

# “Identification of xyloglucan endotransglycosylase/hydrolase (*XTH*) genes in raspberry and characterization of *RiXTH9* at protein and transcriptional levels”

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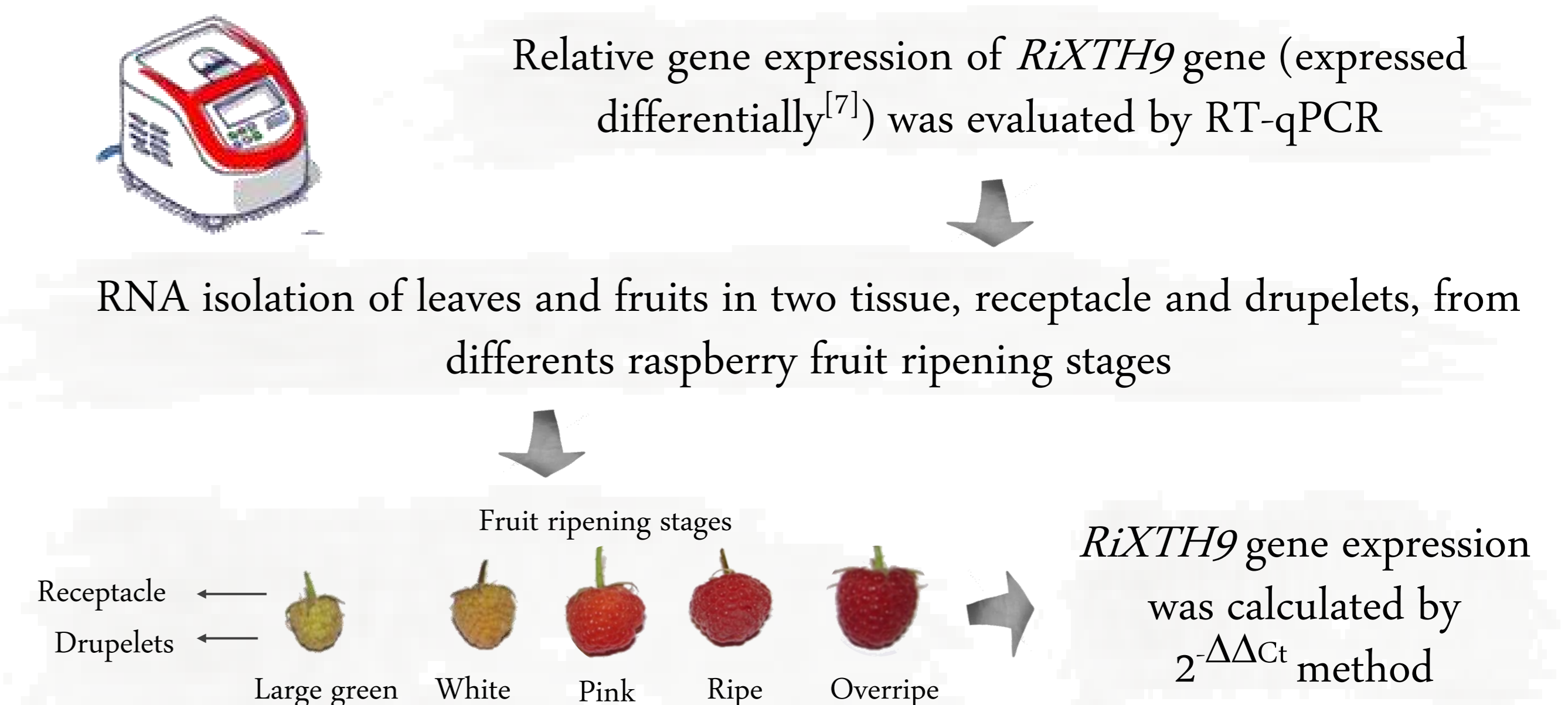
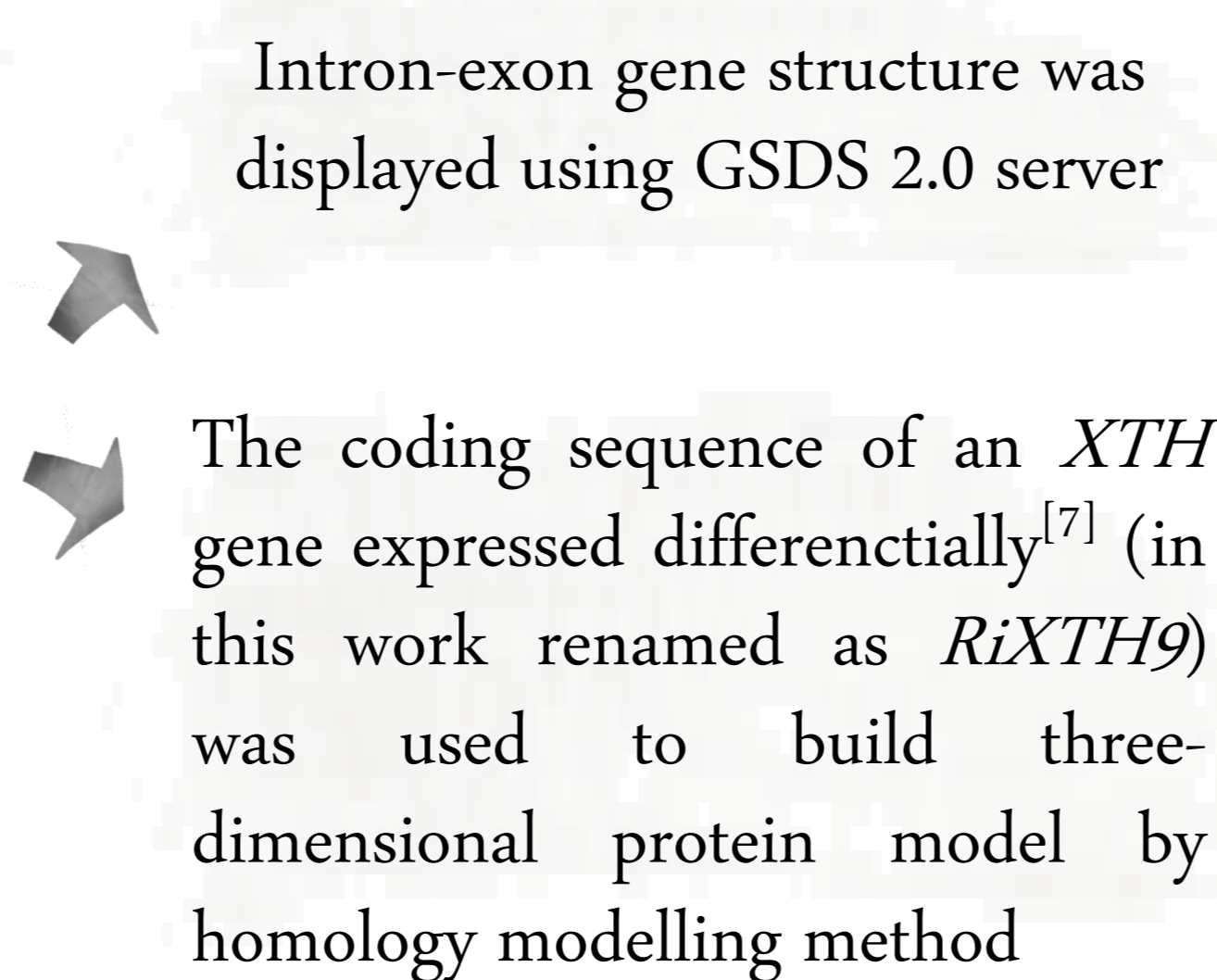
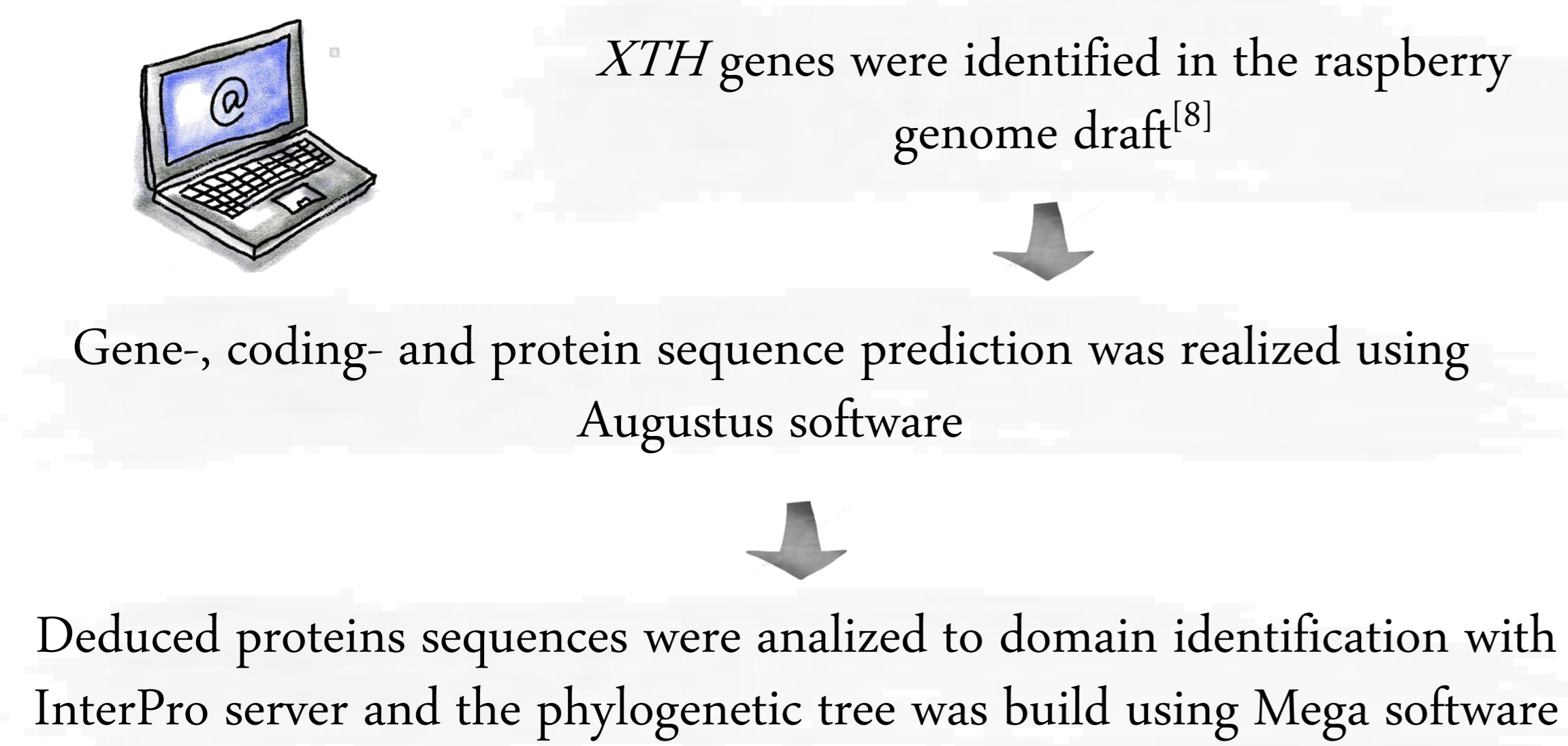
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## Introducción

Raspberry (*Rubus idaeus* L.) is a species with fruit of high nutritional value, but with a short shelf life because it softens quickly<sup>[1]</sup>. In different fruits, softening has been associated with modifications in the cell wall structure and composition due to the action of different enzymes<sup>[2]</sup>. The xyloglucan endotransglycosylase/hydrolases (XTHs) are a family of enzymes related to plant growth and development and these have been associated with modifications in the cell wall catalyzing the breakdown and connection of xyloglucan molecules and modifying the fiber-xyloglucan composite structure<sup>[3]</sup>. In fruits, a relationship of some XTHs with a dual-action, i.e., the maintenance and loss of firmness, has been reported<sup>[4-6]</sup>. During raspberry fruit ripening, analysis of differential gene expression between both green and pink stages suggests the participation of an *XTH* gene in this process<sup>[7]</sup>. However, the XTH family has not been identified at the genomic level in raspberry, and the expression of this *XTH* gene in other fruit ripening stages and tissues is unknown.

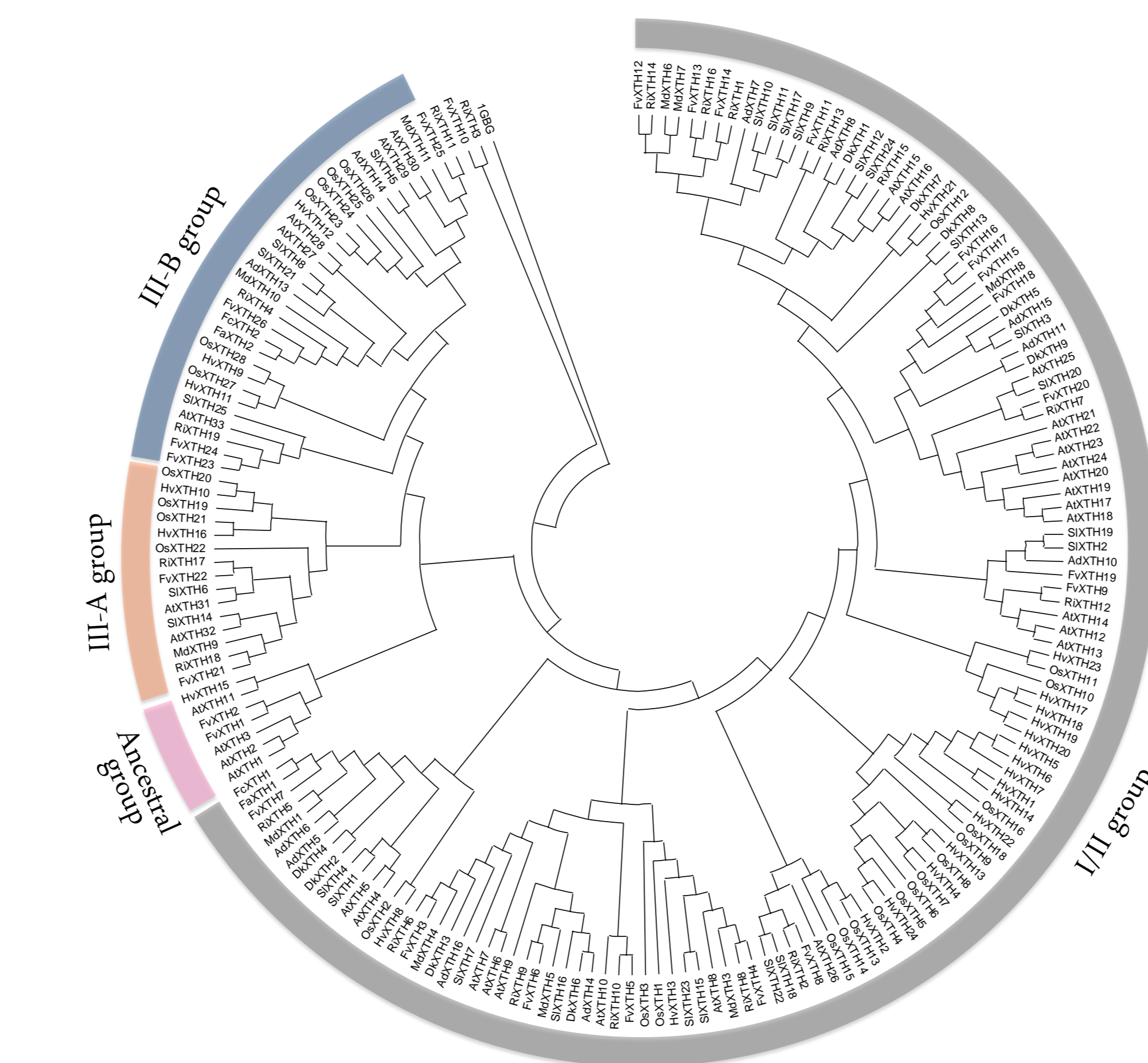
## Methodology



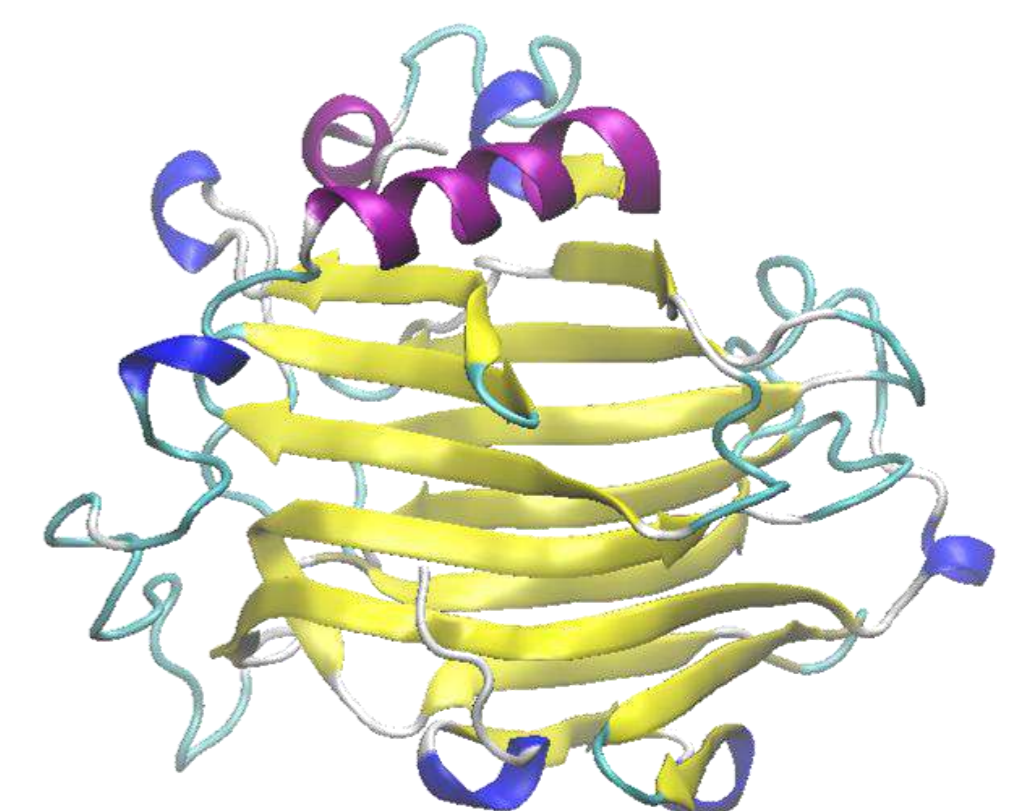
## Results

**Table 1.** XTH gene family in the raspberry genome, deduced protein length, gene structure and protein domain.

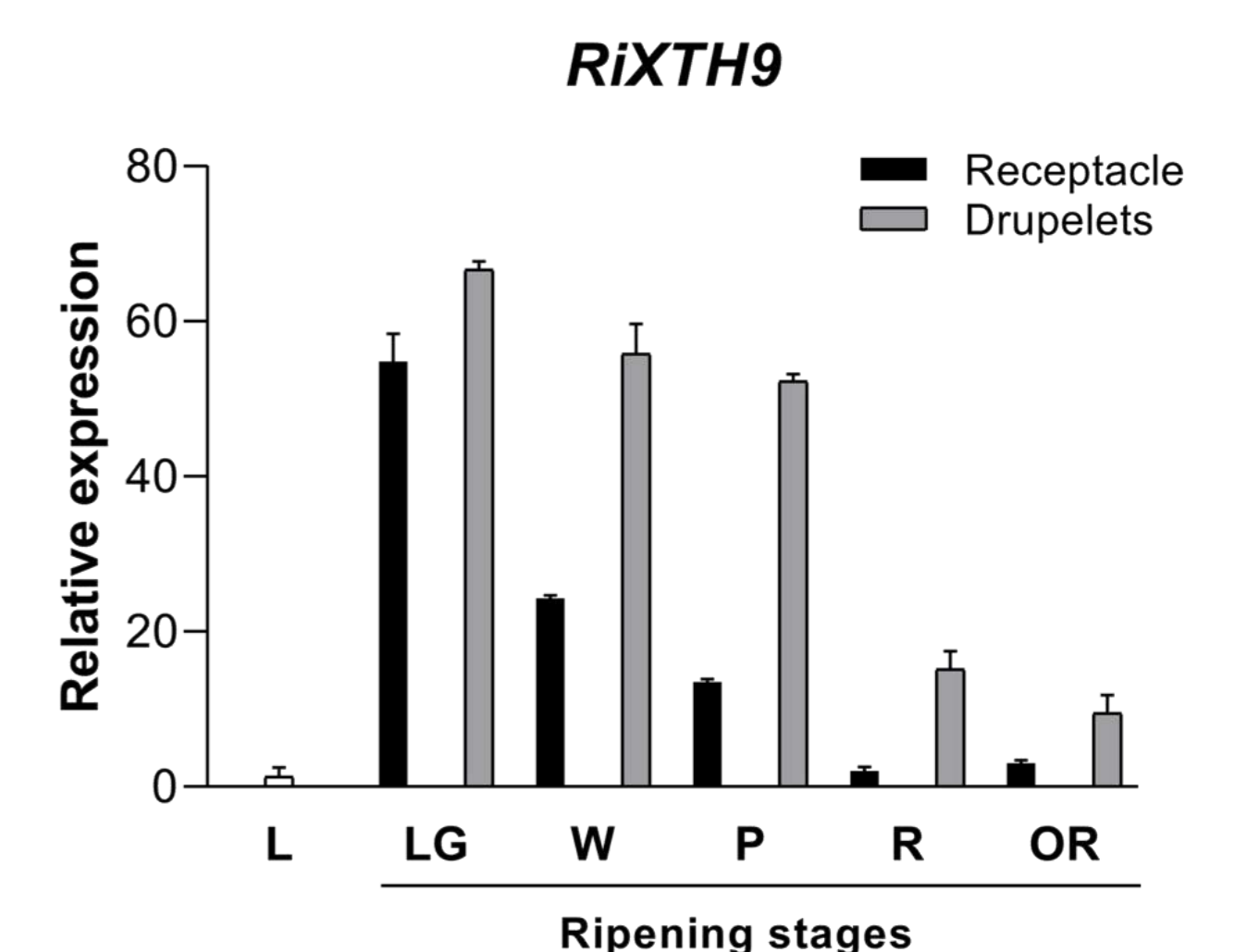
Gen name	Length (aa)	Gene structure	Protein domain
<i>RiXTH1</i>	280		
<i>RiXTH2</i>	289		
<i>RiXTH3</i>	215		
<i>RiXTH4</i>	337		
<i>RiXTH5</i>	387		
<i>RiXTH6</i>	288		
<i>RiXTH7</i>	291		
<i>RiXTH8</i>	302		
<i>RiXTH9</i>	294		
<i>RiXTH10</i>	294		
<i>RiXTH11</i>	348		
<i>RiXTH12</i>	279		
<i>RiXTH13</i>	296		
<i>RiXTH14</i>	295		
<i>RiXTH15</i>	281		
<i>RiXTH16</i>	295		
<i>RiXTH17</i>	283		
<i>RiXTH18</i>	293		
<i>RiXTH19</i>	307		



**Figure 1.** Phylogenetic tree of XTHs proteins from raspberry and another plant species. The tree was built using Maximum-Likelihood Method with 3000 bootstrap replicates.



**Figure 2.** Three-dimensional protein models of raspberry XTH 9. Protein models were visualized using Visual Molecular Dynamics software.



**Figure 3.** Expression analysis of *RiXTH9* gene in drupelets and receptacle during fruit ripening and leaves of 'Heritage' raspberry. L: Leaves; LG: Large green; W: White; P: Pink; R: Ripe and OR: Overripe. Error bars indicate the standard deviation of three biological replicates.

## Conclusions

- 19 XTHs genes were identified in raspberry (*RiXTH1-RiXTH19*).
- Deduced protein sequences have the xyloglucan endotransglycosylase domain.
- Three-dimensional protein models of XTH 9 indicated that it has a  $\beta$ -jellyroll type structure.
- RiXTH9* is expressed in drupelets, receptacle and leaves and it has higher relative gene expression in the large green fruit stage.
- This study provides valuable information for future investigations of the role of XTHs enzymes in changes of raspberry firmness during fruit ripening.

## Acknowledgments

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## References

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