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S&T REVIEW

BOTANICAL CHARACTERISTICS OF CAULIFLOWER (*BRASSICA OLERACEA VAR. BOTRYTIS*)

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ABSTRACT

Cauliflower (*Brassica oleracea var. botrytis*) is an important vegetable crop, cultivated globally in temperate and tropical regions. This biennial plant is characterized by its unique curd, composed of immature flower buds, which is highly valued for its nutritional content, including proteins, minerals, and vitamins. The vegetative growth includes a central stem, large lobed leaves, and a rosette formation. Curd yield parameters such as initiation, development, and harvest time are critical for optimizing production. Floral development, despite remaining incomplete in cauliflower, involves the transformation of the vegetative meristem into a floral meristem, resulting in the formation of the edible curd. Detailed knowledge of cauliflower's vegetative, curd yield, and floral characteristics is essential for improving cultivation practices and enhancing yield and quality.

KEYWORDS

Cauliflower, curd formation, floral meristem, Brassica oleracea, vegetative characteristics.

1. INTRODUCTION

Cauliflower (*Brassica oleracea var. botrytis*) is one of the most important cole crop grown as vegetable throughout the world. It is grown in both temperate and tropical areas. It requires cool temperature and well-drained soil for optimal growth. The edible part of cauliflower is known as curd, which consists of shoot system with short internodes, branches apices and bracts. It has high quality of proteins and peculiar in stability of vitamin C after cooking. It is rich in minerals such as potassium, sodium, iron, phosphorous, calcium, magnesium etc. It also contains vitamin A.

2. VEGETATIVE CHARACTERISTICS OF CAULIFLOWER

This heading is divided into following sub-headings and are discussed below:

2.1 Plant height

The plant height of cauliflower (Brassica oleracea var. botrytis) typically reach a moderate to tall height at maturity, ranges from 30 to 60 centimeters, depending on factors such as cultivar, growing conditions, management practices, genetics. For instance, researchers observed cauliflower plants reaching heights between 40 to 50 centimeters under optimal nutrient management (Gupta and Raja, 2012). Similarly, in other study author has reported cauliflower plant heights ranging from 35 to 55 centimeters in response to varying levels of nitrogen and phosphorus (Sahay, 2016; Singh and Yadav, 2018).

2.2 Stem diameter

The stem diameter of cauliflower typically ranges from 2 to 4 centimeters at maturity, depending on various factors such as cultivar, soil fertility, and environmental conditions. Research found that cauliflower stems had an average diameter of approximately 3 centimeters under optimal growing conditions (Patel and Patel, 2019). Similarly, a study by reported cauliflower stem diameters ranging from 2.5 to 3.5 centimeters when different levels of nitrogen and potassium were applied (Kumar and Sharma, 2016).

2.3 Leaf Number

Cauliflower typically produces a rosette of leaves at the base of the stem during the early vegetative stage, with new leaves emerging sequentially as the plant matures. Cauliflower typically possesses 10-15 leaves per plant at maturity (Gupta and Raja, 2012).

2.4 Leaf Length and breadth

Cauliflower leaves are typically lanceolate or ovate in shape. The length of the leaves typically ranges from 20 to 40 centimeters, while the breadth may vary from 10 to 20 centimeters (Das and Parida, 2018).

2.5 Leaf Type

Cauliflower leaves are generally compound leaves with leaflets arranged in a pinnate manner (Prusty and Das, 2014).

2.6 Leaf Color and texture

Cauliflower leaves are usually a medium to dark green color, though they can vary depending on cultivar and environmental conditions (Saha and Sharma, 2013). Cauliflower leaves typically have a smooth texture with a slight waxy surface.

2.7 Dry Matter Content of Leaf

The dry matter content of cauliflower leaves typically ranges from 8% to 12%, depending on factors such as age, environmental conditions, and nutrient availability (Singh and Kumar, 2015).

2.8 Rosette Diameter

The rosette diameter of cauliflower, which is the spread of the leaves at the base of the plant, can vary depending on plant age and growing conditions. Typically, rosette diameter from 20 to 30 centimeters.

2.9 Fresh Stem Weight

The fresh weight of cauliflower stems at maturity can vary widely, ranging from 100 grams to 500 grams or more, depending on cultivar and growing conditions (Kumar and Sharma, 2016).

2.11 Fresh Leaf Weight

The fresh weight of cauliflower leaves varies depending on size, age, and environmental conditions, with individual leaves weighing from a few grams to 50 grams or more at maturity.

These characteristics collectively contribute to the overall morphology and physiology of cauliflower plants, influencing their growth, development and ultimately their yield and quality.

3. Curd Yield Characteristics of Cauliflower

This heading is also divided into following sub-headings and are discussed below:

3.1 Days to Curd Initiation

The initiation of curd formation in cauliflower typically occurs approximately 40 to 60 days after transplanting, though this time-frame may vary depending on factors such as temperature, soil conditions, and cultivar genetics (Dixon et al., 2009). During this period, the cauliflower plant undergoes physiological changes, with the apical meristem transforming into the curd primordium, eventually leading to the development of the edible curd.

3.2 Days to Curd Harvesting

Cauliflower curds are typically ready for harvesting approximately 10 to 14 days after the initiation of curd formation depending on factors such as cultivar type, environmental conditions, and cultural practices (Davis et al., 2010). Harvesting at the right time is crucial to ensure optimal quality and flavor of the curds, as delaying or harvesting too early can result in inferior taste and texture. At maturity, the curd is at least 15 cm in diameter.

3.3 Curd Height and Diameter

The curd height of cauliflower typically ranges from 15 to 20 centimeters, while the diameter can vary between 10 to 20 centimeters depending on factors such as cultivar selection and growing conditions (Bhandari et al., 2015).

3.4 Individual Curd Weight

Individual curd weight varies depending on factors such as cultivar, environmental conditions, and cultivation practices, but it often falls within the range of 500 grams to 2 kilograms (Dixon et al., 2009). These parameters are important indicators of cauliflower quality and are used by growers to assess crop maturity and readiness for harvest.

3.5 Curd Yield per Hectare

Cauliflower yield per hectare can vary depending on factors such as cultivar, agronomic practices, climate, and soil conditions. On average, cauliflower yield per hectare ranges from 15,000 to 25,000 kilograms (Singh et al., 2017). Achieving optimal yield requires careful management of planting density, irrigation, fertilization, and pest control throughout the growing season.

3.6 Dry Matter Content of Curd

The dry matter content of cauliflower curd can vary depending on factors such as cultivar, maturity at harvest, and environmental conditions. Typically, the dry matter content of cauliflower curd ranges from 8% to 12% (Nguyen et al., 2016). This parameter is important for assessing the nutritional value and quality of cauliflower, with higher dry matter content generally associated with better taste and texture.

3.7 Biological yield

It refers to the total plant biomass produced, including both the edible curd and other plant parts.

3.8 Economic yield

It specifically measures the quantity of marketable cauliflower curd harvested.

3.9 Harvest index

It is the ratio of economic yield to biological yield, indicating the efficiency of conversion of total plant biomass into marketable produce.

Harvest index= Economic Yield/ Biological Yield

Specific numerical values for these parameters can vary based on factors such as cultivar, growing conditions, and management practices, research provides insights into the yield components of cauliflower (Singh et al., 2017). Biological yield, Economic yield, and Harvest index are important parameters for assessing the productivity and efficiency of cauliflower cultivation.

4. Floral Characteristics of Cauliflower

This heading includes the following sub-headings:

4.1 Inflorescence Structure

The "curd" of cauliflower, what we commonly eat, is actually an undeveloped flower head. It consists of a compact cluster of immature flower buds, tightly packed together in a rounded shape resembling that of a flower head.

Figure 1: Curd of Cauliflower

4.2 Floral Meristem

The curd develops from a specialized group of cells called the floral meristem. This meristem is responsible for producing the floral organs, including sepals, petals, stamens, and pistils. In the case of cauliflower, these floral organs remain underdeveloped, resulting in the tightly packed cluster of flower buds.

4.3 Bracts

Surrounding the immature flower buds are a series of modified leaves called bracts. These bracts protect the developing flower buds and contribute to the overall appearance of the curd.

4.4 Floral Development

Like other members of the Brassicaceae family, cauliflower follows a specific floral development pattern. This includes the initiation of floral meristems, differentiation of floral organs, and ultimately, the formation of the curd which are discussed below:

4.4.1 Initiation of floral meristem

The formation of the floral meristem in cauliflower is initiated by genetic and environmental causes, such as changes in day length and temperature. These causes trigger the transition of the vegetative meristem (responsible for leaf and stem growth) to the floral meristem.

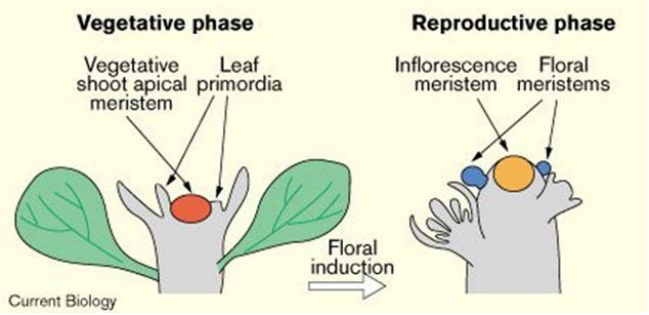


Figure 2: Vegetative & reproductive phase of cauliflower

4.4.2 Differentiation of floral organs

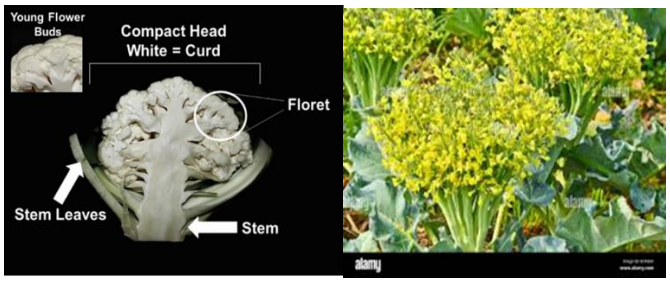
Once the floral meristem is established, it undergoes differentiation to produce the various floral organs, including sepals, petals, stamens, and pistils. However, in cauliflower, these floral organs remain underdeveloped, and the meristem primarily produces a dense cluster of flower buds.

4.4.3 Curd Formation

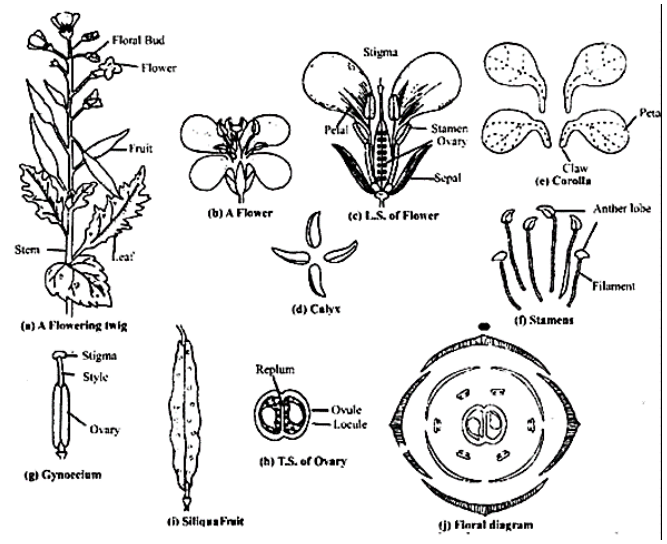
As the floral meristem continues to develop, it produces a compact mass of immature flower buds, known as the curd. The curd is essentially a dense inflorescence composed of tightly packed florets, each representing an undeveloped flower.

4.5 Floral description/Biology of cauliflower

The flowers of cauliflower are typically cruciferous. Two functional nectaries are present, situated between the bases of the ovary short stamens and the other two inactive nectaries are at the bases of pairs of long stamens. The stigma of Brassica species is receptive for 5 days before and 4 days after anthesis. The longer receptivity of stigma is due to the protogynous nature of the flowers. Flowers are borne in racemes on the main stem and its branches. The inflorescence may attain a length of 1-2 cm, but the slender pedicels are only 1.5-2 cm long. The fruits are glabrous siliques, 4-5 mm wide and sometimes over 10 cm long, with two rows of seeds lying along the edges of the replum (false septum, an outgrowth of the placentae). A silique contains from 10-30 seeds, the silique reaches its maximum length from three to four weeks after the opening of the flower from which it is formed. When it is ripe, dehiscence takes place through the two valves breaking away from below upwards, leaving the seeds attached to the placentas.



(A) (B)



(C)

Figure 3: "A" indicates L.S. view of cauliflower; "B" indicates flowering of cauliflower and "C" indicates floral structure and floral diagram of a typical plant (Mustard/Brassica campestris) of family Brassicaceae.

The pollen grains are 30-40 µ in diameter and have germination pores. The bright yellow petals become 15-25 mm long and about 10 mm wide. The buds open under the pressure of the rapidly growing petals. This process starts in the afternoon, and usually the flowers become fully expanded the following morning. The anthers open a few hours later, the flowers being slightly protogynous and pollination takes place the flowers are pollinated by insects, particularly bees, which collect pollen and nectar.

4.6 Floral Formula

There are 4 sepals, 4 petals, 6 stamens and 2 carpels. The carpels form a superior ovary with false septum and two rows of campylotropous ovules. The androecium is tetradynamous, i.e. there are two short and four long stamens. The sepals are erect.

Figure 4: Floral diagram with floral formula

5. Conclusion

Cauliflower, a biennial plant of the Brassicaceae family, showcases distinctive botanical characteristics across its vegetative, curd yield, and floral aspects. Its vegetative stage is marked by a central stem with large, deeply lobed leaves, requiring cool temperatures and well-drained soil for optimal growth. The curd, the edible part of cauliflower, forms from a specialized floral meristem at the stem's apex, comprising tightly packed, under developed flower buds enclosed in protective bracts. Curd yield, influenced by genetics, environment/growing conditions, and cultivation practices, varies in size, color, and texture, making it a significant focus in cauliflower cultivation. Floral characteristics involve the initiation and differentiation of the floral meristem, resulting in the curd's formation, even though with underdeveloped floral organs as compared to other members of the Brassicaceae family. Understanding these botanical traits is crucial for enhancing cauliflower production and quality.

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