Jasmonate and ethylene biosynthetic and signaling pathways during oil palm fruit maturation and ripening

Fabienne Morcillo[1], Maxime Pizot[1], Antony Champion[1], Jayani Perera[1], Stéphane Dussert[1], Thierry Joët[1], James Tregear[1], Bruno Nouy[2] and Timothy Tranbarger[1]

[1]IRD-Cirad, UMR DIADE, Montpellier, France, [2]PalmElit

Introduction and Objectives The oil palm (*Elaeis guineensis*), a monocotyledonous species in the family Arecaceae, has not only an extraordinarily oil rich fleshy mesocarp, but is also the richest dietary source of provitamin A and presents an original model to examine the maturation and ripening regulatory networks in a monocot fruit tissue. Recently we defining precisely the phases of oil palm fruit development based on morphological, physiological and targeted metabolomic data, and an RNA-seq approach was used to analyze the transcriptional basis of the pathways responsible for the remarkable characters of the oil palm mesocarp (Fig. 1) [1]. In the present study, we focus on the possible role of jasmonate (JA) related metabolites that accumulate during mesocarp development (Fig. 2). Our objective was to reconstruct the JA biosynthesis and signal transduction pathways in the mesocarp, to provide insight into the transcriptional regulation and possible roles of the JA pathways and interaction with the ethylene pathways during mesocarp development, ripening and function.

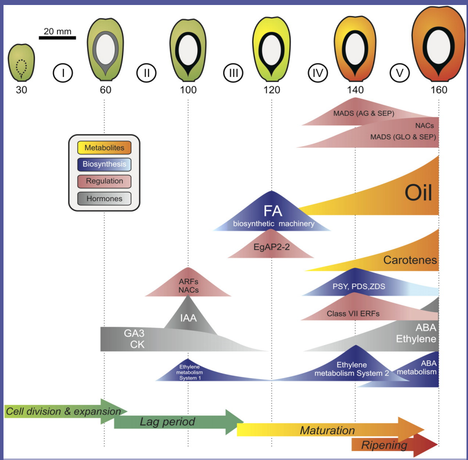


Figure 1. Major events that occur during mesocarp development [(1)].

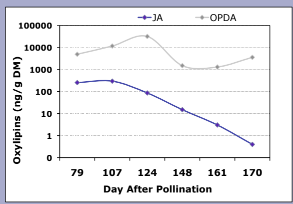


Figure 2. OPDA and JA profiles suggest roles during mesocarp development

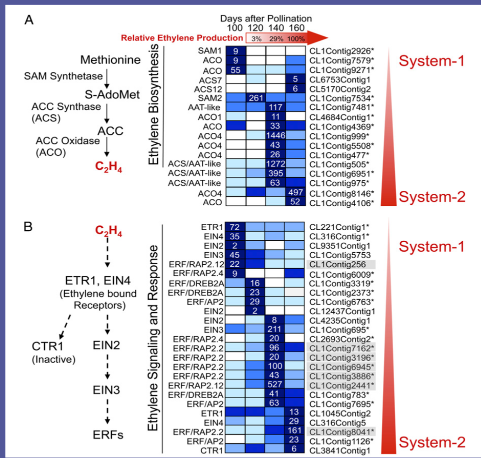


Figure 3. Coordinated Ethylene biosynthesis and signal transduction[(1)]

Results and Conclusions During oil palm mesocarp maturation and ripening, a large increase in ethylene coincides with a coordinated regulation of ethylene biosynthesis and signaling transcripts at 140-160 days after pollination (DAP, Fig. 3). In contrast the JA precursor cis-12-oxo phytodienoic acid (OPDA) and JA (12-hydroxy jasmonic acid) levels peak between 100-125 DAP, then decreases as observed in many dicot fruit such as apple, tomato and strawberry [2,3] (Fig. 2). We used a transcriptome approach to reconstruct the JA biosynthesis and signal transduction pathways that provides evidence for the coordination of these pathways during mesocarp development (Fig. 4 and 5). The results suggest the transcriptional coordination at 100 DAP for several transcripts of the first steps of the JA biosynthetic pathway in the plastid, the ß-oxidation steps in the peroxisome, and in particular the last step in which JAR1 converts jasmonate into the biologically active jasmonyl-isoleucine (JA-Ile) in the cytoplasm. Furthermore, a very clear coordinated regulation of the signal transduction related transcripts is observed at 100 DAP, which corresponds the peak of JA measured in the mesocarp. Finally, the profiles of some of the JA related transcripts suggest regulation by both JA and ethylene and possible interaction between these hormone related pathways. In the future we will focus on whether these transcripts are regulated by exogenous JA and/or ethylene in relation to their function, and the possible roles of the extraordinary quantity of OPDA in the metabolism of the mesocarp.

Figure 4. JA Biosynthesis

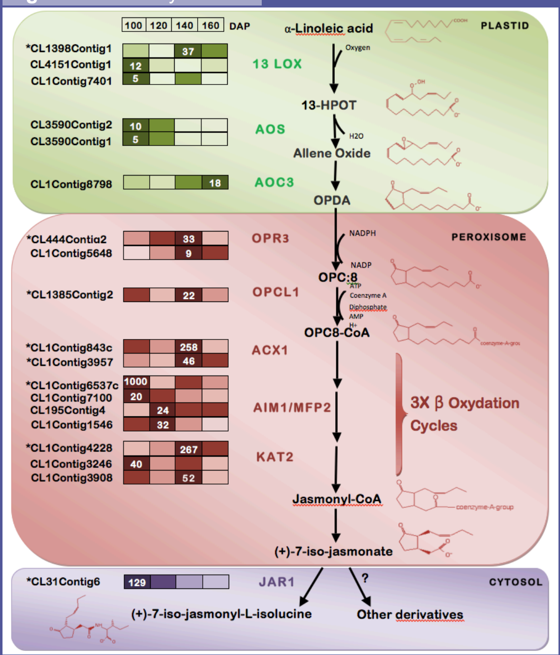
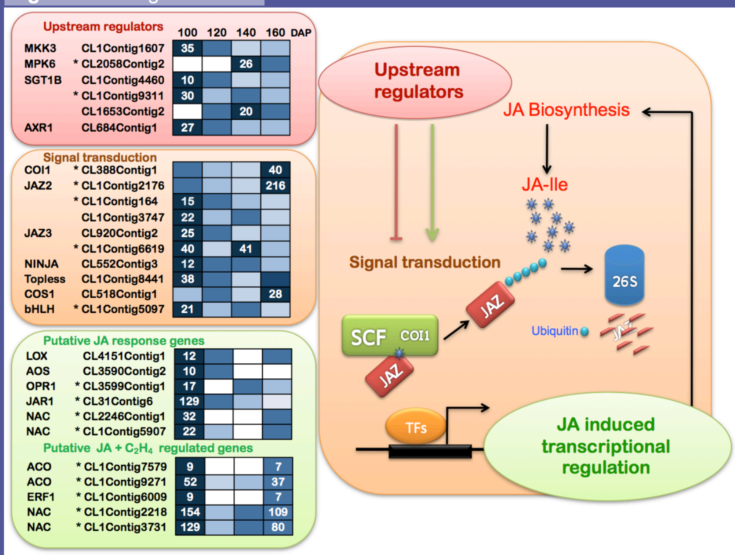


Figure 5. JA Signalization



[1] Tranbarger et al., (2011) Plant Physiology 156:564-584.

[2] Fan et al., (1998) Planta 204:444-449.

[3] Mukkun and Singh (2009) Scientia Horticulturae 123:5-10.