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Abstract

From preventing scurvy to being part of religious rituals, citrus are intrinsically connected to human health and perception. From tiny mandarins to head-sized pummelos, citrus capability of hybridization provides a vastly diverse array of fruit sizes and shapes, which in turn corresponds to a diversity of flavors and aromas. These sensory qualities are tightly linked to oil glands in the citrus skin. The oil glands are also key to understanding fruit development, and the essential oils contained by them are fundamental in the food and perfume industries. We study the shape of citrus based on 3D X-ray CT scan reconstruction of 163 different citrus samples comprising 58 different species and cultivars, including samples of all fundamental citrus species. First, using the power of X-rays and image processing, we are able to compare and contrast size ratios between different tissues, such as the size of the skin compared to the rind or the flesh. Second, we model the fruit shape as an ellipsoidal surface, and later we study and infer possible oil gland distributions on this surface using principles of directional statistics. We finally compare and contrast these overall fruit shape models along their gland distributions across different citrus species. This morphological modeling will allow us later to link genotype with phenotype, furthering our insight on how the physical shape is genetically specified in DNA.

The shape of aroma: measuring and modeling citrus oil gland distribution

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ABSTRACT

From preventing scurvy to being part of religious rituals, citrus are intrinsically connected to human health and perception. From tiny mandarins to head-sized pummelos, citrus capability of hybridization provides a vastly diverse array of fruit sizes and shapes, which in turn corresponds to a diversity of flavors and aromas. These sensory qualities are tightly linked to oil glands in the citrus skin. The oil glands are also key to understanding fruit development, and the essential oils contained by them are fundamental in the food and perfume industries. We study the shape of citrus based on 3D X-ray CT scan reconstruction of 163 different citrus samples comprising 58 different species and cultivars, including samples of all fundamental citrus species. First, using the power of X-rays and image processing, we are able to compare and contrast size ratios between different tissues, such as the size of the skin compared to the rind or the flesh. Second, we model the fruit shape as an ellipsoidal surface, and later we study and infer possible oil gland distributions on this surface using principles of directional statistics. We finally compare and contrast these overall fruit shape models along their gland distributions across different citrus species. This morphological modeling will allow us later to link genotype with phenotype, furthering our insight on how the physical shape is genetically specified in DNA.

Keywords: directional statistics; citrus; oil glands; mathematical biology; data science; shape

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