

Phytochemical profile of bark tissues of two commercial species of *Coffea* contributing to pesticidal properties against coffee white stem borer (*Xylotrechus quadripes* Chevrolat)

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ABSTRACT

Coffee is the most widely consumed beverage globally. The two commercial coffee species are *Coffea arabica* (Arabica) and *Coffea canephora* (Robusta). The economically important pest of coffee is *Xylotrechus quadripes*, known as the coffee white stem borer (CWSB), which causes extensive damage to Arabica coffee. Arabica coffee is totally susceptible to CWSB, while Robusta is tolerant to this pest. CWSB female adults deposit eggs beneath the scaly bark of the main stem, where the early instar larvae hatch and tunnel through the corky bark, feeding on the tissue just below the phloem layer, resulting in bark splitting and formation of ridges around the stem. To investigate the underlying phytochemical differences between the two contrasting *Coffea* species and the interspecific coffee hybrid, bark tissues were analysed using Gas Chromatography-Mass Spectrometry (GC-MS) to identify unique phytochemicals. Significant variations in metabolic profiles were identified between the two *Coffea* species and the interspecific hybrid. Although a total of 40, 42 and 35 phytochemicals were detected in Arabica, Robusta and Sln. 11, respectively, a few phytochemicals such as 1-Octadecene, Hexadecanoic acid, and Flavone are associated with CWSB resistance, as they contain female-larva aggregation pheromones and exhibit pesticidal and insecticidal properties, respectively. Bioassay studies showed evidence of resistance/tolerance in these genotypes against CWSB. The potential use of these genotypes to combat CWSB through Integrated Pest Management in coffee cultivation is discussed.

Keywords: Coffee White Stem Borer, phytochemicals, insecticidal property, Integrated Pest Management.

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INTRODUCTION

Coffee is popularly known as "brown gold" and is considered the highest-value commodity cash crop in the world after petrol and oil (Leroy *et al.*, 2006). India is the seventh-largest producer of coffee, with 395,000 metric tons of coffee exports that earn nearly 10 billion US dollars annually (Santosh Rajus *et al.*, 2021). Coffee belongs to the genus *Coffea* (Rubiaceae) with

over 100 species (Bridson and Verdcourt 1988; Stoffelen 1998; Davis *et al.*, 2006). However, commercial species of coffee is mainly derived from two species, namely *Coffea arabica*, which accounts for 70% of the global market and *Coffea canephora* (robusta), with the rest of 30% contribution (Bridson and Verdcourt 1988; Stoffelen, 1998; Davis *et al.*, 2006; Ferreira *et*

al., 2016). These two species are contrasted in characters genetically with several agronomic traits on account of coffee leaf rust disease (*Hemeilia vastatrix*) and Coffee White Stem Borer (*Xylotrechus quadripes*) (Clarke, 2003., Adriana Farah, 2012; Venkatesha, 2020; Parajuli *et al.*, 2025). *C. arabica* is the only self-fertile, allotetraploid species in the genus, whereas the other species of *Coffea* are diploid and self-incompatible (Lashermes *et al.* 2011). *C. arabica* is highly susceptible to Coffee white stem borer (CWSB), whereas *C. canephora* is highly tolerant to CWSB (Venkatesha *et al.*, 2012; Pandey *et al.*, 2022). Arabica coffee breeding is a continuous process in many Arabica coffee-growing countries and is not limited, as this species is often susceptible to major pests and diseases, unlike robusta coffee, which is hardy and tolerant of these (Wintgens, 2009).

An interspecific hybrid, popularly known as Sln. 11, a hybrid between *C. liberica* x *C. eugenioides*, became the most tolerant variety to CWSB (Ram *et al.*, 2008). CWSB causes annual crop damage of 17-40 million US dollars to the Indian Coffee Industry (Santosh Rajus *et al.*, 2021) and is the most threatening pest to Arabica coffee, with 93% annual crop loss (Basavaraj *et al.*, 2024). CWSB lifecycle spans approximately one year. Female adults lay eggs beneath the scaly bark of the coffee plant's main stem. The larvae hatch and tunnel through the bark, feeding on the tissue just below the phloem layer for about two months. This feeding behaviour causes bark splitting and the formation of ridges around the stem, causing the complete death of the plant (Roobak Kumar *et al.*, 2019). It was estimated that the economic losses caused by uprooting white stem borer-infested plants at a rate of 1 plant per ha amount to about US\$ 642,585 annually in India (Radhakrishnan *et al.*, 1992). In India, over nine million trees are destroyed each year due to CWSB infestation, costing around \$40 million annually for replacement and loss of coffee production. In India, CWSB is a deadly pest of arabica plants and causes extensive damage to the plants and overall coffee production (Venkatesha, 2020). This study provides a complete profile of phytochemical groups in the

two *Coffea* species that contribute to durable resistance to fungal pathogens and insect pests. The utility of the present finding for coffee varietal improvement against CWSB and its possible application to reduce the use of inorganic insecticides in coffee cultivation are discussed. Include very clear objectives of your study

MATERIALS AND METHODS

Collection of samples

Mature trunks from 20-year-old *C. arabica*, *C. canephora* and Sln-11 (a hybrid between *Coffea liberica* x *Coffea eugenioides*) were collected in the germplasm block of Central Coffee Research Institute, Chikmagalur District, Karnataka (13 ° 22" North Latitude and 75 ° 28" East Longitude at an elevation of 824 – 884 MSL). Morphology and cropping behaviour of Arabica coffee, along with an infested stem by CWSB, are shown (Fig. 1).



Figure 1. Mature plant of *Coffea arabica*- About 15 year old healthy plant with fresh vegetative branches and foliage (a); plant showing cropping of ripe cherries at harvesting stage (b); mature plant showing infested portion of the stem with ridges – shown in arrow mark (c); Pin hole tunnel made by Coffee White Stem Borer for entry - shown in arrow mark (d); Close up view of damaged bark as split of bark after severe infestation by CWSB (e); damaged part of inner issues of the stem with larvae (f). Figures (d-f) were sourced from Manikandan *et al.*, 2019)

These three coffee genotypes are morphologically distinct with different bush sizes and unique bark surfaces. In addition, their Reaction to various pests and diseases varies under field conditions (Table 1).

Table 1. Major pests and diseases of *Coffea arabica* (Arabica Coffee) and *Coffea canephora* (Robusta Coffee)

Pests/Diseases	Causative agents	Reaction to Pest and Diseases			Citations
		Arabica	Robusta	Sln.11	
White Stem Borer	<i>Xylotrechus quadripes</i>	S	T	ST	Venkatesha <i>et al.</i> , 2012
Coffee berry borer	<i>Hypothenemus hampei</i>	S	S	S	Damon, 2000
Shot hole borer	<i>Xylosandrus compactus</i>	S	S	S	Harish <i>et al.</i> , 2024
Root knot	<i>Meloidogyne</i> sps	S	S	S	Roxana Myers <i>et al.</i> , 2023
Leaf rust	<i>Hemileia vastatrix</i>	S	T	ST	Pedro Talhinhos <i>et al.</i> , 2017
Anthraxnose	<i>Colletotrichum kahawae</i>	S	S	S	Santoshreddy <i>et al.</i> , 2021
Collar rot	<i>Fusarium stilboides</i>	S	S	S	Soundara Rajan <i>et al.</i> , 2022
Coffee berry disease	<i>Colletotrichum kahawae</i>	S	S	S	Abdi Mohammed <i>et al.</i> , 2015

S- Susceptible; T- Tolerant; ST- Semi Tolerant.

The outer bark was meticulously scraped with a fine knife and made into smaller pieces. These pieces were sun-dried and milled to produce a fine powder. Care has been taken to avoid mixing of samples by thorough cleaning after milling of each sample. The powders were stored in sterile polypropylene bags and maintained at room temperature throughout the study.

Preparation of the extract by the maceration method

About 60 grams of powder samples from *Coffea arabica*, *Coffea canephora* and Sln.11 were separately immersed in a 250 mL sterile flask containing ethanol. Soaking was performed in a sealed flask for 72 hours. Samples were shaken every 6 hours to facilitate extraction. Following the above method, the supernatant from each sample was filtered through Whatman No. 1 filter paper. The filtered extracts were concentrated using a rotary evaporator (Heidolph, Germany) under reduced pressure at 37°C to obtain semisolid crude extracts. The concentrated extracts were carefully collected, and the remaining residues were discarded. The final semisolid crude extracts were stored at 4°C in sterile borosilicate vials for further analysis by following the standard method (Abdullah *et al.*,

2020)

Gas chromatography-Mass spectrometry (GC-MS) Analysis and profiling

GC-MS analysis was performed using a JOEL GC Mate coupled with a secondary electron multiplier, and the gas chromatography was conducted on an Agilent Technologies 6890N Network GC system. The chromatographic separation was achieved using a fused silica column (HP5) with dimensions of 50 mm × 0.25 mm I.D. The experimental conditions included an initial column temperature of 100°C for 20 minutes, followed by 235°C for 3 minutes. The injector temperature was maintained at 240°C, with helium as the carrier gas at a split ratio of 5:4. The injector containing a 1.0 µL sample was introduced at 300°C, with a total run time of 22 minutes. The identification of phytochemically active and thermally stable compounds was accomplished through the combined GC-MS analysis. Phytochemicals were compared with NIST (National Institute of Standards and Technology) standards.

Bioassay

A simple bioassay is used to assess larval activity. One gram of fine powder of *C. arabica*, *C. canephora* and Sln.11 samples was placed at the centre of the sterile Petri plates, and larvae collected from the arabica stem were allowed in

the Petri plates to feed on the powder samples. The final weight of the powdered sample was measured to determine the amount of stem powder remaining in the Petri plates. A similar experiment was done with the ethanolic extracts of all three samples. Extracts were placed on sterile muslin cloths to absorb, then placed at the centre of Petri plates. Five replicate trials, each with 20 active larvae, were tested for behavioural responses, and the results were documented.

Data analysis

Data processing was conducted using the Automated Mass Spectral Deconvolution and Identification System (AMDIS), a tool developed by the NIST. This tool facilitates mass spectral deconvolution, peak picking and identification with target compound libraries generated from the NIST 20 mass spectral library. Peak identification was subsequently confirmed using Agilent Mass Hunter Qualitative Analysis software for gas chromatography-mass spectrometry (GC-MS). This software was also employed to create batch and method files, which are integrated by the RTE (Real-Time Executive) integrator for quantification of samples from *Coffea arabica*, *Coffea canephora*, and Sln.11. ANOVA was performed to determine the significance of treatments on CWSB, and the results are presented.

RESULTS AND DISCUSSIONS

Phytochemical profiles of *Coffea arabica*

Over 40 compounds were detected in *Coffea arabica*, and 11 compounds were found to share commonality with *C. canephora* and Sln.11. GC-MS Chromatogram along with major class of phytochemicals identified in this study is presented (Fig. 2a and Fig. 3a). Biological activities of these compounds are Aromatic Amides, Aromatic Hydrocarbons, Alkenes, Fatty Acid Derivatives, Aldehydes and Carboxylic Acids, and Sugars described below: Aromatic Amide Oxamide N, N'- bis (2'-acetylphenyl) is predominantly (39.8%) present in the bark of Arabica coffee, and these compounds are reported to contain antifungal activity (Meenambiga and Rajagopal, 2018). Aromatic Hydrocarbons, such as 9-Oximino-2,7-diethoxyfluorene (18.43%), a fluorene

derivative, have been reported to have antimicrobial properties (Benoite and Nora 2021; Etsassala *et al.*, 2019). Notable alkenes include 1-Octadecene (3.96%), E,E,Z-1,3,12-Nonadecatriene-5,14-diol (17.89%), and (Z)-4-tridecene, 1-Tetradecene. These compounds are recognised for their antifungal, antibacterial and insecticidal activities. They also exhibit antioxidant potential and act as aggregation pheromones for the Coffee White Stem Borer (CWSB) (Mangalgikar *et al.*, 2023; Mustapha *et al.*, 2016; Mokhtar *et al.*, 2021; Adeniyi *et al.*, 2019; Mohamad Al-Qudah, 2023).

Hexadecanoic acid, methyl ester (4.95%), Oleic acid (5.15%), 11-Octadecanoic acid, methyl ester (77.3%), and (E)-9-Octadecenoic acid ethyl ester (4.40%) were present in the bark of Arabica and reported to show a range of biological activities including antibacterial, antifungal, pesticidal and nematocidal properties and with notable larvicidal effects (Chandrasekaran *et al.*, 2021; Satyan *et al.*, 2009; Diplock *et al.*, 1988; Banaras *et al.*, 2020). The presence of a Flavonoid, flavone (12.25%), provides antibacterial properties (Meenambiga and Rajagopal, 2018; Yang *et al.*, 2015). Aldehydes and Carboxylic Acids, such as Nonanal, an aldehyde, are utilised for their rose-like fragrance in perfumery. Nonanoic acid (pelargonic acid), a carboxylic acid, serves as a herbicide. Phenol, 2,4-bis (1,1'-dimethylethyl) is a phenolic compound used as an herbicide and insecticide in agriculture (Fernando *et al.*, 2025). Sugar, D-mannose acts as a mannose toxicity agent in honeybees (de la Fuente Mónica *et al.*, 1986).

Phytochemical profiles of *Coffea canephora* (Robusta)

Over 42 principal compounds were detected in *C. canephora*, with 9 compounds common to *C. arabica* and Sln.11. The various classes of compounds and their biological activities are described below and presented (Fig. 2b and 3b). Dihydro-normorphine, 3-desoxy- (29.83%), a morphine derivative, was reported for its clinically proven antinociceptive properties. Additionally, 1,2-dihydro-2-methylpavaverine, which contains pavaverine, exhibits a wide range of pharmacological properties (Zarin *et*

al., 2023; Ashrafi *et al.*, 2023).

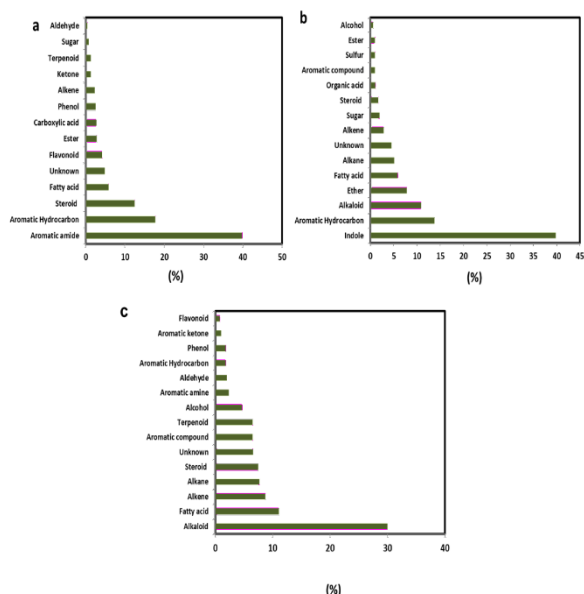


Figure 2. Gas Chromatography and Mass Spectrometry (GC-MS) chromatogram of ethanolic extracts of bark tissues of *Coffea arabica* -Arabica Coffee (a); *Coffea canephora* – Robusta Coffee (b); and Sln.11- a hybrid of *C. liberica* and *C. eugenioides* (c).

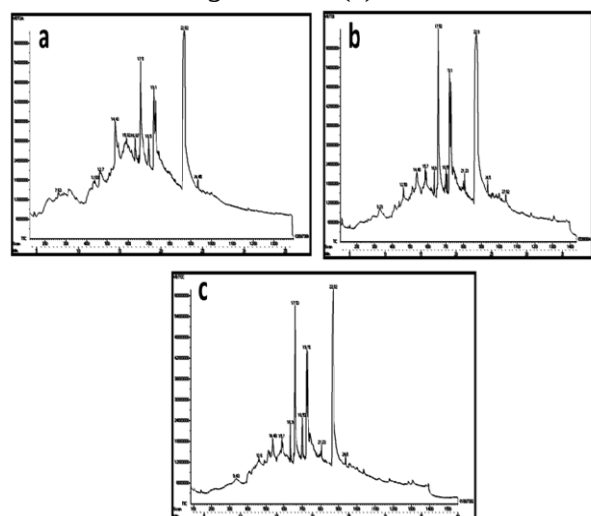


Figure 3. Phytochemicals classified from Gas Chromatography and Mass Spectrometry (GC-MS) analysis of ethanolic extracts of bark tissues of *Coffea arabica* -Arabica Coffee (a); *Coffea canephora* – Robusta Coffee (b); and Sln.11- a hybrid of *C. liberica* and *C. eugenioides* (c). Each class of compounds was represented as a percentage. Compounds such as Octadec-9-enoic acid (16.61%) exhibit insecticidal properties, while Hexadecanoic acid, ethyl ester (18.73%) shows anti-inflammatory, antioxidant, pesticide, and nematocidal activities. Pentadecanoic acid methyl

ester (18.44%) is recognised for its antioxidant, antiviral, and anticancer properties. Oleic acid (22.89%) and (E)-9-octadecenoic acid ethyl ester (22.04%) have been demonstrated to exhibit antibacterial, antifungal, antioxidant, antidiarrheal, anti-inflammatory, pesticidal, and nematocidal activities, with confirmed larvicidal effects (Satyan *et al.*, 2009). 9-Oximino-2,7-diethoxyfluorene (26.99%) is notable for its antimicrobial and antidiabetic properties (Benoite and Nora, 2021; Etsassala *et al.*, 2019). Nicotinic acid, 2-(benzylamino) (6.41%), is used as an insecticide and is predominantly present in *C. canephora*. Notably, 1H-indole, 3-(3,7,11,15-tetramethylhexadeca-2,6,10,14-tetraenyl) (39.8%) is an indole, highly present in robusta but lacking specific biological properties.

Phytochemical profiles of *C. liberica* x *Coffea eugenioides* (Sln.11)

Over 35 compounds were identified in Sln-11, with 10 compounds shared by *C. arabica* and *C. canephora*. The following are the various classes of compounds with their biological activities (Fig. 2c and 3c). Alkaloid, Dihydro-normorphine, 3-desoxy- (30%) is a notable morphine derivative with well-documented antinociceptive properties and is mostly present in Sln-11 (Zarin *et al.*, 2023). Geranyl isovalerate (15.13%) is identified as a terpenoid with applications as a flavouring agent. It is also reported to have antimicrobial and anticancer activities (Perumal *et al.*, 2021).

Heneicosane (15.0%), Eicosane (13.14%) and other saturated hydrocarbons in this group had demonstrated significant antimicrobial, antifungal, anti-inflammatory and antitumor properties (Perumal *et al.*, 2021). Oleic acid (21.34%) and Oxirane octanoic acid, 3-octyl-, methyl ester, are fatty acid derivatives with a range of biological activities. These include antibacterial, antimicrobial, antifungal, antioxidant, antidiarrheal, anti-inflammatory, pesticide, nematocidal, and antiproliferative properties, with proven larvicidal effects (Satyan *et al.*, 2009).

Flavone (12.25%), a flavonoid, provides antioxidant, anti-inflammatory, antibacterial, antimicrobial and anticancer benefits (Meenambiga and Rajagopal, 2018; Yang *et al.*,

Table 2. Phytochemicals from *C. arabica* (Arabica), *C. canephora* (Robusta) and hybrid (Sl-11) associated with control of bacteria (B), fungi (F) and insects (I)

Phytochemicals	Control to			Presence/Absence in			REFERENCE
	B	F	I	Arabica	Robusta	Sl-11	
9-oximino-2-7-diethoxyfluorene	+	-	-	✓	✓	-	Benoite and Nora, 2021;
1-Octadecene		+	+	✓	-	-	Madhavan <i>et al.</i> , 2021; Emmanuel Uka <i>et al.</i> , 2022; Mangalgikar <i>et al.</i> , 2023.
Hexadecanoic acid, methyl ester	+	+	+	✓	-	-	Mustapha <i>et al.</i> , 2016; Chandrasekaran <i>et al.</i> , 2011; Khanday and Sharma 2021; Abdullah 2019; Rizvi <i>et al.</i> , 2023, Shaaban <i>et al.</i> , 2021.
Oleic acid	+	+	+	✓	-	-	Shaaban <i>et al.</i> , 2021; Awa <i>et al.</i> , 2012; Satyan <i>et al.</i> , 2009, Elliot 1997; Balasubramanian <i>et al.</i> , 1988, 1989; Diplock <i>et al.</i> , 1988.
11-Octadecanoic acid, methyl ester	+	+	+	✓	-	-	Susanto <i>et al.</i> , 2021, Shoge and Amusan, 2020; Ali Reza <i>et al.</i> , 2021, Zaman <i>et al.</i> , 2020, Banaras <i>et al.</i> , 2020.
Flavone	+	+	+	✓	-	✓	Denisa <i>et al.</i> , 2023, Pereira <i>et al.</i> , 2024
E,E,Z-1,3,12-Nonadecatriene-5,14-diol	+	+	-	✓	-	-	Elaiyaraja <i>et al.</i> , 2016; Perumal <i>et al.</i> , 2021; Mercy <i>et al.</i> , 2023; Mohammed <i>et al.</i> , 2016; Prabha <i>et al.</i> , 2019; Omotoso and Igbinaduwa, 2018.
Nonanoic acid	-	-	+	✓	-	-	Fernando <i>et al.</i> , 2025
4-Tridecene, (Z)-	-	-	+	✓	-	-	Junwei, <i>et al.</i> , 2000
Oxamide, N,N'-bis (2'-acetylphenyl)	-	+	-	✓	-	-	Meenambiga and Rajagopal, 2018.
Phenol, 2,4-bis 1,1' dimethylethyl)	-	-	+	✓	-	✓	Yang <i>et al.</i> , 2015
d-Mannose	-	-	+	✓	-	-	de la Fuente Mónica <i>et al.</i> , 1986
Octadec-9-enoic acid	-	-	+	-	✓	-	Mokhtar <i>et al.</i> , 2021
Hexadecanoic acid, ethyl ester	-	-	+	-	✓	-	Thoria <i>et al.</i> , 2021; Wirot <i>et al.</i> , 2023; Adeniyi <i>et al.</i> , 2019; Madhavan <i>et al.</i> , 2021; Emmanuel Uka <i>et al.</i> , 2022.
1-Tetradecene	-	-	+	-		-	Wittko Francke and Stefan Schulz, 1999.
Geranyl isovalerate	+	+	-	-	-		Fayyaz Rasool <i>et al.</i> , 2021, Mahmoud A. Al-Qudah, 2023.
Heneicosane	+	+	-	-	-	✓	Vanitha <i>et al.</i> , 2020
Eicosane	+	+	-	-	-	✓	Akpuaka <i>et al.</i> , 2013, Hsouna <i>et al.</i> , 2011, Abbirami Balachandran <i>et al.</i> , 2023, Patrick, 2020
Oxiraneoctanoic acid, 3-octyl-, methyl ester	+	+	-	-	-	✓	Hussein <i>et al.</i> , 2016, Yalpi Karthik <i>et al.</i> , 2023

Plus mark indicates the effectiveness of phytochemicals over bacteria, fungi and insects and their presence in the coffee genotypes

2015; de la Fuente *et al.*, 1986). Phenol, 2,4-bis (1,1'-dimethylethyl) is a phenolic compound predominantly used in agricultural applications as an herbicide and insecticide (Yang *et al.*, 2015).

This study highlights the diverse biological activities of compounds present in *C. arabica*, *C. canephora* and Sln-11, emphasizing their expected differential reactions against various diseases and pests in the genus *Coffea* (Table 2). *C. canephora* is the only commercial species accounting for resistance to the major pest of CWSB. To introduce the resistance to CWSB, interspecific hybrids involving *C. canephora* with other diploid and tetraploid coffee genotypes are attempted in many coffee-growing countries (Prakash *et al.*, 2004). However, a high degree of susceptibility to CWSB remains a major problem. The underlying mechanism of resistance to CWSB is understood to some extent in this study by eliciting the differences of phytochemicals detected in *C. arabica*, *C. canephora* and Sln.11 (a putative hybrid between *C. liberica* and *C. eugenioides*). There were 42, 40 and 35 compounds detected in the ethanolic extracts of

C. arabica, *C. canephora* and Sln. , respectively, with about 10-13 compounds shared between them, and the rest of the compounds were unique to each *Coffea* genotype. Extraction of bark tissues with other solvents is expected to provide further insights into the identification of several other compounds linked to resistance to CWSB. There were some compounds, such as 1-Octadecene, reported to be associated with Female aggregation pheromones (Emmanuel Uka *et al.*, 2022; Mangalgikar Prashant *et al.*, 2023), Hexadecanoic acid, a compound known for pesticidal and nematocidal activity (Chandrasekaran *et al.*, 2021; Abdullah, 2019), and Flavone with insecticidal property (Denisa *et al.*, 2023). Therefore, these compounds are expected to be potential biochemical markers for diagnosing CWSB-tolerant genotypes across a wide range of coffee germplasm.

Bioassay experiments carried out in this study revealed a differential amount of feeding with mortality rate of CWSB larvae upon challenging the larvae of CWSB with powder samples and ethanolic extracts obtained from bark tissues of *C. arabica*, *C. canephora* and Sln.11 (Table 3).

Table 3. Bioassay with powder and ethanolic extracts of bark for movement and feeding activity of Coffee White Stem Borer – Data collected after 21 days.

Genotypes	Feeding activity		Feeding capacity (%)		Death of Larvae (%)	
	P	EE	P	EE	P	EE
<i>C.arabica</i>	+++	+++	47.25 ±3.13 ^a	40.24 ±3.25 ^a	12.25±1.75 ^{abc}	14.50 ±1.25 ^{abc}
<i>C.canephora</i>	+	+	12.50 ±2.50 ^{abc}	10.50 ±1.24 ^{abc}	46.25±2.25 ^a	42.25 ±2.50 ^a
Sln.11	++	++	16.25 ±1.50 ^{ab}	13.25 ±1.50 ^{ab}	39.26±3.25 ^{ab}	40.50 ±3.25 ^{ab}

Values within each column followed by different letters of superscript are significantly different ($P < 0.05$), P- Powder samples and EE – Ethanolic Extract

+++ Active movement: ++ slowest activity without movement; + slower activity around the samples
Feeding Capacity (%): amount of powder extracts consumed/Total weight of powder or crude extract given x 100

Feeding activity, feeding capacity and survival rate of larvae were higher in *C. arabica* than *C. canephora* and Sln.11, revealing the possible role of phytochemicals associated with repellent activity against CWSB in *C. canephora* and Sln.11. Breeding for resistant varieties utilising the diploid origin of *Coffea* is the primary source of genes for pest resistance in Coffee breeding. Distinct movement of CWSB larvae was recorded during the bioassay experiment.

Behaviour of CWSB Larve against ethanolic extracts of bark.

Challenging larvae with the ethanolic extracts of bark powder of *C. arabica* for 48 hrs had revealed an active movement of larvae around the stem powder and lesser mortality after two weeks of maintenance of larvae. Treatment with a similar extract of *C. canephora* kept the larvae away from the feeding point. Larvae were active for three days, followed by slow movement and

higher mortality after two weeks of feeding. In case of Sln.11, larvae were relatively far from the feeding point and active for five days, followed by slow movement. Higher mortality was observed after two weeks of feeding. The present findings are expected to be useful for further studies in a similar direction to understand other potential phytochemicals associated with CWSB.

Implications of Coffee Genetic Improvement

Utilization of tolerant or resistant varieties of crop in agriculture is one of the strategies for integrated pest management (IPM) that reduces the input of harmful inorganic insecticides in food crops. Therefore, identification of more useful biochemicals linked with CWSB in commercial coffee varieties are expected to be useful for screening tolerant genotypes of coffee against CWSB and also to develop viable strategies in IPM. Utilisation of such genetic resources would lead to lesser usage of inorganic pesticides and encourage eco-friendly farming of coffee.

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AUTHOR'S CONTRIBUTION

Vasuki Ramu and Jeyalakshmi Venkatesan: extraction, GC-MS analysis and data preparation; Sivakumar Shanmugam and Vasantha Vairathevar Sivasamy: technical and analytical support of GC-MS data; Soundara Rajan Sannasi: coffee sample collection and identification; Thilaga Sethuraman: manuscript draft preparation; Ganesh Doss: Conceptualisation, writing and editing of manuscript.

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