



The Golden Fruit of Vegetables

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Introduction to genomics (485)

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Outline:

- The genome papers'
- Introducing tomato plant species
- Fun facts about tomato's
- Sequencing strategy
- Sequencing methods
- Assembly
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- Questions



Genome papers

LETTER

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The tomato genome sequence provides insights into fleshy fruit evolution

The Tomato Genome Consortium*

Tomato (*Solanum lycopersicum*) is a major crop plant and a model system for fruit development. *Solanum* is one of the largest angiosperm genera¹ and includes annual and perennial plants from diverse habitats. Here we present a high-quality genome sequence of domesticated tomato, a draft sequence of its closest wild relative, *Solanum pimpinellifolium*², and compare them to each other and to the potato genome (*Solanum tuberosum*). The two tomato genomes show only 0.6% nucleotide divergence and signs of recent admixture, but show more than 8% divergence from potato, with nine large and several smaller inversions. In contrast to *Arabidopsis*, but similar to soybean, tomato and potato small RNAs map predominantly to gene-rich chromosomal regions, including gene promoters. The *Solanum* lineage has experienced two consecutive genome triplications: one that is ancient and shared with rosids, and a more recent one. These triplications set the stage for the neofunctionalization of genes controlling fruit characteristics, such as colour and fleshiness.

The pipeline used to annotate the tomato and potato³ genomes is described in Supplementary Information section 2. It predicted 34,727 and 35,004 protein-coding genes, respectively. Of these, 30,855 and 32,988, respectively, are supported by RNA sequencing (RNA-Seq) data, and 31,741 and 32,056, respectively, show high similarity to *Arabidopsis* genes (Supplementary Information section 2.1). Chromosomal organization of genes, transcripts, repeats and small RNAs (sRNAs) is very similar in the two species (Supplementary Figs 2–4). The protein-coding genes of tomato, potato, *Arabidopsis*, rice and grape were clustered into 23,208 gene groups (≥ 2 members), of which 8,615 are common to all five genomes, 1,727 are confined to eudicots (tomato, potato, grape and *Arabidopsis*), and 727 are confined to plants with fleshy fruits (tomato, potato and grape) (Supplementary Information section 5.1 and Supplementary Fig. 5). Relative expression of all tomato genes was determined by replicated strand-specific Illumina RNA-Seq of root, leaf, flower (two stages) and fruit (six stages) in addition to leaf and fruit (three stages) of *S. pimpinellifolium* (Supplementary Table 1).

Nature
publisher

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Full Paper

OXFORD

Full Paper

Whole-genome re-sequencing of two Italian tomato landraces reveals sequence variations in genes associated with stress tolerance, fruit quality and long shelf-life traits

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Oxford
publisher

Introducing tomato's

You say apple, I say
tomato



This study focus on 3 types of tomato's (*Solanum lycopersicum*), their fleshy fruit and ripening evolutions.

The genome size for the different Tomato:

- ❖ For *S. Corbarino* (COR): 823,643,567 bp ~ 823.6 Mb
- ❖ For *S. lucariello* (Luc): 823,719,672 bp ~823.7 Mb
- ❖ For *S. pimpinellifolium* : 739 Mb
- ❖ Composed of 12 chromosomes

All are from same Order : **Solanales**



Fun Facts

Common names for tomato:

- Love apple
- Golden apple
- Wolf peach

Fun Facts

- Tomatoes' are fruit Not vegetables.
- It contain vitamin A,B,C and Mg^{+2} also Ca^{+2} and iron. Its recommended to consume after cooking due to the releasing of enzymes and nutrient more when its in raw state.
- Its thought to be originally came from the “Aztec” Peru and introduced to Europe and America in the 16th and 19th century.
- Tomato plant is considered as type variety of nightshade plant in which its poisonous thus it wasn't popular in the past.



- The plant leave, stem and root are poisonous, when a 900 g is consumed it will cause death.
- Tomato have large varieties reach up to 10,000. In Italy they have more than 300 different types
- Unfortunately, there is annual festival in Spain called “La Tomatina” in which more than 150,000 kg of tomato is wasted.



Sequencing methods



*The Best
Homemade Italian
Tomato Sauce*

Sequencing methods



Whole plant was used: stem, leaf, roots & fruits.

- Sanger sequencing of selected BAC clone:
- SOLiD sequencing:
- Illumina sequencing:



Interesting facts

- *Solanum* is one of the largest angiosperm genera.
- *Solanum lycopersicum* and *Solanum pimpinellifolium* are considered as close relatives and share 0.6% SNPs divergence
- Tomato chromosomes composed mainly by pericentric heterochromatin and distal euchromatin. Also contains fewer high copy and (LTR). Thus is considered as unusual angiosperm with low copy of DNA.

Sequencing strategies

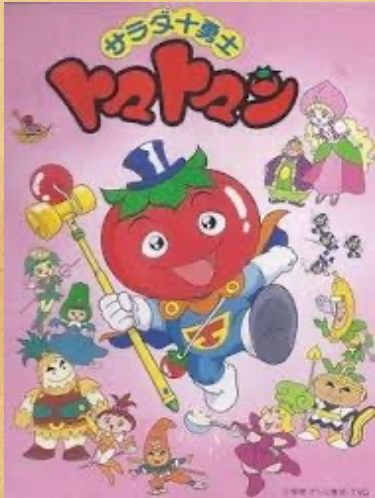
The research used: shotgun, BAC clone, Roche/454 shotgun and mate paired ends



Interesting facts

- Comparison between tomato and potato genome sharing same coding genes paired against *Arabidopsis*.

Tomato	Potato (<i>solanum tuberosum</i>)
34,727 protein coding genes	35,004 protein coding genes
RNA-seq data :30,855	RNA-seq data:32,988
sRNA-seq: 96 conserved miRNA	sRNA-seq: 120 conserved miRNA
They share 18,320 orthologous gene pairs Example: self pruning gene (SP)	



Assembly

- De novo shotgun assembly

Name	Genome size	coverage	#of contig	#of scaffolds	N50 contig	N50 scaffold	G-C content
<i>S. Corbarino</i>	823,6 Mb	15.34x	-	-	-	-	-
<i>S. lucariello</i>	823,7Mb	13.42x	-	-	-	-	-
<i>S. pimpinellifolium</i>	900 Mb	40x	76,534	48,863	27,860	85,811	32%-



Annotations

De novo gene prediction & RNA-seq alignment

Name	#genes	Coding genes	Noncoding genes	SNP
<i>S. Corbarino</i>	43,054	46,065	-	68.8%
<i>S. lucariello</i>	44,579	45,815	-	69.9%
<i>S. pimpinellifolium</i>	34,771	-	-	-

More interesting facts

- Due to genome triplication added new gene family responsible for fruit specific function such as:
- transcription factors & enzymes for ethylene synthesis.
- Red light photoreceptors for fruit quality
- Regulated genes for lycopene synthesis.
- There is >50 protein genes spread in the whole genome controlling the structure of cell wall such as Xyloglucan endotransglucosylase/hydrolases. In which its responsible for the fleshiness of tomatoes.



Questions

- What causes the tomatoes ripening ? Type of hormone?
- What is reasons for 'Heinze 1706' to choose those tomatoes? What special about them.
- Dose it share certain genes with potato plant?