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# Flavonoids: An Antioxidative Defence Mechanism In Vegetables Under Abiotic Stress

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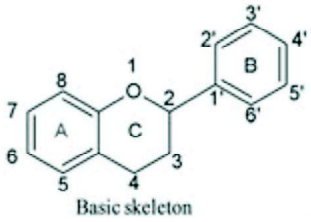
## Introduction

An accelerating global food demand along with the ever-increasing global warming put humanity in jeopardy. The implementation of some bio-based products to develop ecofriendly land practices will help in developing a more sustainable agriculture. The use of bio stimulants such as flavonoids which belong to the largest family of natural products; more than nine thousands of these phenolic substances have been found in various plants (Wang *et al*., 2011). Flavonoids are a versatile set of three phenolic rings, namely A (6 carbon) and B (6-carbon) linked with the central C (3-carbon) ring; C6-C3-C6 which can produce several derivatives and sub-class compounds with distinct substitutions in the basic structure and possess low molecular weight. The major subgroups of flavonoids are; flavonols, flavones, flavanones, flavanonols, flavanols, anthocyanins, iso flavonoids and chalcones. (Panche *et al*., 2016) these biostimulants are involved in physiological functioning of the plants thus projecting a defensive mechanism towards varied abiotic stresses including UV-B radiation, salt stress and drought, at least in part by detoxifying the Reactive Oxygen Species (ROS) produced under stress conditions in plants.




Flavonoids possess a higher antioxidative potential and have an additional capacity of inhibiting polar auxin transport, regulates the

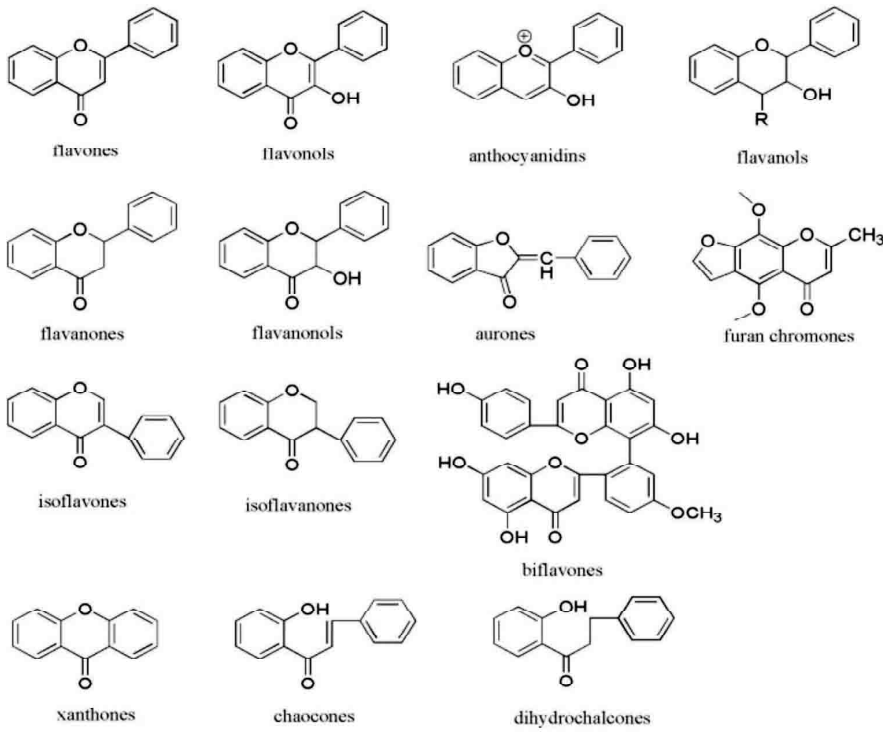



**Figure 1:** Chemical structures and classification of flavonoids (Wang *et al*., 2018)

development of individual organs, tissues and the whole plant, impede the activity of glycoproteins and regulates cellular auxin homeostasis and the cell-to-cell auxin transport. (Brunetti, 2012) Flavonoids can also b regarded as "signaling molecules" (Peer and Murphy 2006 ) or "developmental regulators". These act as screeeners of damaging short solar waves and function as antioxidants to inhibit generation and reducing the reactive oxygen species so formed in plants under stressed conditions.

These are derivatives of quercetin which affects the movement of auxin and regulated the function of the plant as a whole. These compounds help in maintaining the chemical coordination in plants to assist the plants in tolerating, resisting and escaping the environmental stresses; thus acting as stress mitigators. Flavonoids also play a vital role as the secondary metabolites by assisting plant growth.

## Stress Induced Biosynthesis of Flavonoids

### A. UV-B Scavenging Flavonoids

UV-B can bring about drastic metabolic disruption in vegetable crops by negatively affecting photosynthesis, starch concentration and transpiration and promoting cellular damage. The UV radiations also elevate disease susceptibility by reducing the defense mechanisms, which affects the procedure of cell division and inhibits overall plant growth. (Nihorimbere *et al*., 2011) The absorbance of the UV-B radiations by flavonoids enables radiation in a defined wave length range to transit across leaf epidermal cells. Flavonoids possessing a pronounced antioxidant potential accumulates a higher solar irradiance in the presence or in absence of UV-radiation. Upregulation of flavonoids biosynthesis under higher sunlight irradiation regardless of the proportion of varied solar wavelengths which reaches the surface of the leaf due to change

**Table 1: Changes in phenylpropanoid and flavonoid metabolism in response to a variety of abiotic stresses**

| Species | Treatment | Flavonoids affected by treatment | References |
|---|---|---|---|
| *Brassica oleracea* | Cold | Cold induces higher quercetin to kaempferol ratio and increases antioxidant activity of the tissues | Schmidt *et al*., (2010) |
| *Phaseolus vulgaris* | O3-fumigation | Increased *PAL*, *CHS* and *CHI* | Paolacci *et al*. (2001) |
| *Phaseolus vulgaris* | O3-fumigation | Increased accumulation of kaempferol 3-O-glucuronide | Kanoun *et al*. (2003) |
| *Solanum lycopersicon* | Nitrogen deprivation + cold + different light intensities | Maximum increases in quercetin biosynthesis were found in the low nitrogen + cold + high light treatment. Cold, nitrogen deprivation and light had a synergetic effect on *PAL, CHS, F3H, FLS* upregulation | Løvdal *et al*. (2010) |

in ROS/REDOX homeostasis can be concluded. The resistance in vegetables towards UV radiation as a result of flavonoids filtering UV-B by absorbing solar radiations and then detoxifying the reactive oxygen species so produced due to photochemical reactions.

An investigation was carried out in tomato under controlled conditions demonstrated an increase in flower and fruit synchrony under the influence of higher radiations. An increase in the UV-B receptors and the chlorophyll content was also reported along with phenylpropanoid compound that is responsible for UV absorption as a by-product of antioxidant pathway. UV-A and B can also be used to strengthen the quality of fruit by activating the oxidation pathway in plants. (Mariz-Ponte *et al.*, 2018)

### B. Flavanoids to Overcome Salinity and Drought stress

Excessive soluble salt limits the growth of plant especially the osmotic stress and ion toxicity. The soil-water potential is reduced due to increased ion concentration which reduces the ability of water uptake by roots of the vegetables which caused reduced plant growth. Cellular damage due to membrane disruption is caused due to sodium accumulation which affects the physiological processes of the plants such as photosynthesis, respiration, osmoregulation which leads to necrosis thus causing stunted plant growth. An increase in an array of compatible organic solutes is observed so as to balance the solute potential which included sucrose, proline and sorbitol. The plants are well equipped with a specific defence mechanism to endure with such stressful condition which initiates antioxidant pathway which includes enzymes and antioxidant agent such as flavonoids and carotenoids. Flavonoids play a vital role as antioxidant which detoxify and scavenges the ROS so produced due to metabolism during environmental stresses. An enhanced concentration of flavonoids was found in tomato plants which were exposed to salt and drought stress whereas plant development and chlorophyll content was reduced which indicated an insignificant effect of flavonoids on plant physiology and development.

## Conclusion

Flavonoids have been involved as a response by the vegetable crops towards a plethora of stressful agents causing biotic and biotic stresses. Flavonoids have a potential to display an array of functional roles in stressed plants. The flavonoids structures are capable of multiple functions such as UV-screening, ROS scavenging and inhibitor of auxin efflux facilitator proteins. These flavonoids are responsive to different abiotic stresses such as drought, salinity, cold and heat stress and display a higher potential to behave as antioxidants. Flavonoids could be employed as an ecofriendly and sustainable approach towards stress mitigation.

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