



## Inflorescence and Flower traits of Banana

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### Introduction

The flowering traits of banana one of the most complicated elaborating subject matters. Preliminary flowering commonly takes 9-11 month after planting (depending upon variety). Inflorescence is known as Spadix. Colour of the male flower is white or cream in *M. acuminata* and pink in *M. balbisiana*. Physiology of flowering intricate a twin factor is familiar with the aid of Gibberellins and Anthesin. Inflorescence of banana develop deep within the stem from the starting of plant development, long before they start noticing. Generally, the female flowers occur in a series of organized manner called hands and these hands are comprised of individual female part called fingers. These fingers are nothing but individual banana fruit. These hands and fingers are female part and the last portion which is the basal part of the bunch is the male part of the plant called as navel. The number of fingers in each hand and the total number of hands in a bunch are varies in cultivated and wild species of bananas. Generally, in normal market conditions each of hand consists of many flowers and the flowers develop in an ordinary pattern from proper to left. Because of their indefinite flower arrangement pattern the wild banana species called the hairy banana. This hairy banana flowers are never arranged in ordinary right-to-left manner which is seen in the banana species found in supermarket. That is surprising and illustrates an important factor approximately technological know-how: we do not longer usually get the answers we anticipate. Development of inflorescence is a series of complex process to form the final flower parts that we see in banana plants.



### Inflorescence

The inflorescence coming out from pseudo stem and bends downwards after emergence. This inflorescence forms two rows of tightly packed flowers within large, ovate, reddish bracts coming out from each node. These bracts generally shed out after fruit development. The female flowers emerge first and the males at the distal end. From the middle of the bunch hermaphrodite flowers develop but they get aborted after sometime.

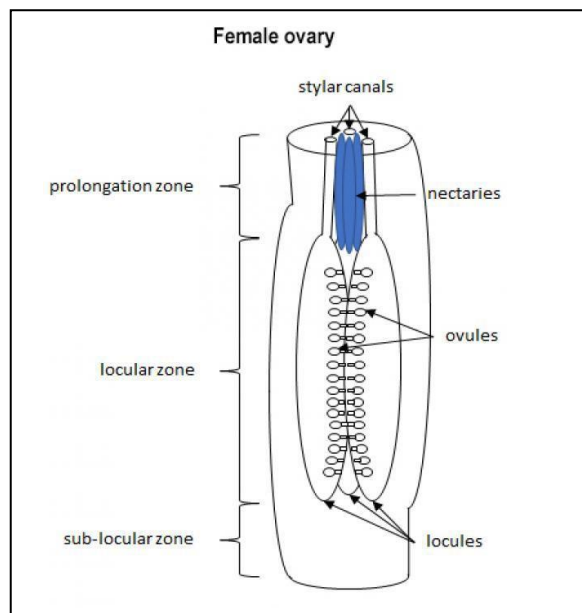
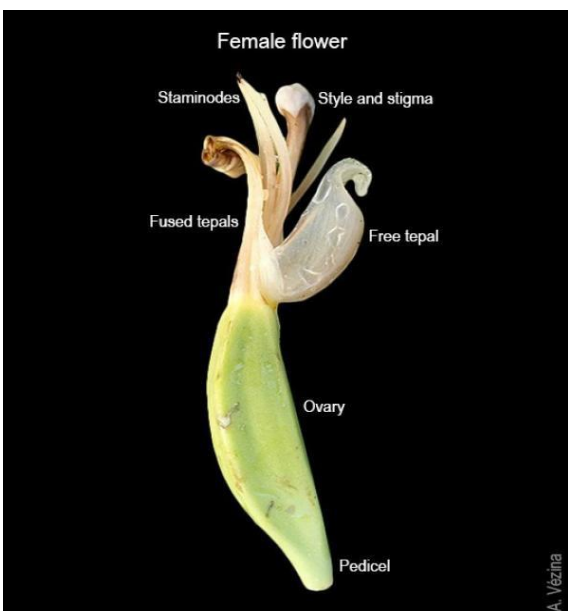
Flowers coming out from each node are called as a hand; each hand consists of 12–20 number of flowers which is referred as fingers and generally 5–15 hands with female flowers are seen in the bunch. One bract open per day in a sequential manner. The length of the peduncle growth is generally 1.5m, terminating with a male flower bud and male flowers enclosed within the bracts. The last hand (false hand) of the female flowers has few fingers (fruit) and the rest of the nodes have non-functional pistils.

The inflorescence stem (rachis) is cut below the false hand, where a finger is left attached to maintain a connection with the plant circulatory system and avoid rachis rotting. The detached rachis removes the male flowers. The 10 cm female flowers of cv. ‘Cavendish’ have an inferior ovary of three united carpels with a short perianth. The perianth consists of five fused and one free segment, forming a tube around the style and sterile androecium and three-lobed stigma. Male ‘Cavendish’ flowers are 6 cm long with five stamens, which rarely bear fertile pollen.

### Type of Flowers

#### Female flower

Female banana flowers consist of large style and stigma. Sometimes there are male organs are



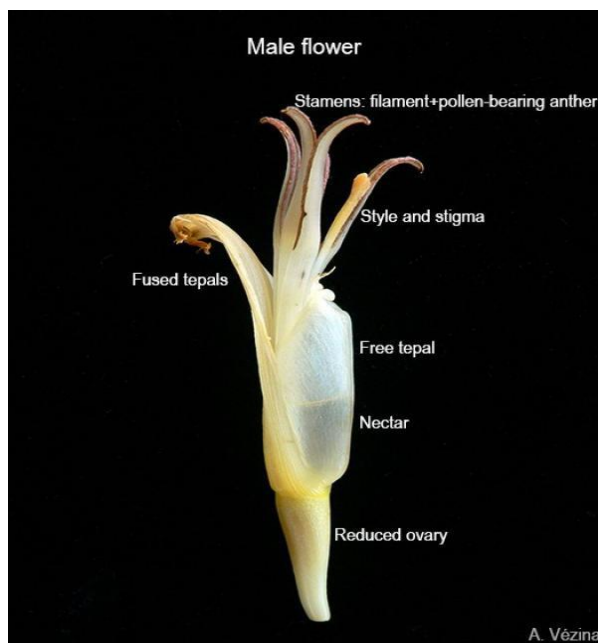


absent. The basal enlarged part which contains the ovules is called the ovary (from the Latin's *ovum*, meaning egg). The ovary, style and stigma together called as pistil and also called a carpel. It is a tri-pistillate ovary. The stigma is the tip portion which receives pollen. Female part is also called gynoecium that produce ovules and ultimately develop into the fruit and seeds.

Anthesis (the period during which a flower is fully open and functional) time of female flower is before male one. An ovary may contain 200 to 300 ovules, which in wild species can potentially develop into that many seeds only after pollination. Generally seedless parthenocarpic fruits (without being pollinated) is seen in edible banana species.

### Male Flower

Male banana flowers have a narrow style and stigma and well-developed anthers. The anthers of wild species usually contain pollen. In edible bananas, the amount of pollen is reduced or absent. Stamen or male flower consists of anther and filament. Male flower typically has five stamens. Collectively the stamens called as androecium.



The style, stigma and male parts of the banana flower are within a tubular structure formed by fusion of five petal-like tepals, with a sixth tepal remaining free.

The gynoecium of male flower is much smaller than in female. Male flowers have nectar. This nectar helps in attracting pollinators (bats and birds) in wild species of banana. Edible bananas do not need to be pollinated, but because their flowers still produce nectar they are visited by animals and insects. Each hand in male flower is enfolded by a bract that lifts when the flowers have finished developing.



### Hermaphrodite flowers

In some wild species the basal female flowers have a functional gynoecium and androecium, and can self-fertilise before bract opening. This type of flowers are called hermaphrodite or perfect.

The hemaphrodite term has to be used to describe basal flowers in *Musa acuminata* ssp. *banksii*, *Musa acuminata* var. *chinensis* , *Musa boman* , *Musa hillii* , *Musa ingens* , *Musa schizocarpa* and *Musa yunnanensis* , but the term may not be referring to the same type of flower in all cases, based on the description.

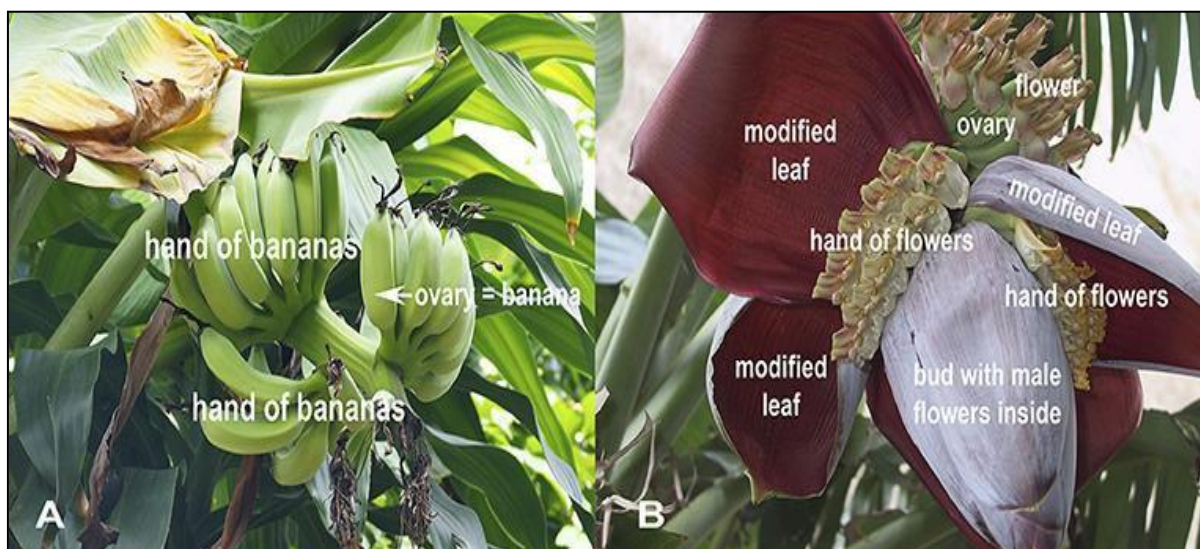
This self-fertilize process is significant because it reduces hybridization and also contribute to genetic isolation.

### Other types of flowers

In some edible bananas, some flowers are there at transition point from the basal female to the distal male portion of the inflorescence that do not produce fruit and have a small ovary. This type of flowers is larger than functional male flowers. Such flowers are called neuter or intermediate.

### Where Do Bananas Come From?

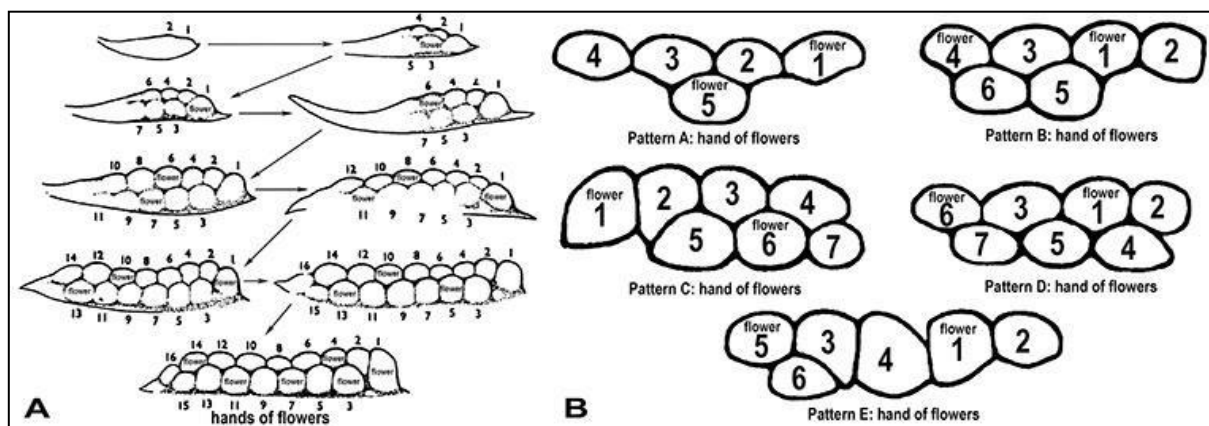
Banana is a long, yellow, curved fruit which can be easily peeled. After the peeling the inside fruit is lightly pale white in colour, soft and sweet. Around the world the Cavendish banana type mostly sold. There are more than 1,000 banana varieties are found around the world. All these varieties are different in taste and look. Bananas are an important and popular food crop. But there are so many mysteries about the banana plants. For example, until Dr. Kirchoff's (Kirschoff, 2017) work, no one had ever completely described the pattern of how banana flowers form. The fruit we consume originate from part of banana flower.







The process of flower formation is called flower development which is most complex process. How the plant first forms its flowers and how it's come out from pseudo stem is the main mystery. Banana flowers form inside the stem of the plant and within the bases of the leaves. By the end when the stem rises above the leaves then the flowers have nearly completed its growing. As because the first ever flower development starts within plant, one has to cut the pseudo stem apart to see that. Flowers form in the Dwarf Cavendish banana plant which mostly used for eating (Fahn, 1953). In Figure 1, these groups are called "hands," because the bananas resemble fingers. The first flower is formed on the right side of the hand (Figure 2A) and the rest of the flowers form in zigzag pattern, back and forth between the top and the bottom rows. Some related banana species have similar patterns.



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- Figure 1 - (A) Clusters of banana fruits arranged in groups called hands.
- Each hand contains many bananas, which develop from the female part of the flower, the ovary (see B).

The hands of flowers are born under a modified leaf that protects them while they are young (see B). Later, when the bananas are nearly ripe, the modified leaf falls off, leaving a scar. (B) A flower cluster with open female flowers and male flowers inside the big red bud at the center of the picture. The male flowers are formed separately, after the female.

- Figure 2 - (A) In supermarket bananas, the first flower (labeled 1) forms on the right side of the hand.
- After that, the flowers develop in a zigzag pattern from right to left. "2" represents the second flower that forms, etc. The base of the hand continues to grow during this time, which makes room for the new flowers. (B) The patterns of flower formation found in the hairy banana. There is little growth of the base of the hand during flower formation in the hairy banana.

But these results might not be same for other species of banana plants specially the wild banana.

### Flowering in Wild Banana

Surprisingly the hairy banana (*Musa velutina*) did not make flowers in the same way. There are five different patterns (Figure 2B). Two of these are similar to previous result (Figure 2B,



patterns A, B). But in other species this is different (Figure 2B, patterns C–E). In one pattern, the order flowers form is the opposite of what previously described (Figure 2B, pattern C). Instead of from right to left, flowers develop from left to right in this pattern and in a total of 29 different patterns.

If anyone compare the two parts of Figure 2, then it will be seen that the supermarket banana that has many more flowers than the hairy banana. The hairy banana only develops 5–7 flowers in a hand. That means, there are 25–40 flowers develop per plant which is arranged in a 5–7 hands. The supermarket banana can produce up to 400 flowers (and bananas) arranged in 20 hands. This may be why the two species make flowers in different ways.

### Flower Structure and Development

Banana flowers also have four parts like almost all flowers:

**Sepals** – It is the outermost flower parts. In general, it mainly protects the other part of flower in budstage.

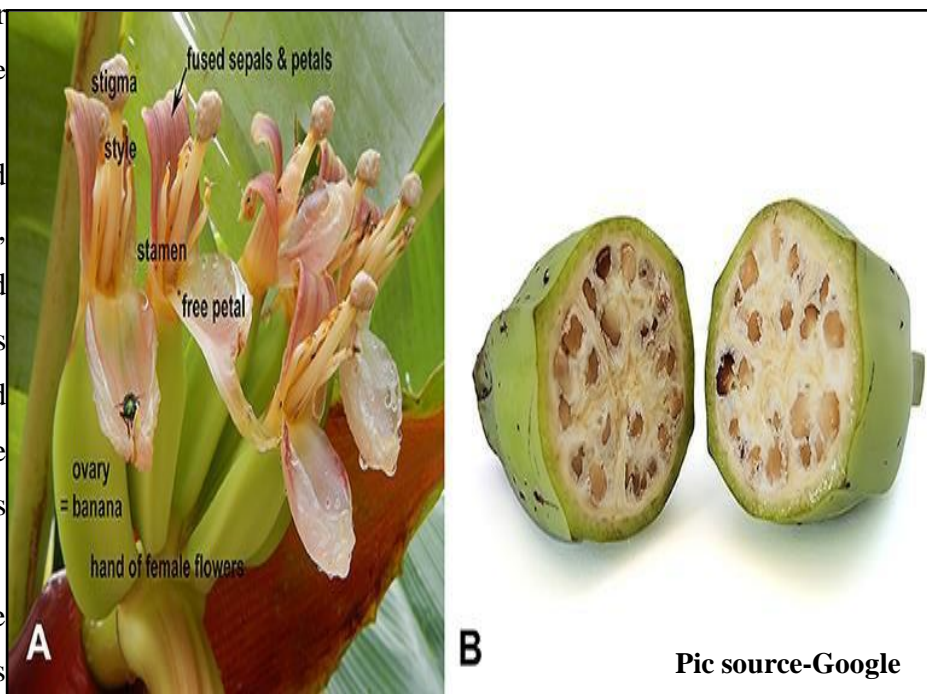
**Petals** – After sepal it is the second most flower part. In most plants, petals attract insects and birds (and people) to the flowers. Insects generally act as pollinizers and helps in reproduction. People admire the flowers, and sometimes cut them to put in vases.

**Stamens** - The male part of the plant. Stamens contain pollen sacs

inside. The Latin root stem means anything that stands upright. The stamens stand upright (Figure 3A).

**Ovary** – It is the fruit forming part. The egg in the ovary develops into seed inside the fruit. The Greek root means egg, but this is tricky because the ovary is not the egg. The egg is inside the ovary. (Figure 3A).

Generally, the outer part of flower i.e., sepal and petal are colorful but not in case of banana. The stamens are the male parts. The ovary is the female part. The hairy bananas are generally the wild nit edible one and the ovary grows into the fruits that is full of seeds (Figure 3B).



Pic source-Google



Banana flowers consists of male and female form and both flowers have sepals and petals (Figures 3, 4). There are three sepals and three petals (Figure 4D). Two of the sepals and all of the petals are fused together, whereas one petal is free (Figures 3A, 4B). In male flowers normal stamens form normal pollen.

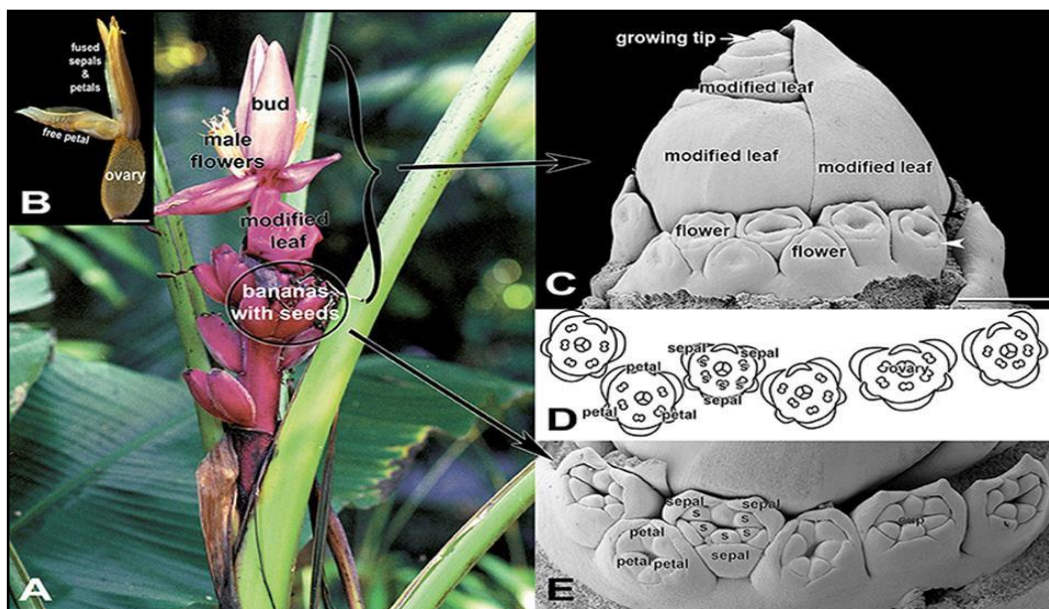
Male flower doesn't produce fruits and only act as pollinizers. The ovary from female flowers only develops into a banana fruit (Figures 1, 3) but the stamens of female are non-functional.

- Figure 3 - (A) A hand of female banana flowers, each with five fused sepals and petals, and one petal that remains unfused.
- The female flowers have stamens (male parts), but the stamens do not produce good pollen grains. Pollen grains contain the sperm. The female part of the flower has an ovary, which will develop into the banana fruit. The style and stigma function in fertilization, which leads to the formation of the banana fruit. (B) A cut fruit of a wild species like the hairy banana, filled with hard seeds. These fruits cannot be eaten.

The stamens consist of two circles, the outer circle with three stamens and the inner circle with two stamens. These five stamens are present in both male and female flowers (Figure 3A), though they have no function in the female flowers. If green banana is cut crosswise, three section of female flower has been seen.

### Floral induction and fruit set

There are no external symptoms of the start of inflorescence development. The flowering stimulus is unknown. Temperature or photoperiodism is not the external reasons and same as and the number of leaves developed might not be the internal cause, as because depending on cultivars and



Pic source-Google



environment, the number of leaves is more or less fixed.

- Figure 4 - (A) A flower cluster of the hairy banana with hands of female flowers below hands of male flowers.
- Unlike supermarket bananas, the flowers point upright in this species. (B) A mature female flower of the hairy banana. The ovary of the female flowers becomes the banana. (C) A cluster of banana flowers with one hand of young female flowers shown. As they form, the hands of flowers are wrapped in modified leaves. (D) A hand of flowers like the one shown in (E). These sepals, petals, stamens, and ovary are all formed on the young flower. (E) A hand of young flowers with the flower parts labeled. The cup grows and eventually forms the ovary and later the banana fruit. stamen.

### Growth and development

Triploidy is the reason behind pollen sterility, while female sterility is due to at least three complementary dominant genes and modifier genes. These sterility genes are found in wild populations and have been selected for fruit edibility. Parthenocarpy is separate from sterility. For the first fortnight after anthesis the ovules increase in size (50% over initial), and later they shrivel and ovary growth slows. In case of parthenocarpic bananas with seeds ('Pisang Awak' ABB) show a fervor of fruit growth and development, due to the presence of growing seeds.

Even without seed development pollination can stimulate fruit growth (Israeli and Lahav, 1986). Outer skin filling increases rapidly in the first 40 days after flowering but the fruit pulp development starts after this. Starch accumulation parallels finger length and diameter increases (Lodh *et al.*, 1971).

In most cultivated types, the bunches bend because of the fruit bunch weight. As the inflorescence emerges from the pseudo stem, it bends towards the sun. Fruits on the inner whorl of a hand can be 15% smaller than those on the outer whorl. Normally the last or last two hands that have smaller hands are eliminated if higher fruit calipers (diameters) are desired. The male inflorescence should be removed soon after bunch development, after completion of female phase to restrict the movement of photosynthates and other nutrient to the male part.

In plantains, there are normally fewer flowers per bunch, although some of the new tetraploids have a very heavy load of fruit. Some plantain types do not have the male part of the inflorescence or it is rudimentary.

### Conclusion

Banana itself is a complex plant species and so as its flowers. At first male flower coming out first then female phase starts. After completion of female phase generally male bud (navel) should be cut down to restrict the flow of photosynthates to the unwanted male inflorescence.





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