Oviposition Preference of *Plodia interpunctella* (Hübner) Among Selected Nuts and Fruits and Identification of Characteristic Volatile Compounds

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INTRODUCTION

Dried fruits and nuts are vulnerable to infestation by *Plodia interpunctella*, causing significant postharvest losses. This study evaluated the oviposition preference of female moths among normal-oleic and high-oleic peanuts, walnuts, hazelnuts, goji berries, and figs. Volatile organic compounds (VOCs) from these commodities were collected and analyzed using Gas Chromatography–Mass Spectrometry (GC-MS). Differential compounds were identified by the partial least square-discrimination analysis (PLS-DA) and further validated by Y-tube olfactometer tests. The findings provide insight into the semiochemical basis of host selection and support the development of VOC-based attractants for improved pest monitoring and environmentally friendly control strategies.

Material and Methods

1. Oviposition Preference

The oviposition preference of *P. interpunctella* females was carried out in a special device that simulates real storage conditions, in which a pair of mating moths were placed in a petri dish suspended 0.3 m below the surface of cover in a cubical steel sheeting chamber (1.2 ×1.2 ×0.9 m). Each commodity in weight of 20 g was placed a single plastic sample cell (4 cm in diameter and 3 cm in height). All samples were arranged in a circular pattern (115.2 cm in diameter) on a sample board that was 0.4m above the ground. The number of eggs laid by the female in each commodity was checked with stereo microscope 72 h later. Each treatment was repeated in nine replicates.

2. VOCs Collection and Chemical Analysis

Volatile organic compounds (VOCs) from peanut kainong 69 and bai 2 were collected using a dynamic headspace sampling system connected with Teflon tubing, as shown in Figure 1. Cleaned glass jars containing 400 g of tested commoditiess were connected to an airflow system that passed through activated carbon, silica gel, a flowmeter, and a VOC trap filled with 100 mg Porapak™ Q adsorbent. The airflow was maintained at 300 mL/min, and blank runs without peanuts were conducted for 90 minutes prior to sample collection for cleaning. Each peanut variety was sampled four times, with each collection lasting 12 hours. VOCs were eluted with 1 mL n-hexane, concentrated to 200 μL, and stored at –80 °C. GC-MS analysis was conducted using a QP2010 instrument with a DB-5MS column under controlled thermal and injection conditions. VOCs were identified by comparing mass spectra with the NIST14.0 and Wiley 275 libraries (match factor >90%) and confirmed using retention indices calculated from C8–C40 alkane standards. All experiments were performed at 27 ± 1 °C, 70 ± 5% relative humidity, and a 16L:8D photoperiod.

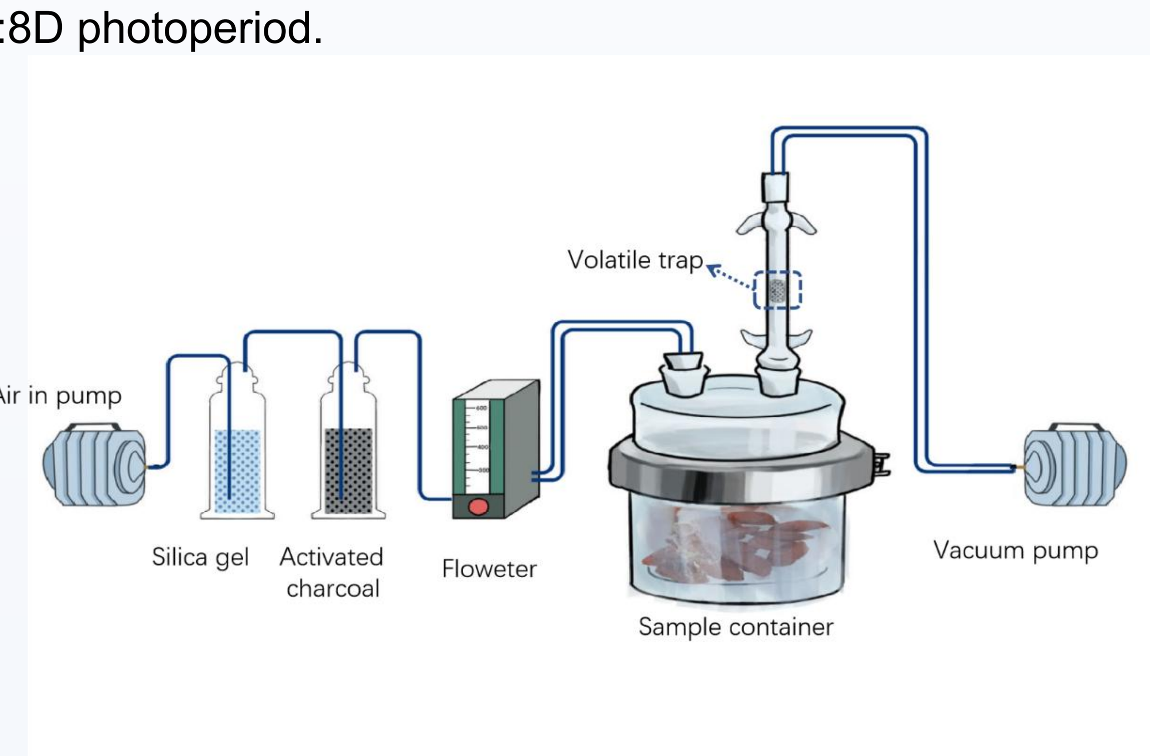

Figure 1. A schematic diagram of dynamic headspace collection systems for VOCs from tested commodities .

3. Y-Tube Olfactometer Bioassay

The Y-tube olfactometer bioassays were conducted on 2-ethyl-1-hexanol, nonanal, ethyl caproate, octane, undecane, eicosane, and hexadecane at concentrations of 10 and 100 μg/μL, which elicited strong antennal responses in *P. interpunctella* in the test. The Y-tube olfactometer consisted of a base tube (30 cm in length, 4 cm in in-ner diameter) and two arms (20.0 cm in length) at 75°. The airflow (400 mL/min) was pumped through an activated carbon air filter, a bottle of distilled water, and a flowmeter before being directed into the two arms of the olfactometer. The test solu-tion at 10μL was applied to a filter paper strip (5 cm long, 0.5 cm wide), and allowed to evaporate for 1 min, then placed into the test arms of olfactometer, with 10 μL of paraffin oil serving as the control. The females that moved to the test arms over 10 cm and stayed more than 10 seconds over there was confirmed to be a "choice". Otherwise, it was taken as "no choice." The Y-tube olfactometer cleaning with anhydrous ethanol and water was done with interval for each five females. The position of two arms were swapped to prevent positional bias. Forty females were examined individually for each concentration of VOC. The bioassay was carried out under laboratory conditions (28±1℃ and 70% r.h.).

RESULTS

- More eggs were laid on goji berry, fig, walnut, hazelnut, and normal-oleic peanut than on high-oleic peanut;
- Seven differential VOCs（VIP>1） were analyzed by PLS-DA and GC-MS;
- Nonanal, ethyl caproate, octane, and undecane, which attracted females, were abundant in goji berry, fig, walnut, hazelnut, and normal-oleic peanut, while the repellent compound 2-ethyl-1-hexanol was more abundant in high-oleic peanut.

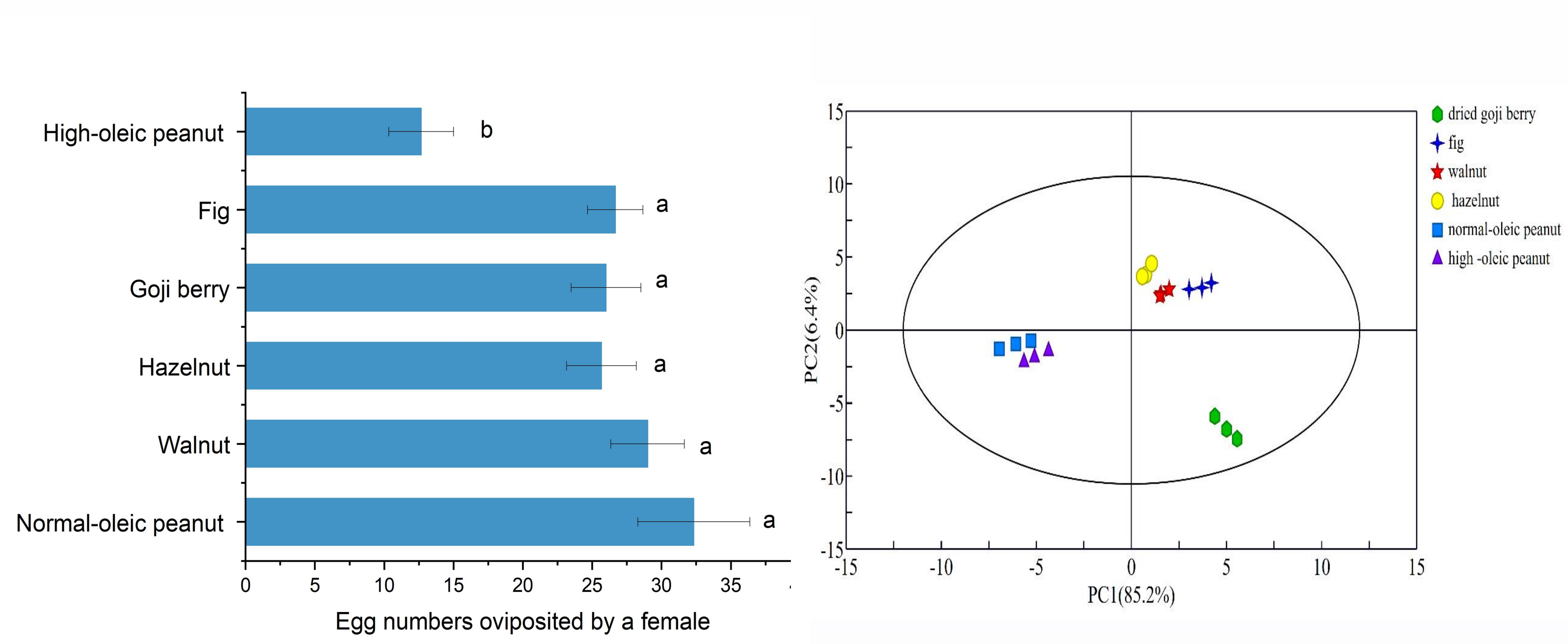

Figure 2. The number of eggs oviposited by *P. interpunctella* females among tested commodi-ties. The bars represent mean number of eggs (Mean± SE) laid by one female in 72 hours. Distinct lowercase letters indicate statistically significant differences based on Tukey's test ($P < 0.05$). (left) and PLS-DA analysis of VOCs in dried goji berry, fig, walnut, hazelnut, normal-oleic peanut, and high -oleic peanut, respectively. (right).

Table 1 Characteristic VOCs (VIP>1) from six commodities in the PLS-DA model.

№.	retention time (min)	VOCs	CAS	relative content (%)					
				goji berriy	fig	walnut	hazelnut	normal-oleic peanut	high-oleic peanut
1	3.820	octane	111-65-9	36.99±4.36a	39.09±5.64a	35.84±6.21ab	26.06±4.89b	10.32±2.56c	—
2	10.814	ethyl caproate	106-30-9	—	0.81±0.14		0.11±0.03	—	—
3	12.025	2-ethyl-1-hexanol	104-76-7	0.32±0.03c	0.6±0.08b	0.21±0.02c	0.19±0.01c	—	1.71±0.01a
4	14.480	undecane	112-42-5	0.39±0.05b	—	1.57±0.04a	—	0.68±0.04b	—
5	14.655	nonanal	124-19-6	0.78±0.04b	1.49±0.04a	0.83±0.02b	0.52±0.01c	0.65±0.04c	0.15±0.01d
6	22.625	hexadecane	544-76-3	0.84±0.05b	2.48±0.13a	0.33±0.04c		0.71±0.15b	0.53±0.01b
7	43.840	eicosane	112-95-8	0.86±0.13a	0.45±0.08b	0.44±0.07b	0.22±0.04c	0.41±0.03b	0.77±0.08a

Data in the table are presented as mean ± SE (N = 3). Different letters within the same row indicate significant differences (one-way ANOVA, Tukey's test, $p < 0.05$). The symbol “—” indicates that volatile organic compounds were not detected in tested commodities.

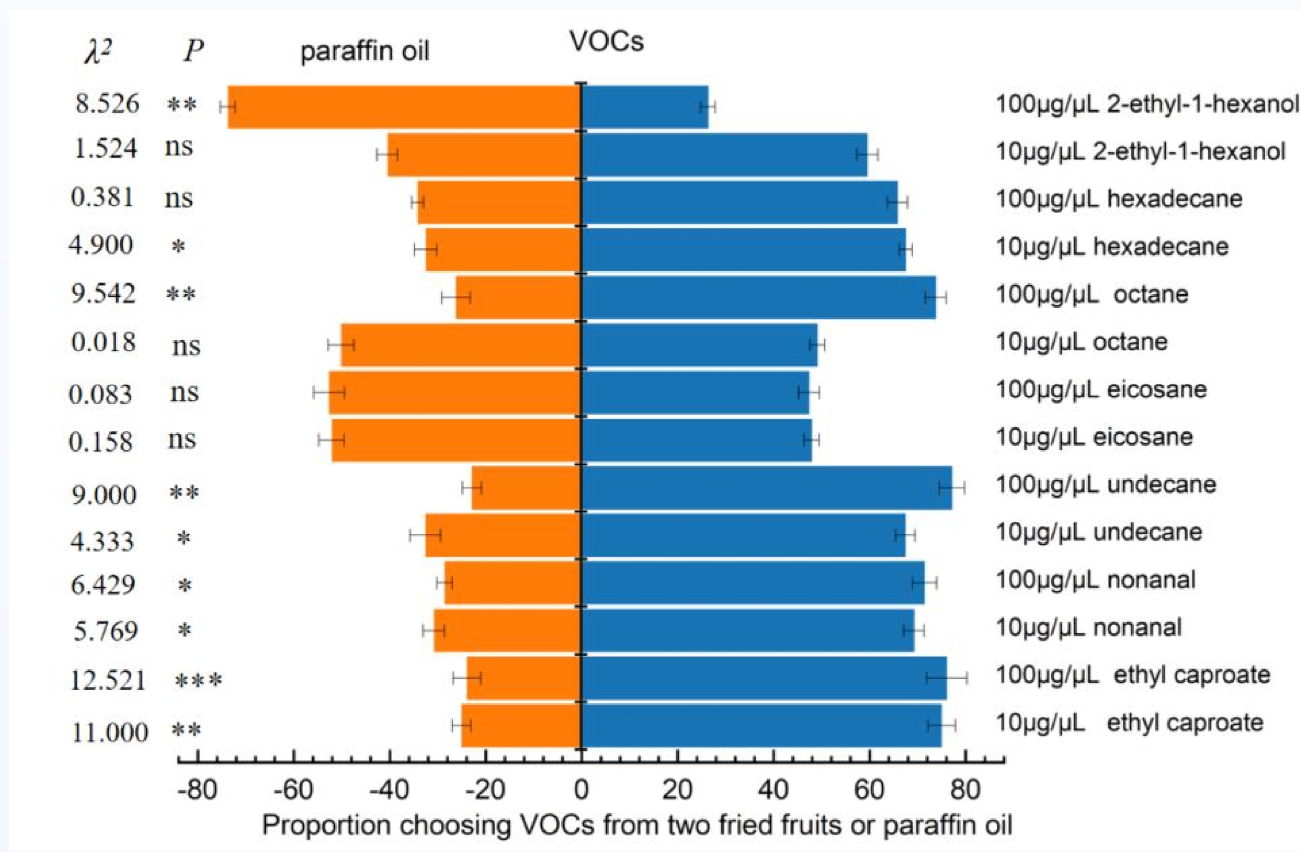

Figure 2. Behavioral responses of mated females to VOCs from tested commodities by Y-tube olfactometer bioassay. “**” represents a difference at $P < 0.01$ level; “*” represents a difference at $P < 0.05$ level; ns = not significant. .

DISSCUSION

- *P. interpunctella* females showed strong oviposition preference for normal-oleic peanut, walnut, hazelnut, goji berry, and fig, which was associated with higher levels of attractive volatiles such as nonanal, octane, undecane, and ethyl caproate.
- The repellent volatile 2-ethyl-1-hexanol, more abundant in high-oleic peanut, significantly reduced female attraction and oviposition behavior.
- These findings highlight the potential of specific VOCs to be developed as attractants or repellents for monitoring and managing *P. interpunctella* infestations in stored products..