava**	**Banana**	**Total/area**	
Agelaia centralis (Cameron, 1907)	6	2	3	11	81	8	4	93	104
Agelaia multipicta (Haliday, 1836)	0	0	0	0	1	0	1	2	2
Agelaia pallipes (Olivier, 1791)	2	0	1	3	3	0	0	3	6
Apoica gelida Van der Vecht, 1972	28	2	1	31	9	3	2	14	45
Mischocyttarus cassununga (R. von Ihering, 1903)	1	0	0	1	3	2	0	5	6
Mischocyttarus drewseni de Saussure, 1857	0	0	0	0	1	0	0	1	1
Mischocyttarus rotundicollis (Cameron, 1912)	2	0	0	2	2	0	0	2	4
Polistes satan Bequaert, 1940	2	0	0	2	0	0	0	0	2
Polistes simillimus Zikán, 1951	6	2	3	11	14	4	11	29	40
Polistes versicolor (Olivier, 1791)	62	23	49	134	24	3	6	33	167
Polybia bifasciata de Saussure, 1854	1	0	0	1	0	0	0	0	1
Polybia chrysothorax (Lechtenstein, 1796)	0	0	0	0	1	0	1	2	2
Polybia erythrothorax Richards, 1978	0	1	1	2	2	0	0	2	4
Polybia fastidiosuscula de Saussure, 1854	0	1	0	1	1	0	0	1	2
Polybia ignobilis (Haliday, 1836)	8	3	12	23	10	19	22	51	74
Polybia jurinei de Saussure, 1854	1	0	1	2	2	3	7	12	14
Polybia occidentalis (Olivier, 1791)	5	2	0	7	22	0	0	22	29
Polybia paulista H. von Ihering, 1896	2	0	0	2	2	0	0	2	4
Polybia platycephala Richards, 1951	0	0	0	0	2	0	0	2	2
Polybia sericea (Olivier, 1792)	55	16	20	91	21	7	16	44	135
Synoeca surinama (Linnaeus, 1767)	40	4	22	66	2	0	0	2	68
Abundance	221	56	113	390	203	49	70	322	712
Average abundance/week*	18.42a	4.67b	9.42ab		16.92a	4.08b	5.83b		
Species richness	15	10	10	17	19	8	9	19	21
Average wealth/week*	4.92a	2.42b	2.91b		5.33a	1.83b	2.33b		

Different letters in the rows indicate significant differences according to the Mann-Whitney U test (p< 0.05). Source: The authors, 2025

Honey tends to be more attractive to social wasps due to its high concentration of simple sugars, such as glucose and fructose, which are readily assimilated and quickly converted into energy (Kostić *et al.*, 2024). These substances are a highly effective food source for both adult wasps and larvae, which depend on rapid energy sources for their growth and development (Taylor *et al.*, 2012). In contrast, fruit juices have a lower concentration of available sugars and a higher water content, which makes them less attractive as an immediate energy source (Souza, 2005; Deibert *et al.*, 2020). In addition, honey has a complex mixture of volatile aromatic compounds (Manyi-Loh *et al.*, 2011), which can act as potent olfactory attractants for wasps.

No influence of the food resource available in the areas on the performance of fruit juices was observed. Guava juice showed similar weekly abundance and richness in both the guava and banana tree areas ($p > 0.05$), a result also observed for banana juice ($p > 0.05$).

The absence of a significant difference between the juices may be related to the similar composition of sugars present in both, such as glucose, fructose, and sucrose (Souza *et al.*, 2020; Freitas & Silva, 2021), which may not generate sufficient discriminatory stimulus for wasps. Although the volatile profiles of the juices are distinct, with guava juice emitting compounds such as hexanoic acid (Ortega *et al.*, 1998) and banana juice containing esters such as isoamyl acetate (Torres *et al.*, 2010), these differences do not appear to be striking enough to generate preference. In addition, environmental factors such as temperature, humidity, and proximity between traps may also have interfered with odor perception.

Of the total number of individuals collected, 390 of 17 species were collected in the guava tree area and 322 individuals of 19 species in the banana tree area. However, there is no significant difference between the community of social wasps that visit banana trees and guava trees ($p = 0.5807$; $F = 0.5627$; $N = 9999$) (Figure 3).

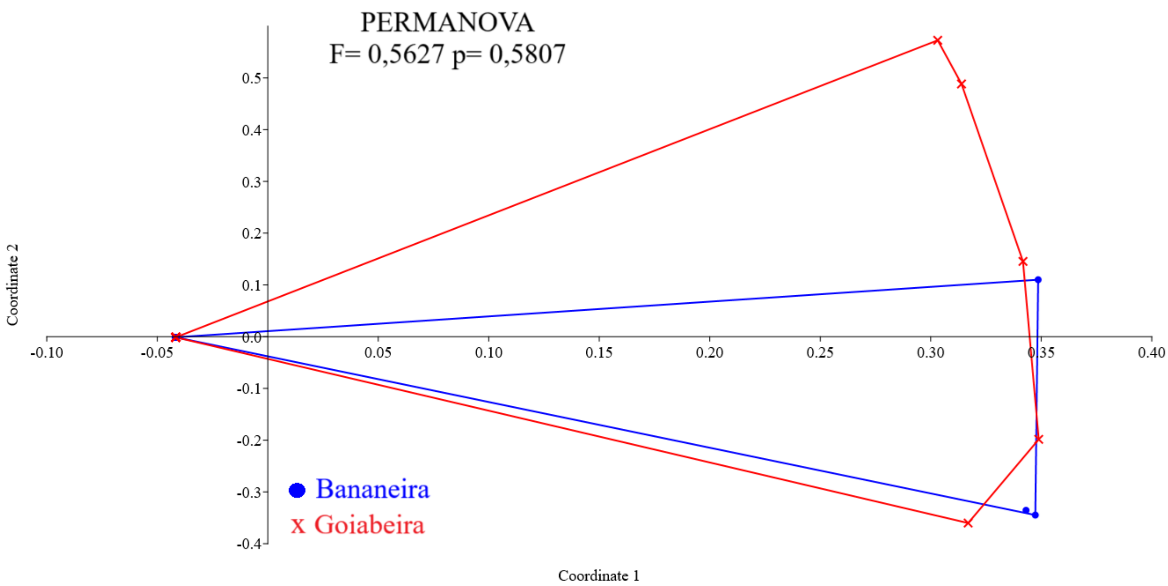

Figure 3: Principal Coordinate Analysis (PCoA) and PERMANOVA results for the social wasp community in the guava and banana tree areas of IFMG - Bambuí Campus, MG. Source: The authors, 2025.

Despite the botanical differences between banana and guava crops, the social wasp community was similar, possibly due to ecological factors shared between the environments. Both crops can offer comparable food resources, with sources of carbohydrates, such as nectaries and the fruits' own , as well as sources of protein, such as agricultural pests, which favors foraging by generalist species (Raveret-Richter, 2000).

In addition, the spatial proximity between crops and their insertion in the same landscape matrix can promote a high overlap of wasp communities, indicating that the local composition reflects the same regional set of species (Elpino-Campos *et al.*, 2007; Souza *et al.*, 2010). This can be confirmed, as of the 21 species collected, 18 had already been recorded on campus (Jacques *et al.* 2024), with the exception of *Agelaia pallipes* (Olivier, 1791), *Polybia platycephala* Richards, 1951, and *Synoeca surinama* (Linnaeus, 1767). With the registration of these new species, the campus now has 39 species of social wasps, the third highest diversity in Minas Gerais (Jacques *et al.*, 2024).

Although the overall composition of the communities was similar, some species were recorded exclusively in one of the areas. *Polistes satan* Bequaert, 1940 and *Polybia bifasciata* de Saussure, 1854 occurred only in guava trees, while *Agelaia multipicta* (Haliday, 1836), *Polybia chrysothorax* (Lechtenstein, 1796), *Mischocyttarus drewseni* de Saussure, 1857, and P. platycephala were exclusive to banana trees (Table 1). Only one or two individuals were collected for these species.

The presence of only one or two individuals of these species can be explained by ecological factors, such as low population density, as in the case of *P. satan* and *M. drewseni*, which have few individuals per colony (Tannure-Nascimento *et al*., 2005; Melo *et al*., 2024). Or due to the chance effect, in which the occurrence of rare individuals is sensitive to sampling effort and stochastic population dynamics (Gotelli & Ellison, 2004). In addition, social wasps are highly mobile and can forage in different habitats (Raveret-Richter, 2000), which can lead to sporadic occurrences of some species in specific areas, even without a strong ecological association.

Microenvironmental heterogeneity between crop areas, such as variations in shading, humidity, and available resources, may also favor the appearance of species with particular ecological preferences but low abundance (Dejean *et al*., 1998). In addition, sampling limitations or collection time may be responsible for the non-detection of these species in one of the areas, and it is possible that they may appear in greater numbers with more intensive sampling.

In terms of dominance, there is also a difference between areas. In guava trees, *Polistes versicolor* (Olivier, 1791), *Polybia sericea* (Olivier, 1792), and *S. surinama* dominate, respectively. In banana trees, *Agelaia centralis* (Cameron, 1907), *Polybia ignobilis* (Haliday, 1836), and P. *sericea* dominate (Table 1).

This difference in dominance can be attributed to a combination of environmental characteristics and distinct ecological interactions between the two habitats. The guava tree area, which is smaller and closer to buildings, may favor more synanthropic species, such as *P. versicolor,* which adapts well to urban environments and has previously been recorded as dominant on campus (Jacques *et al*., 2015). *S. surinama,* an aggressive, medium-sized species (Andena *et al*., 2009), may have its dominance associated with the presence of a nest near the area.

The banana tree area, which is more extensive and close to pastures, may offer greater availability of resources, favoring species such as *P. ignobilis*, frequently recorded in agricultural environments (Jacques *et al*., 2018b, 2024), and A. *centralis,* belonging to a genus with numerous colonies, which can reach millions of individuals (Zucchi *et al*., 1995), increasing their foraging capacity (Hunt *et al*., 2001).

Polybia sericea was dominant in both areas, reinforcing its generalist character and potential use in biological control programs, given its preference for caterpillars (Bichara Filho *et al*., 2009). The species P. *versicolor,* P. *ignobilis*, and S. *surinama* are also potential control agents, with records of predation on agricultural pests (Elisei *et al*., 2010; Jacques *et al*., 2018b; Lourido *et al*., 2019). Thus, the abundant presence of these species in crop areas can contribute significantly to natural pest control.

Conclusion

This study demonstrated that honey is significantly more efficient than banana and guava juices in sampling social wasps, both in terms of abundance and species richness. The absence of a relationship between the efficiency of fruit-based attractants and the crop present (guava or banana) indicates that social wasps respond more strongly to the quality and intensity of the attractive compounds than to familiarity with the local resource. Thus, honey, because it contains high levels of simple sugars and a wide range of volatile compounds, proved to be the most effective attractant. In addition, the composition of the social wasp community was similar between the two areas studied, probably due to their spatial proximity and insertion in the same landscape matrix, with widely distributed generalist species. These findings reinforce the potential of attractive traps, especially with honey, as an efficient and low-cost tool for diversity studies and monitoring of social wasps in agricultural systems.

Despite the promising results, the study has limitations, such as the restricted sampling time and the spatial coverage limited to two nearby areas. These factors may influence the representativeness of the data and make generalizations difficult. Future studies should consider different periods of the year, test new attractants, and apply the methodology in other agricultural landscapes to expand knowledge about the efficiency and selectivity of attractive traps for social wasps.

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