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# Mesophyll Conductance: Important Path to Driver Photosynthesis

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## INTRODUCTION

Diffusion of $CO_2$ from atmosphere to the carboxylation site in the chloroplast is controlled by the diffusive conductance's through stomata and mesophyll tissue. While stomatal opening determines stomatal conductance, the regulation of mesophyll conductance is debated. The thickness of the mesophyll tissue and/or the carboxylation efficiency is expected to govern difference in mesophyll conductance. Photosynthetic rate is very sensitive to the $CO_2$ level present inside the chloroplast, in which photosynthesis takes place and $CO_2$ is fixed. Indicates that higher chloroplastic $CO_2$ mechanism, increase photosynthesis due to availability of substrate. After crossing the stomatal barrier, $CO_2$ has to diffuse across the intercellular air space, cell walls, plasmalema, cytoplasm and stroma. These barriers collectively regulate $CO_2$ transfer from substomatal cavity to the carboxylation site and is called as mesophyll conductance. These pathway of internal $CO_2$ transfer increase $CO_2$ availability at carboxylation site and increases photosynthetic rate.

The estimation of gm requires a model based calculation using gas exchange parameters by "Variable J method" (Lu, Z et al., 2016), one of the gas exchange parameter that is stomatal conductance was determine by using Infrared gas analysis systems (Farquhar and Sharkey, 1985) and it can be estimated through carbon and oxygen isotope discrimination and also by initial slope of the $CO_2$ response curve computed by differentiating the polynomial best fit equation at the $CO_2$ compensation point (dA/dCi) is often considered as a better estimate of carboxylation efficiency (Von Caemmerer et al., 1981).

**Determinants of mesophyll conductance:**

Mesophyll conductance correlates with the leaf thickness and dry mass per unit leaf area. Leaves with lower in dry mass per unit leaf area have more mesophyll conductance and vise-versa (Flexas et al., 2008). Mesophyll conductance is negatively correlate with the cell wall thickness. At the time of photosynthesis, $CO_2$ molecules diffuses across the membrane through intracellular airspace, liquid phase and lipid phase finally reaches to the inside chloroplast for carbon assimilation. In the liquid-phase, the surface area of chloroplasts exposed to intercellular airspaces and cell wall thickness are considered the most important anatomical parameters altering mesophyll conductance (Tomas et al., 2013).

**Mesophyll conductance and photosynthesis:**

Photosynthesis in plants limited only by the two factors one is the stomatal conductance in which entry of $CO_2$ takes place through diffusion process and another one is biochemical conductance which convert light energy to biochemical energy and finally fixed $CO_2$ into sugars. Between the biochemical processes $CO_2$ and the stomatal supply of the substrate, the conductance of $CO_2$ through the mesophyll tissue play an important role. Thus, the diffusive $CO_2$ conductance through the mesophyll is referred to as mesophyll conductance is also an important determinant of carbon assimilation (Flexas et al., 2008). In mesophyll conductance there is transfer of $CO_2$ from substomatal cavity to the carboxylation site called as internal conductance which is having more limitation than the stomatal conductance and its decrease the $CO_2$ concentration from the atmosphere to the carboxylation site. Strong relationship between the mesophyll thickness and photosynthetic rate and the structure of the mesophyll cell affect the photosynthesis by affecting the $CO_2$ entry in the leaf (Warren, 2008). Positive relationship between stomatal conductance and photosynthetic rate (Flexas et al., 2012).

**Regulation of leaves mesophyll surface area**

Leaf development depends on the average irradiance level suggesting more anatomical plasticity in temperate evergreen species. The capacity of plants for adjustment to new light environments depends on the stage of leaf development. Young developing leaves can acclimate to the new light conditions, while older leaves with partly or entirely lignified cell walls can only partly acclimate to altered light conditions (Yamashita et al., 2002). When strong light penetrate on the mature leaves, periclinal divisions of palisade-tissue precursor cells occurred in young leaves that produced two cell layers of palisade tissue, whereas when mature leaves were kept in weak light, such periclinal divisions did not occur. Stomatal density of developing leaves may also be regulated by the conditions of mature leaves (Lake et al., 2001). The molecular mechanisms for these systemic regulations are unknown. However, such mechanisms may play an important role in leaf to function efficiently immediately after unfolding.

**Importance of the mesophyll conductance:**

- Mesophyll conductance is a major actor in photosynthesis. Photosynthesis is predominantly a diffusive process. Diffusive conductance for $CO_2$ transfer between atmosphere and carboxylation site in the chloroplast are governed by stomata and mesophyll factors. Since stomatal conductance links $CO_2$ diffusion and transpiration enhancing mesophyll conductance has great significance in improving water use efficiency of plants.

- Leaf thickness and hence the mesophyll diffusive characteristics plays a pivotal role in dislinking $CO_2$ and $H_2O$ vapour diffusions.
- Mesophyll and stomatal conductance's are in series and hence the smaller conductance would determine $CO_2$ assimilation.

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