CHAPTER 2

The FRUIT:
Food, Fertility, Fascination

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Sensulato, and botanically speaking, fruit is an assemblage of *standard* components intended for the reproduction of a plant organism. A fruit holds the seed(s) destined to produce a new generation, irrespective of its edible qualities (Bell, 1998). Fruit, in the widest and yet most basic context, is nothing but a ripened ovary with seed structures attached to it (Harris & Harris, 2001), and by this virtue both conception and cradle of new life.

Not only have fruits caught the learned attention of plant scientists but also the analytical minds of mathematicians, and inspired the creative talent of cooks, artists, and designers. They have through the Ages delighted mankind with all manner of delectable tastes and textures from the sweet to the sour, tangy, creamy, juicy, and starchy. Fruits played a major role in the departure from shifting cultivation to permanent settlements, the formation of cities, and the identity of cultures in our modern world (Laws, 2011). Without the domestication of fruits human history may well have taken different turns, in both small and big ways.

Today, the commercial descendants of wild fruit command an important share of the world economy, sustaining the lives of billions of humans and livestock around the globe.

The Scientific Angle

The flower is the common precursor to the fruit. But not all plants conform to this rule and the flower-to-fruit scenario seen in angiosperms or flowering plants (the most recent and most advanced level in plant evolution) is replaced by the more primitive strobilus-to-fruit *modus operandi* seen in gymnosperms (e.g. conifers, cycads, gingko and belinjau) and the still more primitive reproductive strategies of ferns and yet lower mosses, lichens and algae, a subject not further explored here. All, however, form structures that produce seeds or spores after male and female parts unite, thus in principle with a similar purpose as true fruits.

In angiosperms the ovary plays the starring role in the drama of producing a fruit (Esau, 1977). Most ovaries start out as tiny structures hidden somewhere among the maze of sepals, petals, stigma(s) and stamens that make up a flower. Often not visible to the naked eye its outer walls protect one or more ovules (more can mean up to thousands!) which need to be fertilized by pollen; successful fertilization means seeds can grow and mature inside this receptacle called a fruit.

In gymnosperms the ovary is absent, and ovules are borne 'naked' on structures called strobili (sing. strobilus). Protective layers of tissue over each ovule will grow together with the ovule into a structure. The end result, though strictly botanically somewhat similar to a fruit.

Plants have also caught the imagination of mathematicians. Plant phyllotaxy and flower morphology often correspond to numbers from Fibonacci sequences (named after the 13th Century mathematician,

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Leonardo of Pisa, also called Leonardo Fibonacci). A good example discussed later in this book is the arrangement of the 'eyes' on pineapples that is always based on a Fibonacci sequence either 8-13-21 or 5-8-13 (Bell, 1998; Catlan, 2011).

The Populist View

The botanical definition of fruit may at times be confusing as it includes - and excludes - structures that we do not readily identify or label as fruit. Think of, for example, pods, beans, ears, cobs; all in fact are fruits. And vegetables like aubergine, long beans, snow peas, red and green chillies, or tomatoes are simply the immature stages of fruit, where only the method of processing qualifies them for our human perception of vegetable. Nuts similarly are really just fruits.

Indeed, fruit wears many hats, not only by botanical definition, but also by use. The most important is that of food, the single other purpose of fruit apart from procreating its own self. Cunningly designed to promote one by serving as the other, consumption (by human or animal) of seeds and often all around animals help disperse the seeds beyond the reach of the mother plant. To the 'consumer', i.e. the hungry human (and fruit-eating animal), fruit is manna - nourishing, tasty, refreshing, healthy, often juicy, tangy, sweet, creamy (not forgetting the durian here!) and whatever else the senses perceive.

Fruits are, and have long been an important agricultural commodity, first of all as a food – to a good portion of animals including humans (Van Ginkel & Villareal, 1996; Gruèzo, 1992; Laws, 2011). Yet fruits not only nourish the body, but equally the soul. They stimulate the imagination of the aesthetically inclined, with a myriad of attractive, curious or fascinating shapes, colours or appendages. Gourds and pumpkins are often used as decorations while fruit baskets are welcomed decorative presents. Just as fruit wears the hat of vegetable, it can just as well be put on the hat of spice, nut, or even fragrance to name just a few possibilites.

Flower to Fruit – How, why, and when not?

Fruits do not just 'happen' on a plant. They may or may not develop, depending on many different factors, some in and many others out of a plant's control (Taiz & Zeiger, 1991). Once a flower, cone etc. is formed other processes begin that will determine whether there is the potential for a fruit. Male (pollen) and female (ovule) parts need to meet and unite for a fruit to form. Pollination may at times take place unaided, but in most cases depends on external help in the form of wind, the presence of pollinators (often insects, but also birds, bats and other animals), and/or the presence of several compatible individuals of a species for 'cross-pollination'. The right timing for pollination is also crucial - when pollen is ripe and female parts receptive. Obviously producing a fruit is not as easy as it is to eat one – as any farmer will agree!

For the plant successful formation of a fruit means everything, and this is just one thing: the production of a new generation. Even though many plants are capable of forming offshoots, or can regenerate from cuttings, reproduction by seed is the best insurance for survival of a species. Each fertilization means the formation of a genetically unique new individual, and ensures genetic diversity within a species (Snustad & Simmons, 2000). Infra-species genetic diversity is a key factor in species' ecological fitness, especially when faced with competition from other species for resources like water, light or nutrients, and in strengthening resistance to pests and

diseases. Seeds instead of vegetative reproduction also mean a better, wider dispersal and the potential of a species to spread to new areas.

Size and shape do matter!

Fruit can be big, even huge in the case of the Coco-de-mer, the fruit of a palm (*Lodoicea maldivica*) native to the Seychelles (Mabberley, 2000; Kesseler & Stuppy, 2006). Individual Coco-de-mer takes 6 years to mature and may reach a length of 30 cm, weigh up to 18 kg and have a circumference of close to 90 cm. Or take the jackfruit, or nangka (*Artocarpus heterophyllus*), the largest of all tree-borne fruits. A single fruit may reach 3 feet (approx. 90 cm) in length and > 1 ½ feet (approx. 50 cm) in width, with a weight tipping 110 lbs (approx. 50 kg), and contain up to 500 individual seeds (Morton, 1973)! Or take the Brazil nut. Unless you know just the right spot to tackle it, even an axe will not cut through this literally tough nut! In Malaysia we wage a constant battle against the formidable durian, just to get to the delectable inner parts. On the other end of the spectrum we find small, even microscopic, fruits and seeds, with some orchid seeds weighing in at barely 3-28 g (~35 millionth of an ounce) (Kesseler & Stuppy, 2006)! The smallest fruits of a flowering plant belong to tiny floating plants known as duckweeds of the genus *Wolffia* (Lemnaceae) where each fruit (or utricle) can measure as little as 0.3 mm in length, about the size of a salt grain!. However, thankfully most fruits hover somewhere in between, easy for the picking by animal and human alike.

The Take on Taste

Fruits come fleshy or dry, hard or soft or something, anything in between, sometimes even both. You get them sweet, sour, juicy, pulpy, jelly-like, fibrous and what not. At times all of a fruit can be popped into your mouth; in other cases you may have to remove inner or outer parts because they are inedible, indigestible or simply hard to handle or tardy to taste.

When unripe we use fruits as vegetables. Chillies, aubergines (terong, brinjal), capsicum (a mild member of the chilli family), the unripe, green stages of many legumes (think beans, peas and other pods), and even unripe bananas, cempedak or nangka are used in savoury delicacies and snacks. Fruits may also appear in the guise of spice. Examples are pepper, cumin, fennel, cardamom, aniseed, nutmeg, fenugreek, coriander, to just name a few. Botanically qualified as fruits, their aromatic properties make them end up in our kitchens in tiny quantities,whole, cracked or ground up, imparting fragrance and taste to curries, stews, cakes and other culinary concoctions.

Fruit is also preserved, in a mind-boggling array of savoury, sweet, tangy, salty, spicy, sour as pickles, preserves, and snacks, with each corner of the world imparting its own particular seasoning and flavours. Just think of Europe's delicious fruit jams, or the spicy Asian acars and assam treats made from mango or lime, or even wild fruit, or the popular Malaysian snacks of goreng pisang (fried bananas), goreng cempedak and jemput-jemput, to name just a few.

Among the many fruits humans consume are also those we would hardly associate with the term fruit. Yet most people in the world depend on one or another on these fruits and would hardly go through a single day with at least one meal containing rice, bread, couscous, or oat porridge. These starchy seeds that form the basis of most global cultures are the fruits of grasses, and are better known as cereal grains (Laws, 2011). All belong to the botanical family Poaceae (also called Gramineae) that also includes the versatile and amazing bamboos and sugarcane. All are packed with large starch reserves and important nutrients. Be they rice, corn, wheat, barley, oats, millet, sorghum or any other cultivated grain, they feed both people and much of livestock around the world. Without their domestication

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human existence as we know it now and throughout history, would have been practically unimaginable and even impossible (Laws, 2011). Not to be forgotten is one of the champions of tropical agriculture, the oil palm. This versatile plant (*Elaeis guineensis Jacq.*) and the equally versatile oil it produces in its fruits is a native of tropical Africa, but has in the last half century revolutionized global agriculture, economy, industry and consumption patterns.

On the other end of the nutrient reserves spectrum are orchids, almost completely devoid of any storage tissue except tiny amounts of oil. These fascinating plants produce fruit in the form of capsules that contain up to several hundred thousand of microscopic seeds that, lacking reserves, can only successfully germinate with the help of certain fungi.

Fruit also takes the form of nuts. Neither fleshy nor sweet they do, however, have a long and loved association with mankind. Rich in proteins and oils/fats they form an important part of our diet apart from being a favorite and healthy energy-packed choice of snack. Nuts also constitute an important source of high energy food for wildlife, and play an important role in forest ecology.

Equally important are the ripe stages of legumes, plants belonging to the bean family. Dried beans and pods, including the many varieties of dhal beans, have rich nutrient reserves in the form of starch and protein. They are used for vegetable dishes, both in Asian and European cuisine, and have long been important staples in many cultures. Able to be stored for long periods, they were and still are invaluable during times of cold and drought when fresh food is hard to come by,

Parts of fruit can also be converted into household utensils and decorative items, or other purposes related to everyday life. Coconut (*Cocos nucifera*) has long been used extensively in crafting utensils, as buttons, vessels, scoops etc. Young nuts contain the cooling, refreshing liquid known as coconut water while older nuts yield an oil-rich milk indispensable in Asian cuisine. The husk covering the hard-walled inner seed yields fibre that can be used for ropes, to weave mats, stuff mattresses, and as a compost or fuel. In Malay language this versatile fruit is known as pokok seribuguna (tree of a thousand uses), with obvious reason!

Order in Chaos?

In all, the plant kingdom is estimated to consist of at least 300,000 species, many as yet not described or even discovered (IUCN, 2011). The vast kingdom Planta (the second largest after Insecta) includes primitive single-celled algae and tiny lichens and mosses, but also curious cacti, highly evolved orchids, herbs, climbers, creepers, as well as modern-day sentinels of an ancient past such as cycads and gingkos. Where in this maze are those that provide us with the fruits so important to mankind?

The by far dominant group are the seed plants, numbering close to 270,000 species (IUCN, 2011). At current knowledge they are classified in 415 families (Chase & Reveal, 2009). Interestingly this diversity in flowering plants is not evenly distributed. The ten largest families of flowering plants include the daisy family (Compositae, 23,600 species), orchids (Orchidaceae, >22,000 species), followed by the pea family (Leguminosae, 19,400 species) an important source of edible fruits (Stevens, 2011). The grass family, likewise, is among the largest flowering plant families with more than 10,000 known species and their fruits important in world nutrition.

However, it is some of the smaller plant families that contribute much to the variety of fruit humans have consumed throughout history. Apple, cherry, plum, pear, quince, and a host of berries, all belong to the same family, Rosaceae, and are relatives of the beautiful rose. Rambutan, litchi, longan, pulasan and mata kuching are all produced by members of the family Sapindaceae. Mango, binjai, kwinias as well as cashew nut and pistachio belong to the family Anacardiaceae, together with Poison ivy, sumac and the feared Rengas trees of Southeast Asia. Rutaceae, a family with global distribution, provide us with everything citrus, i.e. lime, lemon, orange, pomelo, grapefruit, and their many cultivars and varieties. Not to be ignored is the grape family, Vitaceae, whether it is for the succulent fruit or the wines that are made from them.

Conclusion

Many more plant families and individual fruits deserve mention, but are not within the scope of this book. Much that is deserving of mention in the context of fruit should be discussed, but needs here to be deferred. Fruit morphology, anatomy, uses, properties, their influence on mankind are fascinating topics that further define and refine the identity of fruit weaving together aspects of history, culture, civilization, economics and science. Fruit touch our lives, daily, constantly, in different layers, on many different levels, in all possible, and impossible, guises. It is hoped that this book on fruits will effect a new appreciation for these wonders of the natural world that play such a pivotal role in the existence of our own species.

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