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Chitinase Dynamics and Resistance Mechanisms in Coffee Leaf Rust Infection

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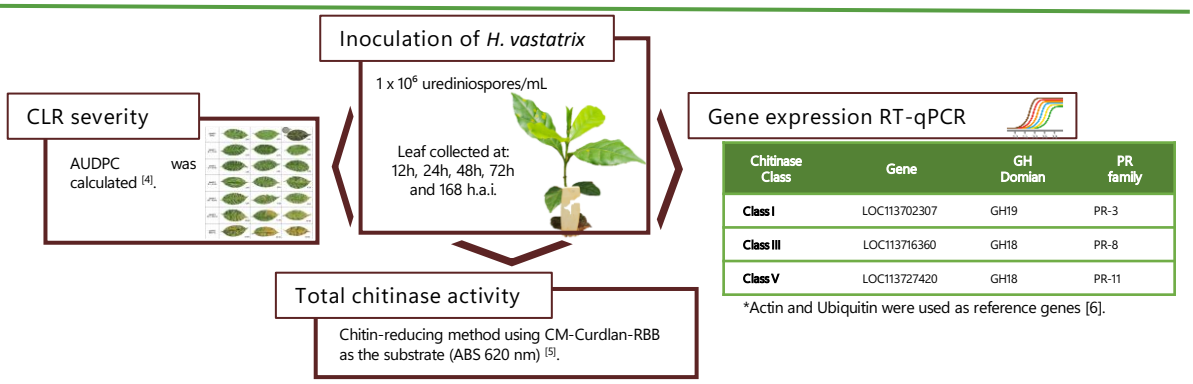
Introduction

In plants, pathogen recognition through PTI and ETI triggers defense responses, including the production of chitinases—antifungal enzymes that degrade fungal cell walls. Chitinases[1], classified into GH18 and GH19 families and five structural classes (I–V), play key roles in pathogen resistance[2,,3]. This study examines chitinase activity and gene expression in two *Coffea arabica* cultivars, Arara (resistant) and Catuaí IAC 144 (susceptible), to investigate their responses to coffee leaf rust (CLR).

Materials/Methods

Two independent experiments were conducted using *C. arabica* cultivars Arara (resistant) and Catuaí Vermelho IAC 144 (susceptible) arranged in randomized blocks. Plants were inoculated with *H. vastatrix* urediniospores, and young leaves were collected to assess total chitinase activity and gene expression (RT-qPCR). Coffee Leaf Rust severity was also performed.



Chitinase Class	Gene	GH Domian	PR family
Class I	LOC113702307	GH19	PR-3
Class III	LOC113716360	GH18	PR-8
Class V	LOC113727420	GH18	PR-11

*Actin and Ubiquitin were used as reference genes [6].

Results/Discussion

CLR severity

The area under the disease progression curve (AUDPC) for the Catuai IAC-144 cultivar inoculated with *H. vastatrix* was 27.29%, indicating severe chlorosis and abundant urediniospore pustules (Fig. 1). In contrast, the resistant cultivar Arara showed no disease symptoms (AUDPC = 0), exhibiting only flecks characteristic of a hypersensitive response (HR) to *H. vastatrix*.

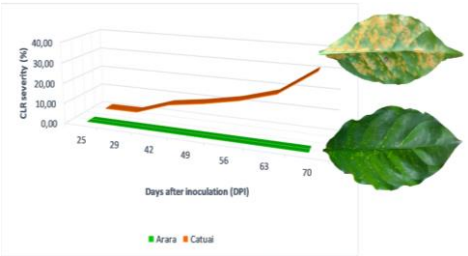


Fig. 1: Coffee Leaf Rust Severity evaluated in *C. arabica* Arara and Catuaí IAC 144 cultivars.

The clear manifestation of disease in Catuai IAC-144 and its absence in Arara confirmed the validity of the experimental infection, ensuring reliable comparisons of biochemical and molecular defense responses.

Total chitinase activity and gen expression

Total chitinase activity was similar in both cultivars when normalized to the control (Fig. 2). At 48 hours post-inoculation, the susceptible Catuaí IAC 144 showed a significantly greater increase than the resistant cultivar.

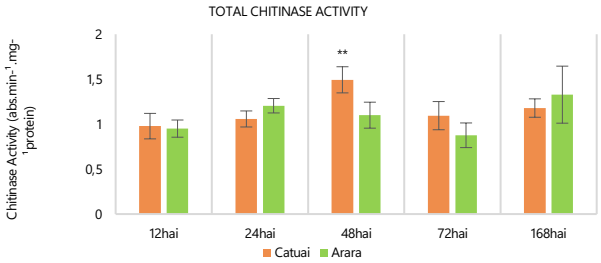


Fig. 2: Temporal profile of total chitinase activity in Arara (resistant) and Catuaí (susceptible) cultivars inoculated with *H. vastatrix*. Values were normalized by control. Means values were significantly different according to Tukey (p< 0.01 ~ "**").

Gene expression RT-qPCR

Gene expression analysis of chitinase genes revealed clear differences between cultivars (Fig. 3). *Chi* class I showed higher expression in the susceptible Catuaí IAC 144, indicating an early response (12–14 h), also observed for *Chi* class III (24 h). In contrast, Arara showed upregulation of all *Chi* genes at 48 h, with *Chi* III and *Chi* V remaining elevated thereafter. Sustained expression of *Chi* I, *Chi* III, and *Chi* V in Arara suggests an effective antifungal response combining basal and pathogen-induced defenses, whereas in Catuaí IAC 144 only basal defenses were activated, leading to a less effective response.

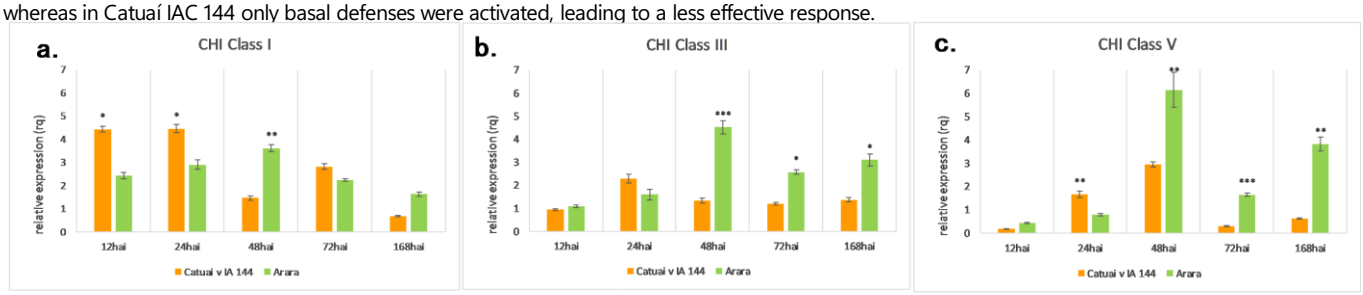


Fig. 3: Expression of chitinase genes (Chi I, Chi III, and Chi V) in Arara (resistant) and Catuaí (susceptible) coffee cultivars.. Values were normalized by control. Means values were significantly different according to Tukey (p< 0.001 ~ "***", p< 0.01 ~ "**", p< 0.05 ~ "*").

Conclusion/Perspectives

Arara's resistance to coffee leaf rust (CLR) involves sustained, isoform-specific upregulation of *Chi* III and *Chi* V, while the susceptible Catuaí IAC 144 shows only transient or early induction of *Chi* I and *Chi* III, highlighting the importance of the timing and duration of gene expression. These findings could be applied in the future to breeding programs for CLR-resistant coffee varieties, potentially using marker-assisted selection.

References:

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