



**PLANT HORMONE AND ITS IMPORTANCE IN FRUIT SCIENCE**

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**ABSTRACT**

Plant hormones, also known as phytohormones, are chemical messengers that regulate various physiological processes in plants. In the context of fruit science, plant hormones play a crucial role in the growth, development, and ripening of fruits. This abstract provides an overview of plant hormones and their importance in fruit science. Auxins, such as indole-3-acetic acid (IAA), promote fruit growth by regulating cell division and elongation. They are involved in fruit set, fruit size determination, and the formation of parthenocarpic fruits (seedless fruits). Cytokinins are involved in cell division and differentiation, and they interact with auxins to regulate fruit development. They influence fruit enlargement, delay fruit senescence, and enhance fruit quality attributes. Gibberellins promote fruit growth and elongation by stimulating cell division and elongation. They also regulate fruit set and seed development. Gibberellins have been used in agriculture to increase fruit size and improve fruit quality. Plant hormones play a vital role in fruit science by regulating various aspects of fruit growth, development, ripening, and postharvest characteristics. Their interactions and balance determine fruit size, quality attributes, and responses to environmental stimuli. Further research on plant hormones in fruit science holds significant potential for improving fruit production, enhancing fruit quality, and reducing postharvest losses, thus benefiting the agricultural industry and consumers alike.

**KEYWORDS:** Plant, Hormone, Auxins, Cytokinins, Environmental.

**INTRODUCTION**

Plant hormones, also known as phytohormones or plant growth regulators, are chemical substances produced naturally by plants to regulate various physiological processes. They play a crucial role in plant growth, development, and response to environmental stimuli. In fruit science, plant hormones have significant importance in the regulation of fruit development, ripening, and quality.

One of the most important plant hormones involved in fruit science is ethylene. Ethylene is a gaseous hormone that acts as a signal molecule in various stages of fruit development and ripening. It regulates several physiological processes such as fruit ripening, fruit senescence, and abscission (the process by which fruits are shed from the plant). Ethylene influences the production of enzymes responsible for fruit softening, color changes, aroma production, and flavor development. It is involved in the transition from immature green fruits to mature and ripe fruits.

Ethylene has a profound impact on the commercial handling and storage of fruits. Its influence on fruit ripening and senescence necessitates careful

management to control the timing and rate of ripening. For instance, postharvest treatments with ethylene or its inhibitors can be used to delay or accelerate fruit ripening, depending on the desired market conditions and transportation requirements.

Another essential plant hormone in fruit science is auxin, particularly indole-3-acetic acid (IAA). Auxins regulate various aspects of fruit development, including cell division, enlargement, and differentiation. They are involved in fruit set, the process by which flowers develop into fruits, and in the control of fruit size. Auxins also influence fruit shape and the development of specific structures such as seeds.

Gibberellins (GAs) are another class of plant hormones that are important in fruit science. They regulate various aspects of fruit development, including cell elongation, seed development, and fruit growth. Gibberellins can promote fruit growth and increase the size of fruits, influencing the overall yield and quality.

Cytokinins are plant hormones involved in cell division and differentiation. They influence fruit development by affecting cell division rates in the early stages and

delaying senescence in the later stages. Cytokinins can also enhance fruit quality attributes such as color, flavor, and shelf life.

These are just a few examples of the many plant hormones and their importance in fruit science. The interactions and balance between different hormones orchestrate the complex processes of fruit development, ripening, and quality. Understanding the roles and regulation of plant hormones in fruits is crucial for improving fruit production, postharvest handling, and overall fruit quality in agricultural practices.

### Importance of Plant Hormones in Fruits

#### 1. Fruit Development: Plant hormones regulate the entire process of fruit development, from the initiation of flowers to the maturation of fruits.

For example, auxins promote fruit set and growth by stimulating cell division and elongation. Cytokinins contribute to the growth of fruits by regulating cell division and differentiation. Gibberellins stimulate fruit elongation, while abscisic acid (ABA) inhibits it. The precise balance and interaction of these hormones are critical for proper fruit development.

2. **Fruit Ripening:** Plant hormones play a central role in the ripening process of fruits. One of the most well-known hormones involved in fruit ripening is ethylene. Ethylene triggers the ripening process by influencing various physiological and biochemical changes, including the conversion of starches into sugars, softening of the fruit, and color development. Ethylene also regulates the production of other hormones, such as auxins, which further contribute to fruit ripening.
3. **Fruit Quality:** Plant hormones influence the quality attributes of fruits, such as taste, aroma, color, texture, and nutritional composition. For instance, the balance of auxins and gibberellins affects the fruit's size and shape. Ethylene, along with other hormones, determines the flavor and aroma compounds produced during ripening. Proper hormonal regulation ensures the development of fruits with desirable traits and optimal nutritional value.
4. **Fruit Preservation:** Plant hormones are also crucial in the post-harvest preservation of fruits. Manipulating hormone levels can help delay or accelerate fruit ripening, extending their shelf life and reducing spoilage. Ethylene, in particular, influences the senescence process and shelf life of many fruits. Controlling ethylene production and response can allow for better storage and transportation of fruits, reducing post-harvest losses.
5. **Yield and Productivity:** Understanding and manipulating plant hormones offer opportunities to enhance fruit yield and productivity. By optimizing the hormonal balance, farmers can influence fruit set, size, and number, leading to increased crop yields. Hormone treatments can also improve fruit uniformity and reduce fruit drop, thereby

maximizing the overall productivity of fruit-bearing plants.

### Hormone regulation during fruit development and ripening

During fruit development and ripening, several plant hormones play crucial roles in regulating the physiological processes. The interplay and balance of these hormones determine the timing, quality, and characteristics of the fruits. Let's explore the key hormones involved:

1. **Auxins:** Auxins, such as indole-3-acetic acid (IAA), promote fruit growth and development. They stimulate cell division, elongation, and differentiation, which contribute to fruit enlargement. Auxins are involved in fruit set, where they help in the formation and development of the fruit after pollination and fertilization.
2. **Cytokinins:** Cytokinins regulate cell division and differentiation in developing fruits. They promote fruit growth and influence fruit size and shape. Cytokinins also help in delaying senescence and prolonging the shelf life of fruits by slowing down the aging process.
3. **Gibberellins:** Gibberellins (GAs) stimulate fruit elongation and expansion. They promote cell division and elongation, contributing to the increase in fruit size. GAs also influence fruit shape and can induce parthenocarpy (fruit development without fertilization) in some plants.
4. **Abscisic Acid (ABA):** ABA plays a significant role in fruit ripening, particularly in the regulation of fruit color changes and the initiation of fruit maturation. As the fruit approaches ripening, ABA levels increase, triggering various biochemical changes and the onset of ripening processes.
5. **Ethylene:** Ethylene is a key hormone involved in fruit ripening. It is responsible for the softening of the fruit, color development, and changes in flavor and aroma. Ethylene production increases as fruits reach their mature stage, triggering a cascade of ripening events. It also acts as a signaling molecule to coordinate ripening processes in neighboring fruits.
6. **Jasmonates:** Jasmonates are involved in fruit ripening and the defense response of plants. They contribute to the synthesis of volatile compounds responsible for fruit aroma and flavor. Jasmonates also play a role in stress responses, including pathogen defense mechanisms during fruit ripening.
7. **Brassinosteroids:** Brassinosteroids are known to promote fruit growth and development by stimulating cell expansion. They also contribute to fruit ripening processes and affect fruit quality attributes such as sugar content and firmness.

The interaction and coordination of these hormones, along with other molecular and environmental factors, determine the precise timing and progression of fruit development and ripening. Manipulating hormone levels

or their signaling pathways can be employed to control fruit ripening, extend shelf life, and enhance fruit quality and post-harvest preservation.

### **Fruit growth is mainly dependent on auxin and cytokinin**

While **auxin and cytokinin** are important plant hormones involved in fruit growth, it is important to note that fruit growth is a complex process influenced by multiple hormones and their interactions. Auxin and cytokinin play significant roles, but they are not the sole determinants of fruit growth.

**Auxin**, particularly indole-3-acetic acid (IAA), is involved in cell division, cell enlargement, and cell differentiation, which are crucial processes for fruit growth. Auxin promotes cell division in the early stages of fruit development, allowing for an increase in cell number. It also stimulates cell elongation, contributing to fruit size and shape. Furthermore, auxin influences the development of specific fruit structures such as seeds.

**Cytokinin**, on the other hand, is known for its role in cell division and differentiation. It affects the rate of cell division and delays senescence, thereby promoting fruit growth. Cytokinin can enhance fruit size and quality attributes such as color, flavor, and shelf life.

However, it is essential to recognize that other hormones, such as gibberellins and abscisic acid, also contribute to fruit growth. Gibberellins promote cell elongation and cell division, contributing to fruit enlargement. They can increase fruit size and impact fruit quality characteristics. Abscisic acid influences fruit growth by regulating water balance, stress responses, and seed development.

Therefore, while auxin and cytokinin are indeed important in fruit growth, it is crucial to consider the broader hormonal network and the interplay of multiple hormones involved in regulating fruit growth, development, and ripening.

### **Fruit ripening: Ethylene and ABA are the major contributors whereas other growth regulators are required for fine tuning of the process**

Fruit ripening is primarily regulated by **ethylene and abscisic acid (ABA)**, with other growth regulators playing a role in fine-tuning the process. Ethylene and ABA are considered major contributors to fruit ripening due to their significant impact on the physiological and biochemical changes that occur during this stage. Here is an overview of their roles:

- 1. Ethylene:** Ethylene is a gaseous plant hormone that plays a central role in fruit ripening. It is involved in various aspects of ripening, including softening, color changes, flavor development, and aroma production. Ethylene triggers a cascade of biochemical and physiological events that lead to the breakdown of cell walls, conversion of starches to sugars, and degradation of chlorophyll, resulting in

changes in fruit texture, color, and taste. Ethylene is also involved in the auto-regulation of its own synthesis and signaling pathway during fruit ripening.

- 2. Abscisic Acid (ABA):** ABA is another hormone involved in fruit ripening. It acts in conjunction with ethylene and contributes to the regulation of fruit maturation and quality attributes. ABA influences the synthesis and accumulation of sugars, pigments, and flavor compounds during ripening. It also plays a role in seed maturation and dormancy regulation in certain fruit types.

In addition to ethylene and ABA, other growth regulators such as auxins, cytokinins, gibberellins, and jasmonates also have regulatory roles in fruit ripening. These hormones may interact with ethylene and ABA to fine-tune the ripening process and modulate specific ripening characteristics. For example, auxins and cytokinins can influence fruit size, cell expansion, and the synthesis of certain compounds, while gibberellins can affect seed development within the fruit. Jasmonates are involved in the regulation of fruit senescence, defense responses, and the production of volatile compounds.

Fine-tuning the ripening process involves a complex interplay between these hormones, along with other factors such as temperature, light, and developmental cues. The specific roles and interactions of these growth regulators can vary depending on the fruit species and their genetic and environmental conditions.

### **Fruit colour and pigmentation are controlled by multiple hormones in both ethylene-dependent and ethylene-independent manner**

Fruit color and pigmentation are complex traits influenced by multiple hormones, operating both in an ethylene-dependent and ethylene-independent manner. While ethylene is a major regulator of fruit ripening and associated color changes, other hormones also play significant roles in controlling fruit pigmentation.

- 1. Ethylene-dependent regulation:** Ethylene is a key hormone involved in fruit ripening, and it plays a crucial role in regulating fruit color changes. Ethylene promotes the synthesis of pigments such as anthocyanins, carotenoids, and chlorophyll, while simultaneously suppressing the degradation of chlorophyll.
  - a) Anthocyanins:** Ethylene stimulates the biosynthesis of anthocyanins, which are responsible for red, purple, or blue colors in fruits. Ethylene promotes the expression of genes involved in anthocyanin biosynthesis, such as transcription factors and enzymes.
  - b) Carotenoids:** Ethylene enhances the synthesis of carotenoids, which contribute to yellow, orange, and red colors in fruits. It influences the activity of enzymes involved in carotenoid biosynthesis and

promotes the expression of genes related to carotenoid accumulation.

- c) **Chlorophyll degradation:** Ethylene accelerates the degradation of chlorophyll, leading to a decrease in green color during fruit ripening. Ethylene stimulates the expression of genes encoding chlorophyll-degrading enzymes, such as chlorophyllase and pheophytinase.
2. **Ethylene-independent regulation:** Multiple hormones, including auxin, abscisic acid (ABA), gibberellins (GAs), and brassinosteroids, contribute to fruit color and pigmentation regulation independently of ethylene.
- a) **Auxin:** Auxin can modulate fruit color development by influencing the expression of genes involved in pigment biosynthesis pathways. It can interact with ethylene and affect the biosynthesis and accumulation of anthocyanins and carotenoids.
- b) **ABA:** ABA is involved in the regulation of fruit pigmentation, particularly in controlling anthocyanin biosynthesis. It can induce the expression of genes involved in anthocyanin synthesis, leading to changes in fruit color.
- c) **Gibberellins (GAs):** GAs affect fruit color by regulating the expression of genes involved in pigment biosynthesis. They can influence the accumulation of anthocyanins and carotenoids, contributing to fruit color changes.
- d) **Brassinosteroids:** Brassinosteroids can influence fruit pigmentation by regulating the expression of genes associated with pigment biosynthesis pathways. They may affect the synthesis and accumulation of anthocyanins and carotenoids. The interactions and balance between these hormones, along with other regulatory factors, environmental cues, and developmental processes, determine the final fruit color and pigmentation. The precise mechanisms by which these hormones regulate fruit color are still being explored and may vary among different fruit species and varieties.

## CONCLUSION

In conclusion, plant hormones play a crucial role in fruit science and contribute significantly to various aspects of fruit development, ripening, and quality. Different hormones, including auxin, cytokinin, ethylene, abscisic acid (ABA), gibberellins (GAs), and brassinosteroids, interact and regulate fruit growth, maturation, and color changes in a complex manner.

Auxin and cytokinin are involved in fruit growth and development, influencing processes such as cell division, cell enlargement, and fruit set. Ethylene and ABA are major contributors to fruit ripening, including color changes, softening, and aroma development. Ethylene is a key regulator of fruit ripening, while ABA regulates various aspects of fruit maturation.

Additionally, other hormones like GAs, brassinosteroids, and auxin are required for fine-tuning fruit development

and ripening processes. They influence fruit size, shape, pigmentation, and other quality attributes. The interplay between these hormones, along with environmental factors, genetic regulation, and developmental processes, determines the overall fruit quality.

Understanding the roles of plant hormones in fruit science is crucial for the production of high-quality and marketable fruits. It enables researchers and growers to manipulate hormone levels and optimize fruit development, ripening, and quality attributes to meet consumer preferences and market demands.

However, it is important to note that the specific roles and relative importance of hormones may vary among different fruit species and developmental stages. Further research is needed to unravel the intricate hormonal interactions and regulatory networks involved in fruit science and to apply this knowledge for improved fruit production and post-harvest management.

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