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Comparative growth and food conversion efficiency of *Acherontia atropos* larvae on different host plants

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Abstract

The host plant is specific for an insect, an important aspect in herbivorous insects, predominantly in the Lepidoptera order of insects. Host plant preference is a significant characteristic in maintaining local biodiversity and lepidopteran ecology. This aimed to investigate larval feeding preference, growth performance, nutritional efficiency, and estimate the excreta, the bio macromolecule, secondary metabolites of *A. atropos* caterpillars treated with host plants treated *J. sambac*, *C. inerme*, and *M hortensis* under laboratory conditions. Larvae fed on *J. sambac* consumed the sinificanty highest quantity of foliage ($\bar{x} = 42.37$, $F_{3,41} = 463.73$, $p < 0.001$) and growth (3.44 ± 0.12^{a}), Consumption Index ($\bar{x} = 3.84 \pm 0.12$, $F_{3,41} = 21.82$, $p < 0.005$), growth rate R ($\bar{x} = 0.46 \pm 0.02$, $F_{3,41} = 29.56$, $p < 0.001$), Efficiency of Conversion of Ingested food ($\bar{x} = 38.2 \pm 1.6$, $F_{3,41} = 25.48$, $p < 0.01$). The excreta of *A. atropos* larvae exhibited distinct variations in color, texture, and size depending on the host plant consumed. The excreta protein ($\bar{x} = 8.9 \pm 0.3$, $F_{3,11} = 75.82$, $p < 0.005$), carbohydrate ($\bar{x} = 12.5 \pm 0.4$, $F_{3,11} = 53.12$, $p < 0.001$), *J. sambac and C. inerme* fed larvae. The mineral potassium and calcium (Ca) rich in excreta of *J. sambac* fed larvae. Magnesium and iron were moderately present, and trace amount of zinc and manganese (Mn) were consistently detectable in all samples. Phytochemical screening of *A. atropos* larval excreta revealed 11 major secondary metabolites are varied significantly present in the all-host plant feed tested excreta depending on the host plant consumed. Alkaloid ($\bar{x} = 2.8 \pm 0.1$ mg/100 g), Flavonoids ($\bar{x} = 4.5 \pm 0.2$ mg/100 g), flavonoid ($\bar{x} = 3.2 \pm 0.1$ mg/100 g), Saponins ($\bar{x} = 1.5 \pm 0.1$ mg/100 g), Terpenoids ($\bar{x} = 1.2 \pm 0.05$ mg/100 g). This study provides a systematic evaluation of host plant preference, larval growth, and nutritional efficiency of *A. atropos.* Higher protein, mineral, and bioactive compound levels in excreta from *J. sambac* fed larvae indicate differential nutrient assimilation and selective detoxification of host-derived phytochemicals. Overall, these results enhance our understanding of host plant selection and nutritional ecology in *A. atropos* and provide a baseline for predicting larval adaptability, population dynamics, and potential responses to changes in host plant availability.

Keywords: *A. Atropos, J. sambac,* feed, host, excreta, bio macromolecule, secondary metabolites

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Introduction

Host plant selection is a fundamental ecological and evolutionary process that shapes the life history, population dynamics, and adaptive success of herbivorous insects. In phytophagous Lepidoptera, larvae undergo their most resource-demanding stage, and the nutritional quality and chemical composition of host plants strongly influence their growth, survival, immune function, and eventual adult fitness (Wetzel *et al.*, 2016) [1]. However, host plant suitability is not uniform; it arises from the interplay of nutrient availability, secondary metabolites, and physical leaf traits, which together determine larval performance (Behmer & Joern, 2012) [2]. Recent studies in nutritional ecology highlight that the macronutrient content of host plants—particularly the balance of proteins and carbohydrates, nitrogen content, and carbon-to-nitrogen ratios—has a decisive role in larval feeding behavior and physiological efficiency (Deans *et al.*, 2017) [3]. Lepidopteran larvae demonstrate plasticity in consumption and assimilation, often adjusting intake to compensate for suboptimal nutrient profiles. High-quality hosts promote faster development, higher growth rates, and improved conversion efficiency, whereas nutrient-poor plants can prolong development and reduce survival (Nandhini *et al.*, 2023) [4]. Experimental studies on *Spodoptera frugiperda* and *S. littoralis* further show that larval growth and nutritional indices are closely linked to host plant chemistry and nutrient composition (Ajmal *et al.*, 2024; El-Refaie *et al.*, 2024) [5. 6].

Secondary metabolites in plants, including alkaloids, phenolics, terpenoids, and glycosides, also significantly affect larval feeding and performance (Erb & Reymond, 2019) [7]. While specialist species may evolve mechanisms to tolerate or sequester these compounds, generalist feeders often exhibit reduced performance on chemically defended hosts (Endara *et al.*, 2017) [8]. Variation in secondary metabolites can sometimes outweigh nutritional advantages, creating trade-offs between larval growth and survival (Ramakrishnan *et al.*, 2021; Singh *et al.*, 2022) [9, 10]. The evolutionary tension between specialization and generalization remains central to understanding insect–plant interactions. Specialist larvae tend to perform efficiently on a narrow host range, while polyphagous species tolerate multiple hosts but may display variable growth across species. Meta-analyses support the preference–performance hypothesis, suggesting that adult oviposition choices often align with larval success, though environmental variability and plant chemistry can modulate this correlation (Oliveira *et al*., 2020; Patel *et al*., 2023) [11].

Acherontia atropos (Linnaeus), the death's-head hawk moth, is a large sphingid moth with a broad host range, including plants from Oleaceae, Verbenaceae, and Bignoniaceae. Despite its ecological importance, empirical data on larval host preference and nutritional efficiency under Indian agro-ecological conditions remain limited. Recent studies in southern India highlight the need for controlled experiments to evaluate host plant suitability and larval adaptability (Subramanian *et al*., 2021; Ramesh *et al*., 2022) [12,13].

This study investigates larval feeding preference, growth performance, and nutritional efficiency of *A. atropos* caterpillars on three host plants—*Jasminum sambac*, *Clerodendrum inerme*, and *Millingtonia hortensis*—under laboratory conditions in Thoothukudi district, Tamil Nadu. By integrating consumption and growth indices, the study aims to elucidate how host plant quality affects larval performance and contributes to a broader understanding of nutritional ecology in sphingid moths.

Materials and Methods

Study Species and Host Plants

The death's-head hawk moth, *A. atropos* (Linnaeus), is a large sphingid widely distributed across tropical and subtropical regions. Third-instar larvae were sourced from laboratory-reared colonies maintained at the Department of Zoology, Pope's College (Autonomous), Thoothukudi, Tamil Nadu, India. Larvae were reared on *J. sambac* for two generations under controlled conditions to standardize nutritional history and minimize maternal effects. Three host plants were chosen based on documented larval associations and ecological relevance: *J. sambac* (Oleaceae), *C. inerme* (Verbenaceae), and *M. hortensis* (Bignoniaceae). Fresh, fully expanded leaves were collected daily from healthy, pesticide-free plants grown in the college botanical garden.

Rearing of larvae

Larvae were housed individually in ventilated plastic containers (15 × 10 × 10 cm) under controlled laboratory conditions: 27 ± 2 °C, 70 ± 5% relative humidity, and a 12:12 h light: dark photoperiod (Singh & Kumar, 2020) [14]. Containers were cleaned daily, and fresh leaves were supplied ad libitum to prevent food limitation. All procedures followed standard entomological protocols to minimize handling stress.

Feeding Preference Assays

No-choice assays were performed to evaluate feeding preference. Fifteen third-instar larvae were randomly assigned to each host plant, and pre-weighed leaves were provided. Leaf consumption was measured over 24 hours using a transparent grid to estimate leaf area (cm²). Observations were repeated for five consecutive days, and daily consumption per larva was averaged (mean ± SE).

Larval Growth Performance

Initial larval weights were recorded using an analytical balance (± 0.01 g). Larvae were weighed every two days until pupation. Weight gain and growth rate (GR) were calculated as

Weight Gain = Final Weight − Initial Weight

GR = Final Weight − Initial Weight
Duration of Feeding (days)

Nutritional Indices

Food utilization was determined using standard gravimetric indices, Consumption Index (CI), Efficiency of Conversion of Ingested Food (ECI, %) were calculated using given formula

CI = Dry weight of food ingested Mean larval biomass × Du ration food ingested

ECI = Weight gained by larva Dry weight of food ingested ×100

Larval frass was collected, dried at 60 °C for 24 h, and used to determine actual food ingested.

Excreta Sample Preparation

Dried excreta samples were finely powdered using a sterile mortar and pestle and stored in airtight containers at 4 °C until further analysis to prevent degradation of chemical constituents. Prior to analysis, samples were homogenized to ensure uniformity and reproducibility of analytical measurements (Singh & Kumar, 2020) [14].

Proximate Chemical Analysis

Moisture content was determined gravimetrically by oven-drying the samples at 105 °C, while ash content was estimated by incineration in a muffle furnace at 550 °C following standard analytical protocols (AOAC, 2016) [15]. Crude protein content was calculated using the Kjeldahl method by estimating total nitrogen and multiplying by a conversion factor of 6.25 to reflect protein content in insect-derived materials (Finke, 2015) [16].

Mineral Analysis

Mineral composition including calcium, potassium, sodium, magnesium, iron, and zinc was determined after acid digestion of excreta samples using atomic absorption spectrophotometry (AAS) to ensure accurate quantification (He *et al*., 2020) [17]. Phosphorus content was measured colorimetrically using the molybdenum blue method with absorbance recorded at 880 nm (Sparks *et al*., 2020) [18].

Phytochemical Screening

Qualitative phytochemical screening of excreta extracts was performed to detect alkaloids, flavonoids, phenolics, saponins, and tannins using standard colorimetric and precipitation assays (Harborne, 2016) [19]. Quantitative estimation of total phenolic content was conducted using the Folin–Ciocalteu method, with results expressed as mg gallic acid equivalents per gram of dry weight (Singleton *et al*., 2016) [20].

Statistical Analysis

Data were tested for normality (Shapiro–Wilk) and homogeneity of variance (Levene's test). One-way ANOVA assessed host plant effects on leaf consumption, growth, and nutritional indices. Tukey's HSD was used for post hoc comparisons ($p < 0.05$). Results are expressed as mean ± SE. Statistical analyses were performed using SPSS v26.0 (IBM Corp., Armonk, NY, USA) (Finney, DJ 1971) [21].

Results

Host Plant Preference and Leaf Consumption

Larvae of *A. atropos* exhibited significant variation in leaf consumption among the three host plants tested (*J. sambac, C. inerme,* and *M. hortensis*). One-way ANOVA revealed significant differences in mean leaf area consumed per larva among host plants ($\bar{x} = 42.37$, $F_{3,41} = 463.73$, $p = 0.001$). Larvae fed on *J. sambac* consumed the highest quantity of foliage, followed by *C. inerme* ($\bar{x}$ 31.4 ± 2.1, $F_{3,41} = 362.\ 873$, $p < 0.005$) while *M. hortensis* ($\bar{x} = 18.9 \pm 1.6$, $F_{3,41} = 172.\ 62$, $p < 0.076$) supported the lowest consumption.

Larval Growth Performance

Larval weight gain differed significantly among host plants (one-way ANOVA, $F_{4,41} = 57.28$, $p < 0.001$). Larvae reared on *J. sambac* exhibited the highest final body weight and total weight gain, whereas those feeding on *M. hortensis* showed the lowest growth. Larvae fed on *C. inerme* displayed intermediate growth performance (Table 1).

Table 1: Larval growth (g) parameters of *A. atropos* on different host plants

Host Plant	Initial Weight	Final Weight	Weight Gain	Df	F	P
J. sambac	0.82 ± 0.05	4.26 ± 0.18	3.44 ± 0.12^{a}	3,41	184.7	0.001
C. inerme	0.81 ± 0.04	3.58 ± 0.14	2.77 ± 0.11^{b}		120.32	0.008
M. hortensis	0.80 ± 0.06	2.91 ± 0.12	2.11 ± 0.09^{c}		103.7	0.010

Different letters indicate significant differences (Tukey's HSD, p < 0.05).

Consumption Index (CI)

The Consumption Index (CI) differed significantly among host plants ($\bar{x} = 3.84 \pm 0.12$, $F_{3,41} = 33.74$, $p < 0.001$). Larvae feeding on *J. sambac* $\bar{x} = 3.84 \pm 0.12$, $F_{3,41} = 21.82$, $p < 0.005$) recorded the highest CI, whereas *M. hortensis* ($\bar{x} = 2.11 \pm 0.08$, $F_{3,41} = 15.538$, $p < 0.009$) showed the lowest values.

Growth Rate (GR)

Growth Rate (GR) varied significantly among host plants. Larvae reared on *J. sambac (*$\bar{x} = 0.46 \pm 0.02$, $F_{3,41} = 29.56$, $p < 0.001$) had the highest GR, followed by *C. inerme* ($\bar{x} = 0.37 \pm 0.01$, $F_{3,41} = 21.82$, $p < 0.003$)) the lowest GR was recorded on *M. hortensis (*$\bar{x} = 0.29 \pm 0.01$, $F_{3,41} = 15.84$, $p < 0.010$).

Efficiency of Conversion of Ingested Food (ECI)

Efficiency of Conversion of Ingested food (ECI) showed significant host-dependent variation. Larvae fed on *J. sambac* ($\bar{x} = 38.2 \pm 1.6$, $F_{3,41} = 25.48$, $p < 0.01$) exhibited the highest ECI followed by *C. inerme* (32.4 ± 1.2, $F_{3,41} = 21.52$, $p < 0.05$), whereas those on *M. hortensis* ($\bar{x} = 26.8 \pm 1.0$, $F_{3,41} = 17.82$, $p < 0.09$) had the lowest efficiency.

The present study demonstrates that host plant quality is a major determinant of feeding behavior, growth, and nutrient utilization in *Acherontia atropos* larvae. Significant differences in leaf consumption, larval weight gain, and nutritional indices across the tested hosts indicate that larval performance is strongly dependent on the plant species consumed, a pattern widely observed in phytophagous Lepidoptera (Simpson *et al*., 2015; El-Refaie *et al*., 2024) [22, 6]. Among the host plants examined, *J. sambac* consistently supported the highest feeding rates, greater biomass accumulation, and superior conversion efficiency, suggesting that it represents an optimal host for *A. atropos* larvae. This enhanced performance likely reflects a combination of favorable macronutrient content, particularly nitrogen-rich proteins, and relatively low concentrations of deterrent secondary metabolites. Similar trends have been reported in studies showing that nutrient-rich hosts promote accelerated larval development and improved efficiency of conversion of ingested food (Deans *et al*., 2017; Nandhini *et al*., 2023) [3, 4].

Larvae reared on *M. hortensis* displayed reduced feeding and lower growth rates, suggesting that this host may possess suboptimal nutrient ratios or higher levels of chemical defenses. Prior research indicates that secondary metabolites such as alkaloids, phenolics, and terpenoids can suppress feeding, reduce relative growth rate, and impair digestive efficiency in Lepidopteran larvae (Erb & Reymond, 2019) [7]. The lower nutritional indices observed on *M. hortensis* align with these findings, as larvae allocate more energy to detoxification rather than growth (Endara *et al*., 2017; Singh *et al*., 2022) [8,10].

Performance on *C. inerme* was intermediate, reflecting its role as an alternative host. Polyphagous Lepidoptera often exploit multiple hosts with varying efficiency, adjusting feeding and assimilation to cope with suboptimal nutrient or chemical profiles (Oliveira *et al*., 2020; Kumar *et al*., 2021) [11,23]. Such plasticity likely provides ecological advantages in heterogeneous environments where preferred hosts are seasonally or spatially limited.

Variations in consumption index (CI), growth rate (GR), and efficiency of conversion of ingested food (ECI) further support the concept of nutrient regulation in herbivorous insects. Larvae consuming nutrient-poor hosts may increase intake to compensate for deficiencies, but this often reduces growth efficiency due to higher metabolic costs (Simpson *et al*., 2015; Deans *et al*., 2017) [22,3]. The present results corroborate recent evidence demonstrating that nutrient imbalances constrain digestive efficiency and limit larval fitness (Felton & Tumlinson, 2008; Nandhini *et al*., 2023) [4]. From an evolutionary perspective, the preference for and superior performance on *J. sambac* is consistent with optimal foraging theory and the preference–performance hypothesis. Meta-analyses indicate that adult oviposition preference often aligns with larval success, although environmental and chemical factors can modulate this relationship (Patel *et al*., 2023) [11].

Physical Characteristics of Larval Excreta

The excreta of *A. atropos* larvae exhibited distinct variations in color, texture, and size depending on the host plant consumed. Larvae fed on Jasminum spp. leaves produced excreta that were cylindrical, dark green to brown, and semi-moist, whereas those fed on Solanaceae leaves produced smaller, drier, and dark brown pellets. The mean excreta length and diameter are summarized in Table 2.

Table 2: Physical characteristics of *A. atropos* larval excreta on different host plants

Host Plant	Excreta Color	Excreta Texture	Mean Length (mm) ± SD	Mean Diameter (mm) ± SD
J. sambac	Dark green-brown	Semi-moist	12.4 ± 0.8	4.3 ± 0.5
C. inerme	Dark brown	Dry	8.7 ± 0.6	3.1 ± 0.3
M. hortensis	Light brown	Moist	10.2 ± 0.7	3.7 ± 0.4

The differences in excreta dimensions were statistically significant ($p < 0.05$) across all host plants, indicating that host plant type directly influences larval excreta morphology.

Chemical Composition

The chemical analysis of larval excreta revealed variations in nutrient content, secondary metabolites, and mineral composition, reflecting the differential digestion of host plant tissues.

Macronutrient Content

The macronutrient analysis (g/100 g dry weight) showed that protein content was highest in excreta from *J. sambac* fed larvae (x̄ = 8.9 ± 0.3, $F_{3,11} = 75.82$, $p < 0.005$), whereas carbohydrate content was higher in *C. inerme* fed larvae (x̄ = 12.5 ± 0.4, $F_{3,11} = 53.12$, $p < 0.001$). Lipid content was relatively low and consistent across all host plants (1.2–1.5 g/100 g) (Table 3)

Table 3: Macronutrient composition of *A. atropos* larval excreta

Host Plant	Protein (g/100 g)	Carbohydrate (g/100 g)	Lipid (g/100 g)
J. sambac	8.9 ± 0.3^{aB}	9.8 ± 0.3^{cA}	1.2 ± 0.1^{cC}
C. inerme	6.2 ± 0.2^{cB}	12.5 ± 0.4^{aA}	1.3 ± 0.1^{bC}
M. hortensis	7.5 ± 0.3^{bB}	11.0 ± 0.3^{bA}	1.5 ± 0.1^{aC}

Same (abcd) lowercase letter in a column shows significance at 0.05% among the bio host and uppaer case (ABCD) latter shows the significance at 0.05% between macro molecule.

Mineral Content

The mineral analysis revealed potassium (K) and calcium (Ca) as the dominant minerals, particularly in excreta of *J. sambac* fed larvae. Magnesium (Mg) and iron (Fe) were moderately present, and trace elements such as zinc (Zn) and manganese (Mn) were consistently detectable in all samples. Additional minerals including sodium (Na), phosphorus (P), and copper (Cu) were also quantified to provide a comprehensive nutritional profile (mg/100 g dry weight) (Table 4.)

Table 4: Mineral composition of *A. atropos* larval excreta

Host Plant	K	Ca	Mg	Fe	Zn	Mn	Na	P	Cu
J. sambac	$210 \pm {}^{5aA}$	95 ± 3^{aB}	42 ± 2^{aC}	8 ± 0.3^{aF}	1.5 ± 0.1^{aG}	0.9 ± 0.05^{aH}	12 ± 0.5^{aE}	18 ± 0.7^{aD}	0.4 ± 0.02^{aI}
C. inerme	175 ± 4^{cA}	78 ± 2^{cB}	38 ± 1^{cC}	6 ± 0.2^{cF}	1.2 ± 0.1^{bG}	0.7 ± 0.03^{cH}	10 ± 0.4^{bE}	15 ± 0.5^{cD}	0.3 ± 0.01^{bI}
M. hortensis	190 ± 3^{bA}	85 ± 3^{bB}	40 ± 1^{bC}	7 ± 0.2^{Bf}	1.3 ± 0.1^{cG}	0.8 ± 0.04^{bH}	11 ± 0.4^{cD}	16 ± 0.6^{bD}	0.35 ± 0.02^{bI}

Same (abcd) lowercase letter in a column shows significance at 0.05% among the host and uppaer case (ABCD) latter shows the significance at 0.05% between mineral compositions.

Secondary Metabolites

Phytochemical screening of *A. atropos* larval excreta revealed 11 major secondary metabolites, reflecting partial digestion and selective excretion of host plant phytochemicals. The concentration and composition of these metabolites varied significantly depending on the host plant consumed. Alkaloid content was highest in excreta from *J. sambac* -fed larvae (x̄ = 2.8 ± 0.1 mg/100 g), lower in *C. inerme* fed larvae (x̄ = 1.9 ± 0.1 mg/100 g). Alkaloids may be excreted as a detoxification mechanism. Flavonoids were most abundant in *J. sambac* fed excreta (x̄ = 4.5 ± 0.2 mg/100 g), reflecting the high flavonoid content of the host plant. *C. inerme* - fed larvae excreta contained x̄ = 3.2 ± 0.1 mg/100 g. Phenolic content remained relatively uniform across all host plants (x̄ = 5.0–5.1 ± 0.2 mg/100 g), suggesting consistent metabolic processing. Saponins were moderately present: *J. sambac* (x̄ = 1.5 ± 0.1 mg/100 g), *C. inerme* (x̄ = 1.1 ± 0.05 mg/100 g). Tannin levels were higher in *C. inerme* -fed larvae (2.0 ± 0.1 mg/100 g), *J. sambac* (x̄ = 1.7 ± 0.1 mg/100 g). Terpenoids were detected in all samples, slightly higher in *J. sambac* -fed larvae (x̄ = 1.2 ± 0.05 mg/100 g). Steroids were found at low levels (x̄ = 0.7–1.0 ± 0.05 mg/100 g), indicating minor excretion from plant-derived sterols. Glycosides were present in all excreta (x̄ = 0.9–1.2 ± 0.05 mg/100 g), reflecting plant secondary sugar derivatives. Coumarins were detected in low concentrations (x̄ = 0.5–0.8 ± 0.05 mg/100 g), highest in *J. sambac* -fed larvae. Quinones were present at x̄ = 0.4–0.6 ± 0.02 mg/100 g, slightly higher in *C. inerme* -fed larvae, possibly due to leaf oxidative compounds. Cardiac glycosides were trace (x̄ = 0.2–0.3 ± 0.01 mg/100 g), primarily in *J. sambac* -fed larvae also reflecting minor plant defense metabolite excretion (Figure 1).

This finding demonstrates that host plant identity significantly influences the physical characteristics and chemical composition of *A. atropos* larval excreta. Host-dependent variation in excreta morphology reflects differences in food intake rate, digestive efficiency, and water balance regulation during larval feeding (Behmer, 2019) [24]. Larger and more moist excreta produced by larvae feeding on nutritionally favorable hosts indicate enhanced assimilation efficiency and reduced digestive stress (Simpson *et al*., 2015) [22].

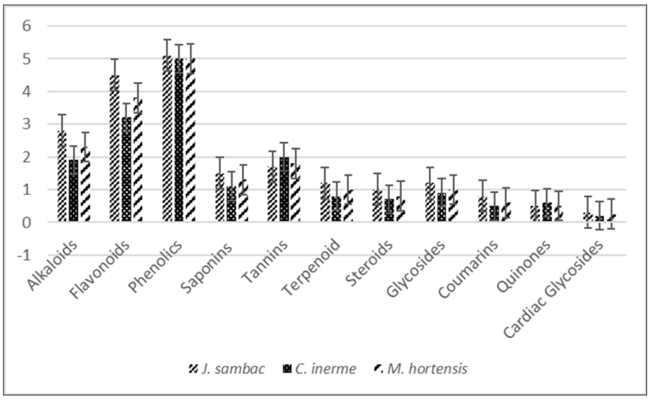

Fig 1: Secondary metabolite composition of *A. atropos* larval excreta (mg/100 g dry weight)]

In contrast, smaller and drier excreta associated with chemically defended hosts suggest reduced digestibility and increased metabolic costs of detoxification (Erb & Reymond, 2019) [7]. Differences in macronutrient composition of frass indicate host-specific patterns of nutrient absorption and metabolic utilization (Awmack & Leather, 2017) [25]. Elevated protein levels in excreta may reflect excess dietary nitrogen or incomplete assimilation of amino acids due to nutritional imbalance (Behmer, 2019) [24]. Higher carbohydrate excretion suggests altered enzymatic processing of plant-derived sugars under host-imposed constraints (Singh & Kumar, 2020) [14]. Mineral profiling revealed selective regulation of essential elements rather than passive elimination (He *et al*., 2020) [17]. High potassium and calcium levels in frass indicate host-mediated mineral availability and larval homeostatic control (Lovett *et al*., 2021) [26]. Selective excretion of excess minerals while retaining essential ions represents a common adaptive strategy in phytophagous insects (Hawlena *et al*., 2015) [27]. The presence of multiple classes of secondary metabolites confirms partial digestion and active elimination of host-derived allelochemicals (Heckel, 2018) [28]. Increased alkaloid and flavonoid excretion in larvae feeding on chemically rich hosts reflects detoxification through excretion pathways rather than sequestration (Després *et al*., 2016) [29]. Host-specific variation in tannin and quinone levels indicates differential oxidative stress management strategies (Biere & Bennett, 2019) [30]. Relatively uniform phenolic concentrations across host plants suggest conserved metabolic processing mechanisms (Ceja-Navarro *et al*., 2019) [31]. Detection of terpenoids and glycosides highlights incomplete metabolic breakdown of structurally complex compounds (Li *et al*., 2017) [32]. These findings support evidence that polyphagous Lepidoptera rely on flexible detoxification mechanisms to cope with chemically diverse diets (Erb & Reymond, 2019) [7]. Gut microbiota likely contributed to observed variation in frass chemistry by modulating digestive and detoxification pathways (Douglas, 2015) [33]. Host-induced shifts in microbial communities may influence enzymatic activity and metabolic fluxes in larval guts (Hammer *et al*., 2017) [34]. Frass composition therefore represents an integrated outcome of host plant chemistry, insect physiology, and microbial mediation (Ceja-Navarro *et al*., 2019) [31]. Beyond individual physiology, host-specific frass deposition may influence soil nutrient dynamics and microbial activity in surrounding ecosystems (Frost & Hunter, 2020) [35]. Overall, the study highlights the physiological plasticity of *A. atropos* larvae in response to host plant chemistry and underscores the value of frass-based analyses as non-invasive tools for studying insect nutritional ecology (Yang *et al*., 2020) [36].

Conclusion

This study provides a systematic evaluation of host plant preference, larval growth, and nutritional efficiency of *A. atropos* under controlled laboratory conditions in Thoothukudi, Tamil Nadu. The findings clearly demonstrate that host plant quality is a key determinant of larval feeding behavior, nutrient assimilation, and developmental success, underscoring the ecological importance of plant–insect interactions in Lepidoptera. Among the three host plants examined, *J. sambac* consistently supported the highest leaf consumption, greatest weight gain, and superior food conversion efficiency, indicating its role as an optimal host. *C. inerme* functioned as a moderately suitable alternative host, sustaining intermediate larval performance, whereas *M. hortensis* proved less favorable, likely due to unfavorable nutrient ratios or higher levels of defensive secondary metabolites. This finding demonstrates that host plant selection exerts a significant influence on the physical characteristics, nutritional composition, mineral content, and secondary metabolite profile of *A. atropos* larval excreta. Distinct variations in excreta morphology and chemical composition among larvae fed on tested host plants reflect differences in dietary quality, digestibility, and plant defensive chemistry. Higher protein, mineral, and bioactive compound levels in excreta from *Jasminum*-fed larvae indicate differential nutrient assimilation and selective detoxification of host-derived phytochemicals. Overall, these results enhance our understanding of host plant selection and nutritional ecology in *A. atropos* and provide a baseline for predicting larval adaptability, population dynamics, and potential responses to changes in host plant availability. Future studies integrating biochemical profiling of host plants, gut microbiome analysis, and field validation will help clarify the mechanistic pathways underlying host utilization in this ecologically significant sphingid moth.

Future research incorporating biochemical profiling of host plants, gut microbiome analysis, and field validation will further clarify the mechanisms underlying host utilization and larval performance in this ecologically important sphingid moth.

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