

The ecological role of fruit aroma

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Fruits are a highly valuable source of food. They are packed with tasty and healthy nutrients and are often characterized by alluring colorful displays and an attractive aroma. Yet it is still unclear which evolutionary forces drove fruits to acquire such a diverse range of different attractive traits. In two new studies, scientists from the German Primate Center and their international collaboration partners show that the aroma of ripe fruits may be an adaptation whose function is to attract primates to consume the fruits and consequently disperse their seeds.

Immobile plants rely on vertebrates such as primates, birds and bats, which disperse their seeds over large ranges. Fleshy fruits are long known to have evolved to be attractive to these vertebrates. In return to seed-dispersal services, they provide fleshy pulps rich in nutrients such as sugars, fat, protein, vitamins and minerals. In addition, many fruits acquired traits such as colorful displays, which increase their detectability and attractiveness to vertebrate seed dispersers. Fruit aroma, just like color, may advertise ripeness and quality to seed dispersers who rely strongly on their sense of smell. Yet until recently, this idea has received very little attention.

Primates as seed dispersers

Primates are among the most important seed dispersers in tropical ecosystems. Until recently, they have been considered to be primarily visual animals whose reliance on the sense of smell is limited. Yet several studies from the past years indicate that primates in fact possess a well-developed sense of smell. Thus, fruits that rely on primates' seed

dispersal services may have also evolved to advertise their ripeness and quality through ripe [fruit](#) aroma.

Fruit aroma advertises ripeness

Two recent studies, led by scientists from the German Primate Center in collaboration with scientists from Germany, Sweden and Mexico, have tested this hypothesis and provide the first evidence that fruit aroma may be an adaptation whose function is to advertise ripeness to seed-dispersing primates. In one study, the group examined patterns of odor emission from ripe and unripe fruits. Fruit odor samples were collected at the DPZ field station in the heart of the Peruvian Amazonian rainforest. The results showed that fruits dispersed by primates tend to change their odor profiles upon ripening, thus providing a unique and reliable aroma signature that can allow primates to identify ripe fruits. In contrast, fruits dispersed by birds, which tend to rely on vision rather than the sense of smell, do not change their odor profiles upon ripening. As a result, the odors of bird-dispersed ripe fruits are very similar to those of unripe fruits and fruit aroma is not a reliable ripeness cue in these species. The fact that a substantial change of odor is apparent only in fruits dispersed by primates indicates that it is not a byproduct of fruit maturation that characterizes all fleshy fruits, but rather a trait which is present only in fruits whose main seed disperser is likely to use the odor to identify ripe fruits.

Monkeys identify ripe fruits by their odor

Consequently, a second study attempted to examine how well primates can "work" with the odor signals provided by these fruits. The scientists created several synthetic odor mixtures that mimicked the odors of ripe and unripe fruits, as well as fruits of varying degrees of ripeness. They then conducted experiments with spider monkeys, a species which

specializes on ripe fruits and provides seed-dispersal services to many plant species. The experiments tested whether spider monkeys can discriminate between the odors of ripe fruits and either unripe or partially unripe fruits. The results were clear: spider monkeys excelled in the task. They easily discriminated between the odors and were repeatedly able to use this ability to successfully locate rewards. These results confirm that spider monkeys are capable of relying on the odors emitted by fruits to identify that they are ripe. Furthermore, they can do so even when the odor of unripe fruits becomes increasingly similar to the odor of ripe fruits. Thus, fruit [odor](#) is a reliable signal, which allows [spider monkeys](#) to identify ripe fruits.

"Taken together, our studies demonstrate for the first time that the pleasant aroma that characterizes many ripe fruits may have an important ecological function of mediating the communication between plants and primates that disperse their seeds", says Omer Nevo, lead author of both publications. "Primates benefit from the ability to easily and reliably identifying ripe fruits. In return, plants are selected to provide odorous fruits that attract [primates](#) and promote seed dispersal."

More information: Omer Nevo et al. Fruit Odor as A Ripeness Signal for Seed-Dispersing Primates? A Case Study on Four Neotropical Plant Species, *Journal of Chemical Ecology* (2016). [DOI: 10.1007/s10886-016-0687-x](#)

Omer Nevo et al. Chemical recognition of fruit ripeness in spider monkeys (*Ateles geoffroyi*), *Scientific Reports* (2015). [DOI: 10.1038/srep14895](#)

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