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Comparative analysis of chlorophyll content in polluted and non-polluted grape (*Vitis vinifera*) and guava (*Psidium guajava*) plants

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Abstract

Chlorophyll, the green pigment responsible for photosynthesis, is a vital indicator of plant health. Environmental pollution can significantly impact chlorophyll content, affecting plant growth and productivity. This study aimed to estimate and compare the chlorophyll content in grape (*Vitis vinifera*) and guava (*Psidium guajava*) plants grown in polluted and non-polluted areas. Leaf samples from both plant species were collected from polluted (industrial and urban) and non-polluted (rural and forest) sites. Chlorophyll content was estimated using spectrophotometry and expressed as mg/g fresh weight. The results revealed significant differences in chlorophyll content between polluted and non-polluted plants of both species. Grape plants from polluted areas showed a decrease in chlorophyll content compared to those from non-polluted areas. Similarly, guava plants from polluted areas exhibited a reduction in chlorophyll content. These findings suggest that environmental pollution can adversely affect chlorophyll content, potentially impacting plant growth and productivity. This study contributes to our understanding of the effects of pollution on plant health and highlights the need for sustainable environmental practices.

Keywords: Chlorophyll content, pollution, grape, guava, spectrophotometry, plant health.

Introduction

Leaf chlorophyll concentration is an important parameter that is regularly measured as an indicator of chloroplast content, photosynthetic mechanism and of plant metabolism. Chlorophyll is an antioxidant compounds which are present and stored in the chloroplast of green leaf plants and Mainly it is present in the green area of leaves, stems, flowers and roots (Srichaikul *et al.*, 2011) ^[6]. However, the chlorophyll production is mainly depended on penetration of Sun light and it is the main source of energy for plant (Srichaikul *et al.*, 2011) ^[6]. In the laboratory it is Commonly determined by using mortar and pestle to Extract the pigments using an organic solvent such as acetone or dimethyl formamide (Arnon 1949) ^[3]. Chlorophyll a and Chlorophyll b are essential pigments of the plant photosystems (Richardson *et al.*, 2002) ^[4]. Moreover the chlorophyll a is the primary photosynthetic pigment play important role in plant physiology and it can be act as nutrition in decline blood sugar conditions, detoxification, digestion, excretion and decreasing allergens (Srichaikul *et al.*, 2011) ^[6]. Pigment in plants which helps to produce energy in plant (Srichaikul *et al.*, 2011) ^[6]. However the chlorophyll a concentration is 2-3 times higher than that of secondary chlorophyll b in plants (Srichaikul *et al.*, 2011) ^[6]. To obtain ratio of chlorophyll a and b the readings should be taken the wavelength of 650nm, which was in between the absorption maxima of both (Arnon 1949) ^[3]. Green plants have different characters because of the presence of various pigments like chlorophyll, carotenoid, other pigments and water content which together constitute the spectral characters of a plant body. However the chlorophyll content has medicinal qualities. The chlorophyll is also plays important role in plant physiology and it can be act as nutrition in decline blood sugar conditions, detoxification, digestion, excretion and decreasing allergens (Srichaikul *et al.*, 2011) ^[6]. However, in using modern technique like satellite remote sensing technology being used for analysis of leaf chlorophyll concentration can also be measured. Variation in leaf chlorophyll content can provide information about the physiological condition of a leaf or plant.

Grapes are is basically a subtropical crop. However, in India, grapes are cultivated for their excellence also under tropical conditions. In India, Grapes are cultivated in an area of 111.4 thousand ha with a total production 1234.9 thousand tons and productivity of 11.1 tons/ha. In India top Grapes producing states including states include Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and Mizoram. The most grown variety of grapes is Thompson Seedless and clones.

Monreith 1972, Foyer *et al.* 1982 studied in chlorophylls, Chl a and Chl b, are virtually essential pigments for the conversion of light energy to stored chemical energy. The amount of solar radiation absorbed by a leaf is a function of the photosynthetic pigment content.

Filella *et al.* 1995, In addition, Chl gives an indirect estimation of the nutrient status because much of the leaf nitrogen is incorporated in Chl.

Much work was on non-destructive estimation of leaf Chl in species of plants other than grapes, including maple, chestnut, and beech, eucalyptus.

A conceptual model that uses three discrete spectral bands to estimate the content of plant pigments such as total chlorophyll, anthocyanin, and carotenoids was developed recently.

Steele *et al.* 2008 studied that SPAD-502 has adequate sensitivity to Chl contents in grape leaves when the pigment content is less than 300 mg m⁻². Above that level, however, the accuracy of the instrument diminished considerably.

Psidium guajava L is a fruit-bearing tree commonly known as guava, which belongs to the family Myrtaceae. The French call it goyave or goyavier; the Dutch, guyaba, goejaaba; the Surinamese, guaveor goejaba; and the Portuguese, goiaba or goaibeira. Hawaiians call it guava or kuawa. In Guam, it is a base. In Malaya, it is generally known either as guava or jambu batu. Guava grows nearly throughout India up to 1500 m in height and is cultivated commercially in almost all states, the total estimated area being 50,000 hectares.

Stone studied in pre-columbium times *Psidium guajava* grow in all tropical and subtropical areas would, adapts to different climatic conditions but prefers dry climates.

Wealth of India (2003) [7] research on leaves and bark of guava tree have a long history of medicinal uses in decreases dysentery, vomiting and sore throats and to regulate menstrual cycles.

Manosroi *et al.*, (2006) [5] study on leaves of guava showed anti-proliferative activity, which was 4.37 times more than vincristine.

Tea made from the guava leaves or its extract in a cup of warm water can help to empty the bowel easily. Journal of smooth Muscle research in 2008 published an article in which some researcher tested the effect of guava leaves on the peristalsis castor oil-induced diarrhoea.

Materials and Methods

Material: Fresh leaf of plant, Mortar and pestle, Muslin cloth, Whatman filter paper No.1, Standard instrument like spectrophotometer.

Photosynthetic Pigment Analysis: Three grams of fresh leaves were put in 100% acetone (50 ml for each gram), homogenized at 1000 rpm for 1 min. The homogenate was then filtered through double layered muslin cloth and again centrifuged at 2500 rpm for 10 min. The extract was removed in a 10 ml graduated cylinder. Clear leaf extract (supernatant) was transferred with a pipette to a 1 cm path length cuvette and absorbance readings taken against a solvent blank in UV-visible spectrophotometer at 663, 640, 510, 480 nm wavelength to determine the concentrations of photosynthetic pigments like chlorophyll 'a', chlorophyll 'b' and total chlorophyll content. The amount of Chl-a, Chl-b, and Carotenoid were calculated in the term of Magnesium pigment/gm of fresh leaves by using the following formula (Duxbury and Yentsch, 1956 and Maclachlan and Zalick 1963) [1, 2].

Formula for calculation

$$\text{Chl. a (mg/ fresh weight)} = \frac{12.3 D_{663} - 0.86 D_{645}}{d \times 1000 \times W}$$

$$\text{Chl. b (mg/ fresh weight)} = \frac{19.3 D_{645} - 3.6 D_{663}}{d \times 1000 \times W}$$

$$\text{Carotenoids (mg/ fresh weight)} = \frac{7.6 D_{480} - 1.49 D_{510}}{d \times 1000 \times W}$$

Table 1: Non-polluted Leaves Chlorophyll content

Sr. No.	Name of plants	Chl-a mg/fresh wt.	Chl-b mg/fresh wt.	Carotenoids mg/fresh wt.
1.	<i>Vitis vinifera</i>	0.270	0.163	0.051
2.	<i>Psidium guajava</i>	0.049	0.045	0.024

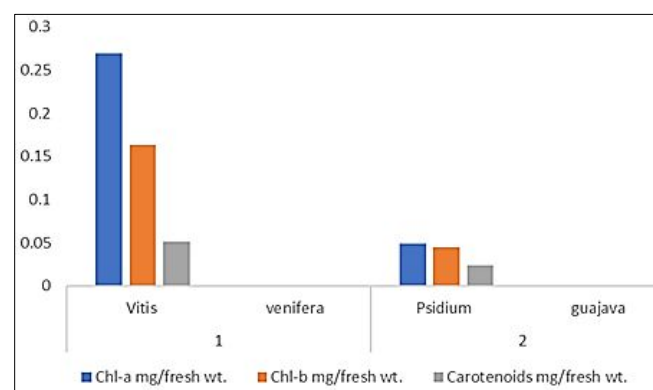


Fig 1: Pigment Composition in Non-Polluted Plants

Table 2: Polluted Leaves Chlorophyll content

Sr. No.	Name of plants	Chl-a mg/fresh wt.	Chl-b mg/fresh wt.	Carotenoids mg/fresh wt.
1.	<i>Vitis vinifera</i>	0.052	0.034	0.003
2.	<i>Psidium guajava</i>	0.049	0.015	0.01

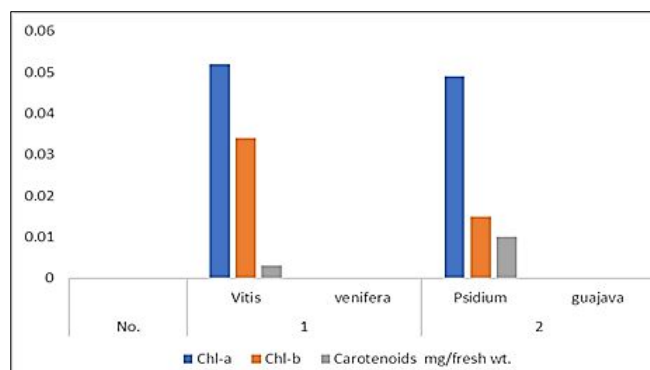


Fig 2: Pigment Composition in Polluted Plant

Vitis vinifera

Classification

Kingdom: Plantae

Order: Vitales

Family: Vitaceae

Genus: Vitis

Species: vinifera

Common name: Grape vine

External morphology: Grapes are basically a subtropical crop. However, in India, grapes are cultivated for their excellence also under tropical conditions. In India, Grapes are cultivated in an area of 111.4 thousand ha with a total production 1234.9 thousand tons and productivity of 11.1 tons/ha. In India top Grapes producing states including states include Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and Mizoram. The most grown variety of grapes is Thompson Seedless and clones. The grapes plant shoot carries the nodes from which the leaves and clusters of grapes will grow. Leaf is breathing organs of the grapevine which also serves to nourish it. Bud or node is either leaf or fruit. Bearing shoot will develop. Tendrils are the climbing organs of the grapevine.

Uses

- Fresh fruit eaten or processed into wine raisins juice, with some cultivars adapted for the canning industry.
- Grape seed contain 6-20% oil, used for edible purpose soaps and as linseed substitute.
- Leaves have astringent taste, used in diarrhoea.
- Juice of unripe fruit astringent, used in throat affections.
- Dried fruit as demulcent, cooling, sweet, laxative, stomachic, used in thirst, heat of body, coughs, hoarseness, consumption and in wasting diseases.
- Used in cosmetics and personal care products because of its natural antioxidant properties

Psidium guajava

Kingdom: Plantae

Order: Myrtales

Family: Myrtaceae

Genus: Psidium

Species: guajava

Common name: Guava

External morphology: Guava is a common tropical fruit cultivated in many tropical and subtropical regions. It's common name guava, lemon guava. Its family is Myrtaceae, native to Mexico, central guava. America, and northern south America. In 2011, India was the largest producer of

guavas. It's mature trees of most species are fairly cold hardy and can survive temperatures slightly colder than 25°F (-4 °C) for short periods of time, but younger plants will likely freeze to the ground.

Guava is a fast-growing evergreen shrub or small tree that can grow to a height of 3-10m. Guava produces low drooping branched from the roots. The trunk is slender, 20cm in diameter, convert with a smooth green to red brown bark that peels off in thin flakes.

Uses

- Guava is an edible fruit and can be eaten raw or cooked.
- The processing of the fruits yield by-product that can be fed to livestock.
- The leaves can also be used as fodder.
- The entire fruit is a key ingredient in punch and the juice is often used in culinary source (hot or cold), candies, dried Snacks, fruit bars and desserts or dipped in chamoy.
- Red guava can be used as the base of salted products such, substitution for tomatoes, especially to minimize activity.
- A drink may be made from an infusion of guava fruits and leaves.
- Tea of guava tree leaves is considered medicinal.

Results

The chlorophyll a content of non-polluted leaves of *Vitis vinifera* (0.270mg/ fresh wt.) and chlorophyll b content the non-polluted leaves (0.163mg/ fresh wt.) and the Carotenoids that content of non-polluted leaves were (0.051mg/fresh et. wt.).

Chlorophyll content of Polluted Leaves of *Vitis vinifera* (0.052mg/ fresh wt.) and chlorophyll b content the polluted leaves (0.034mg/ fresh et wt.) and the Carotenoids that content of polluted leaves were (0.003mg/ fresh et wt.).

The chlorophyll a content of non-polluted leaves of *Psidium guajava* (0.049mg/ fresh et wt.) and chlorophyll b content the non-polluted leaves (0.045mg/ fresh et wt.) and the Carotenoids that content of non-polluted leaves were (0.024mg/ fresh et wt.).

The chlorophyll a content of polluted leaves of *Psidium guajava* (0.049mg/ fresh et wt.) and chlorophyll b content the polluted leaves (0.015mg/ fresh et wt.) and the Carotenoids that content of polluted leaves were a (0.01mg/ fresh et wt.).

Vitis vinifera and *Guava guajava* showed a significant decrease in its chlorophyll content due to road side dust and result also indicate that there was negative correlation between the chlorophyll content and growth rate during investigation.

The study also reveals that reduction in plant length, number of leaves and total chlorophyll content in polluted areas. Dust accumulation altered the chlorophyll content in *Vitis vinifera* and *Guava guajava*.

Greater decrease in chl-a, chl-b and carotenoid content observed at *Vitis vinifera* shows that value is (0.052, 0.034, 0.003) and *Psidium guajava* shows the value is (0.049, 0.015, 0.01) respectively. While the plant growth also gradually decreased with increased dust concentration.

Discussion

Road side pollutant had a significant effect on chlorophyll content of *Vitis vinifera* and *Guava guajava* compared with

plant from non polluted area. Total chlorophyll content of *Vitis vinifera* and *Guava guajava* showed that the losses are generally attributed to the road side dust which contained mixture of toxic metals. This dust is falling on the soil caused a shift in pH to the alkaline side, but favourable to pasture grasses. Reduction of plant length might be due to the decreases in phytomass, net primary production and chlorophyll content in response to the road side dusts. Darley demonstrated that dust deposited on bean leaves in the presence of free moisture interfered with rate of carbon dioxide exchange, but no measurement of starch was made. The decreased in chlorophyll contents in the leaves of *Vitis vinifera* and *Guava guajava* might be due to long time accumulation of dust on plant leaves that interrupt the sunlight to reach the leaf. observed reduction of pigment content in plant species due to dust accumulation.

Conclusion

On the basis of this study, it could be concluded that the phonological behaviour of *Vitis vinifera* and *Guava guajava* was found to be highly affected. It is clear tat road side dust pollution is an operative ecological factor causing deterioration in the quality of our environment and economically important crop plants.

The experimental analysis of the effect of dust on vegetation help to recommended plant for use as screens in order to mitigate dust and improve air quality.

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