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# QUANTITATIVE ANALYSIS OF SOURCE-SINK RELATIONSHIP IN LEAVES AND FRUIT OF *CUCUMIS MELO* L.

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**ABSTRACT**
*Cucumis melo* L. commonly known as Musk-melon is highly diverse species of the family Cucurbitaceae having many varieties. Musk-melon generally used as a part of salad or direct consumed as a fruit. The plant is climbing or creeping herb which grown in most parts of India as well as world because of its high economic values. This plant is having tremendous ethno- medicinal uses such as to treat kidney and bladder stones, painful and burning micturition, ulcers, suppression of urine and cough. The properties of fruit like colour, taste, odour, texture and nutritive value are the result of photosynthetic product accumulates in the form of fruit or used in metabolic activity. Quantitative analysis of leaf and fruit shows significant difference in the amount of carbohydrate such as reducing sugar, starch is higher in fruit than leaf. While the amount of protein, total phenol and total free amino acid is higher in the leaf. All the pigments such as chlorophyll a & b, total chlorophyll, carotene and lycopene are found in higher concentration in leaf than the fruits. Thus, this data can lead us to the knowledge of source to sink relationship in plant which can help to improve quality of fruits.

**Key words:** *Cucumis melo* L., Leaf, Fruit, Quantitative analysis, Source to sink relation.

## INTRODUCTION:

Majority of fruits are naturally low in fat, sodium, calories and lack cholesterol. Fruits contain many vital nutrients that are under consumed, such as potassium, dietary fibre, vitamin C, and folic acid. In the present situation to maintain the nutrition value is hard because use of pesticides, pollution and urge of yield which is the result of high population. It is keenly needed to have knowledge about how to maintain the nutrition value and try to improve the quality of the fruits or vegetable with high production value. In the present scenario that information is essential to encounter the hunger of GLOBE.

Production and quality of fruits or vegetable depend on photosynthesis performed by Leaf as a source and accumulation of access end product of photosynthesis that is stored in the fruits as sink for that product. As it is explained by Taiz and Zeiger; sources are Producing and exporting organs like typically mature leaves, while non-photosynthetic organs like fruits, roots and tubers and immature leaves are known as sinks (Taiz and Zeiger, 2006). In recent days some agronomists try to alter the source-sink relationship for satisfactory fruit production and quality (Gil, 2006). The maintenance between vegetative and generative growth of a tree is of great importance for growth and production of fruit plants (Park, 2011). During photosynthesis light is engrossed by photosynthetic pigments and photons (radiant energy) are converted into chemical energy. (Pandya, et. al. 2016)

Photosynthate production is frequently unable to fulfil the demands during development and growth of fruits following heavy and prolonged flowering (Chacko et. al., 1982).

Photosynthesis is a process in which light energy is captured by green plants (mainly by the chlorophyll in leaves) and used to synthesize reduced carbon compounds from carbon dioxide and water. Throughout the development fruits gather carbohydrates, generally as starch, sucrose, or hexose sugars (Kozlowski and Pallardy, 1997) which are highly dependent on the fruit maturity stage and varies according to cultivar, leaf-fruit ratio and growing conditions (Friedrich and Fischer, 2000).

The members of family Cucurbitaceae are highly economically important. As per the Chakravarty mentioned in their research in 1982 The Cucurbitaceae family includes 118 genera and 825 species. out of that in India 36 genera and 100 species are present. Among them *Cucumis melo* L. is highly diverse species. Musk melon is an annual climber having unisexual yellow flowers and juicy fruits. Musk melon is having economic importance and many medicinal values such as to treat kidney and bladder stones, painful and burning micturition, ulcers, suppression of urine and cough (Fahamiya N., *et. al.* 2016).

The knowledge of source to sink relation of *Cucumis melo* L. will help to improve the nutritional quality of fruit. Thus, the quantitative analysis of leaf and fruit is carried out in the *Cucumis melo* L.

**MATERIAL AND METHODS:**

Seeds of *Cucumis melo* L. (Var.- Gujarat Musk Melon-3) Collected form the Anand Agriculture University, Anand, Gujarat and grown in the premises of Sir P. P. Institute of Science. After the fruit growth leaves and fruit were collected for the Quantitative analysis. (Fig.1)

Physical and Physico-chemical analysis were carried out with the methods described by Mazumdar & Majumder, 2003. Parameters such as Weight, Length, Width, volume, color, shape, specific gravity, pH, Total Acidity, total soluble solids were included for analysis. While edible matter content, juice content, seed content measured for the fruits only. The moisture content of leaf and fruit was measured by the method explained by Berwal *et al.,* 2004.

The pigment analysis was done by the method of Devi (2002). For their 5 gm tissues of leaves and fruit wall were homogenized in 80% acetone and centrifuged. The absorbance was taken at different wavelengths for chlorophyll a, chlorophyll b, total chlorophyll. The estimation of Carotene and lycopene were carried out by the method described by Tomes, (1963) and Wang, (2005). Extraction of carotene and lycopene was done with 60:40 Hexane: Acetone. The amount of total anthocyanin was extracted with ethanolic-hydrochloric mixture which described by Mazumdar & Majumder, 2003.

Estimation of Total Sugar was accomplished by following the method of Hedge and Hofreiter (1962) described by Thimmaiah (2016) Reducing and non-reducing sugars were estimated spectro-photometrically extracting 1gm sample in 10 ml 80% ethanol and the supernatant was evaporated in boiling water bath. The residue was dissolve in 5ml distilled water and was estimated spectro-

photometrically by using DNS (Dinitro salicylic acid) reagent described by Pandya and Mehta (2016), Miller, (1972).

Estimation of total amino acid was taken place by ninhydrin method which is described by Moore and Stein (1948). Proteins were estimated by extracting 1gm sample in Distilled water. The supernatant was estimated using Folin-Ciocalteu reagent (FCR) method described by of Lowry *et al* (1951). The amount of total phenolic contents was estimated by extracting 1gm sample in 10ml 80% ethanol and the extract was evaporated in boiling water bath. The residue was dissolved in 5ml distilled water and by using Folin-Ciocalteu reagent (FCR) under alkaline condition (20% Na2co3) phenols were estimated spectro-photometrically (Bray & Thrope, 1954).

Enzyme activity of Amylase was measured with method described by Bernfield, P. (1955). Invertase activity in leaf and fruit were measured by the method of Sridhar and Ou, (1972) while the Catalase estimated by titrimetric method given by Barber J. M. (1980). Peroxidase activity analyzed by the method described by Summer and Gjessing, (1943) Thimmaiah (2016). The standard deviation is calculated by using statical calculations in Microsoft Excel. (n=3)

**RESULTS:**

**Morphological and Physical measurements:**

The leaves of *Cucumis melo* L. are acute, light and dark green colored with Rough and hairy surface and wavy margin. The fresh weight of leaf is 4.7 g. The length and width are 19.66 cm and 12.16 cm respectively. The fruits are round, yellowish orange colored from outside and green from inside which is edible part. The fresh weight of Fruit was 263.3 g while the length and width are 7.75 cm and 7.9 cm respectively. The peel thickness is 0.09 cm. Peel wax is present on the fruit. The Edible matter content of *Cucumis melo* is 63.7 %, juice content is 60% while seed content is 57 g. The measurement of central cavity shows length of 5.5 cm and width of 5 cm. The moisture content is 90% and 94% in leaf and fruit respectively.

**Physico- Chemical Analysis:**

The pH, total acidity and total soluble solids of leaf is **7.8**, **1.16** and **0.4%** respectively. While pH fruit is **6.4**, total acidity is **0.36** and total soluble solids is **0.7 %**. (Table No. 2)

**Biochemical Analysis:**

- **Pigment:**

The amount of Chlorophyll a, Chlorophyll b and total chlorophyll in leaf found 0.12 mg/g, 0.19 mg/g. 0.32 mg/g while in fruit 0.0012 mg/g, 0.0011 mg/g and 0.024 mg/g respectively. The chlorophyll concentration was found higher in leaf than fruit. (Fig.2) As chlorophyll, Carotene and Lycopene content also present in higher amount in leaf than the fruit. The amount of carotene and lycopene is 0.86 µg/ ml and 0.723 µg/ ml in leaf. On the other hand, in fruit the carotene and lycopene were found 0.196 µg/ ml and 0.209 µg/ ml respectively (Fig. 4). The amount of Anthocyanin measured 0.877 mg/100g and 0.008 mg/100g in leaf and fruit individually (Fig. 3). (Table No. 3)

- **Carbohydrate:**

The amount of all the carbohydrates found higher in fruit than leaf. The amount of total sugar in leaf is 109.09 µg/ ml and in fruit

is 300 µg/ ml. The amount of reducing sugar is 17.77 µg/ ml and 21.11 µg/ ml in leaf and fruit respectively. While the reducing sugar is 97.32 µg/ ml in leaf and 278.89 µg/ ml in Fruit. The starch content is 189.09 µg/ ml and 1790.9 µg/ ml in leaf and fruit individually. The pectic substance is 16% in leaf and 28% in fruit. (Table No: 4, Fig. 5,6)

- **Total amino acid, Proteins and Phenol:**

The amount of total free amino acid is 13.34 µg/ ml in leaf and 3.17 µg/ ml in fruit while the protein content is 30.15 µg/ ml and 6.46 µg/ ml in leaf and fruit respectively. The total phenol concentration is 6.38 µg/ ml in leaf and 0.67 µg/ ml in fruit. Leaf shows higher amount of all three amino acid, protein and phenol in compare of fruit. (Table No. 5, Fig. 7)

- **Enzymes:**

The Amylase and Catalase activity were found higher in fruit on the other hand the enzyme activity of Invertase and peroxidase found higher in Leaf. The amount of amylase, invertase, catalase, peroxidase activity in leaf is 0.0008 mg/min/mg protein, 0.0009 mg/hrs./mg protein, 15.4 unit/g, 0.69 unit/g respectively. The amount of amylase, invertase, catalase, peroxidase activity in fruit is 0.0238 mg/min/mg protein, 0.0001 mg/hrs./mg protein, 56.33 unit/g, 0.131 unit/g respectively (Table No. 6, Fig. 8 to 11)

**DISCUSSION:**

The moisture content is higher in the fruit in compare to leaf which is support the work of Osuagwu and Edeoga (2014). The higher concentration of pigments in leaves than the fruit and higher concentration of sugars in fruits are supported by the results of Pandya and Mehta (2016). According to Menon and Rao (2012) in this regard the mobilization of the starch in the mother plant could be from the concerted action of activities of amylases. The sugar metabolizing enzymes also positively correlated with the accumulation of sucrose in the muskmelon fruit and therefore the overall carbohydrates and enzymatic profiles suggest a common feature for non-photosynthesizing starch-accumulating organs which is resembles with current study the higher amylase activity and lower invertase activity found in the fruit.

Osuagwu and Edeoga (2014) found the lower amount of protein in fruit than leaf in *M. charantia*, *L. cylindrica* and *T. cucumeria* which is similar with present study. While they found lower carbohydrate, content is fruit than fruit, unlike that the higher carbohydrate content is present in fruit of C. melo. The phenol content of leaf shows the similar data with the data of Nadhiya R. *et. al.* (2019) the phenol content of fruit is lesser than leaf which is similar with the results of Ganji S. M. *et.al.* (2019) and Ismail, H. I., (2010)

Ben-Amor *et al.*, (1999) and Menon *et. al.* (2012) noted the higher concentration of catalase enzyme in the fully ripen stage of Musk melon which resembles with the current study. Chisari *et al.* (2010) Menon *et. al.* (2012) stated that Peroxidase activity could contribute to determine the firmness of outer tissues, together with the processes involved in early stages of ripening, the lower amount of peroxidase in the ripened stage is supported above statement.

The plants have different metabolic activities in all the organs. In this experiment the different concentration of Pigments, carbohydrates, proteins, amino acids, phenols and enzymes reveal the changes occurrence during source to sink transportation of metabolites.

**CONCLUSION:**

Quantitative analysis of leaf and fruit reveal the source to sink relationship of *Cucumis melo* L. Leaves are the site of photosynthesis (Sink)and thus the higher amount of pigment found in leaves than fruit. Fruit is the sink where the excess products were accumulated especially sugar and starch content which is clearly seen in this experiment, higher amount of carbohydrates found in the fruits of *Cucumis melo* L. protein, phenol, amino acids show higher amount in leaf in compare of Fruit. Enzyme activity of amylase and catalase found higher in fruit on the other hand, Invertase and Peroxidase show higher activity in the leaf.

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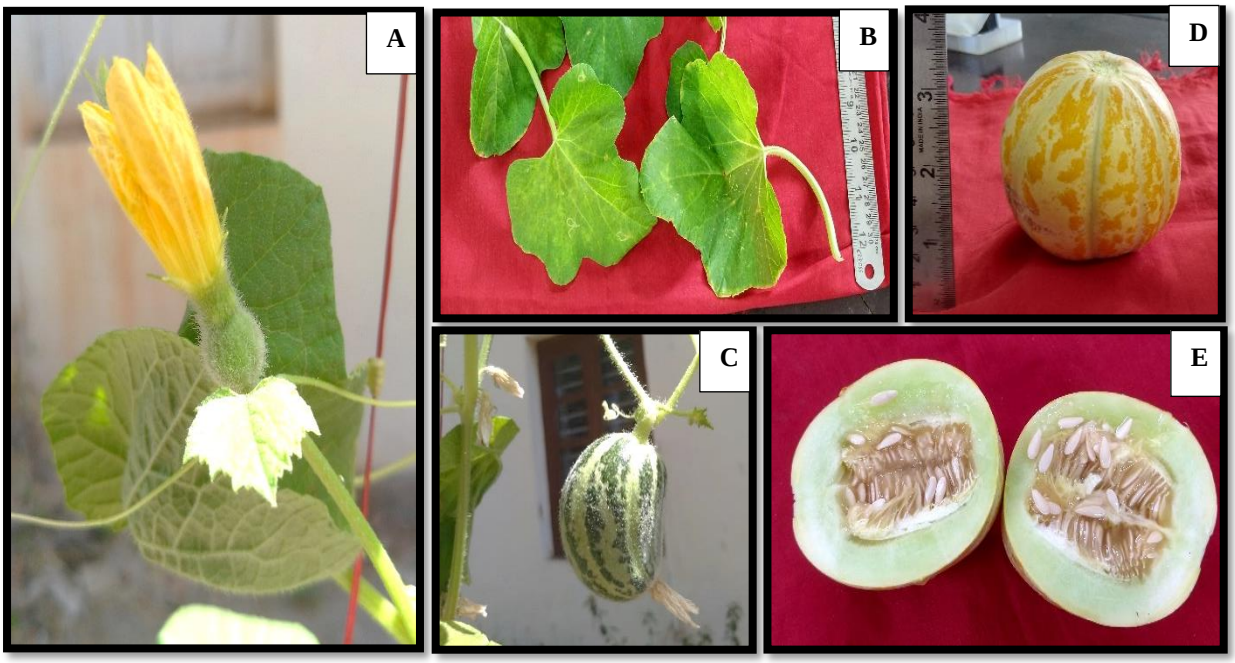


**Fig.1 (A) Fruit Development (B) Leaves (C) Developing Fruit (D) Ripen Fruit (E) Fruit with seed content and Central cavity**

**Table No. 1**

| Sr. No. | Parameter | Leaf | Fruit |
|---|---|---|---|
| 1. | Fresh Weight | 4.7 g | 263.3g |
| 2. | Volume | 5.06 ml | 277.5 ml |
| 3. | Length | 19.66 cm | 7.75 cm |
| 4. | Width | 12.16 cm | 7.9 cm |
| 5. | Peel thickness | ------ | 0.09 cm |
| 6. | Edible matter Content | ------ | 63.7 % |
| 7. | Seed content | ------ | 57 g |
| 8. | Juice Content | ------ | 60% |
| 9. | Specific Gravity | 0.92 | 0.94 |
| 10. | Moisture content | 90% | 94% |

**Table No: 2**

| Sr. No. | Sample | pH | Total titrable acidity | Total Soluble Solids |
|---|---|---|---|---|
| 1. | Leaf | 7.8 | 1.16 | 0.4 |
| 2. | Fruit | 6.4 | 0.36 | 0.7 |

**Table No: 3**

| Sr. No. | Pigment | Leaf | Fruit |
|---|---|---|---|
| 1. | Chlorophyll a (mg/g) | 0.12 ± 0.0052 | 0.0012 ± 0.0025 |
| 2. | Chlorophyll b (mg/g) | 0.19 ± 0.0268 | 0.0011 ± 0.0005 |
| 3. | Total Chlorophyll (mg/g) | 0.32 ± 0.0052 | 0.0024 ± 0.0037 |
| 4. | Carotene (µg/ ml) | 0.86 ± 0.0045 | 0.196 ± 0.0015 |
| 5. | Lycopene (µg/ ml) | 0.723 ± 0.0055 | 0.209 ± 0.0030 |
| 6. | Anthocyanin (mg/100g) | 0.877 ± 0.0112 | 0.008 ± 0.001 |

Values of statistically significant at 5% level (n=3)

**Table No: 4**

| Sr. No. | Carbohydrates | Leaf | Fruit |
|---|---|---|---|
| 1. | Total Sugar (µg/ ml) | 109.09 ± 0.0230 | 300 ± 0.0015 |
| 2. | Reducing sugar (µg/ ml) | 17.77 ± 0.0005 | 21.11 ± 0.0026 |
| 3. | Non- reducing sugar (µg/ ml) | 91.32 ± 0.0232 | 278.89 ± 0.0015 |
| 4. | Starch (µg/ ml) | 189.09 ± 0.0036 | 1790.9 ± 0.0153 |
| 5. | Pectic Substances (%) | 16 ± 0.0152 | 28 ± 0.01 |

Values of statistically significant at 5% level (n=3)

**Table No. 5**

| Sr. No. | Sample | Total amino acid (µg/ ml) | Protein (µg/ ml) | Total Phenol (µg/ ml) |
|---|---|---|---|---|
| 1. | Leaf | 13.34 ± 0.0065 | 30.15 ± 0.0020 | 6.38 ± 0.001528 |
| 2. | Fruit | 3.17 ± 0.0080 | 6.46 ± 0.003215 | 0.67 ± 0.0011 |

Values of statistically significant at 5% level (n=3)

# Plate 1

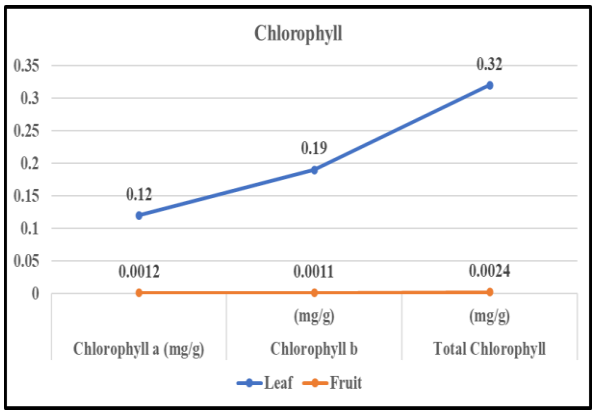


**Fig. 2 Chlorophyll Content**

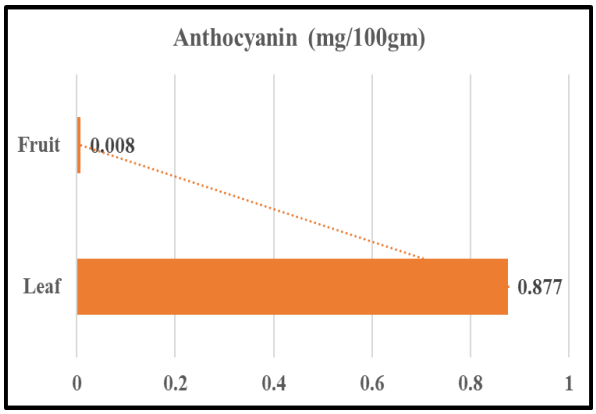


**Fig. 3 Anthocyanin**

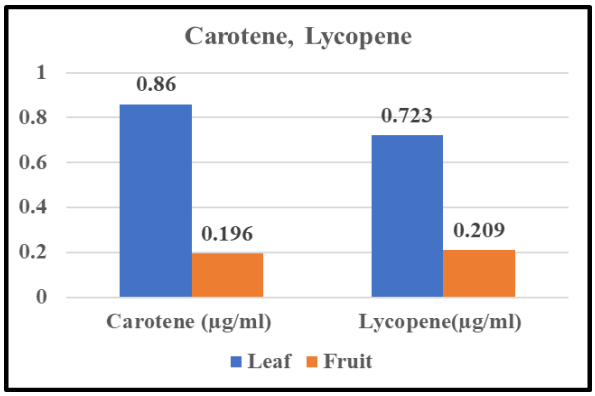


**Fig. 4 Carotene and Lycopene**

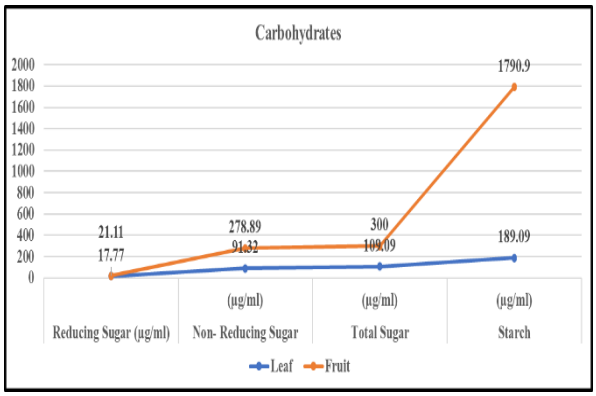


**Fig. 5 Carbohydrates**

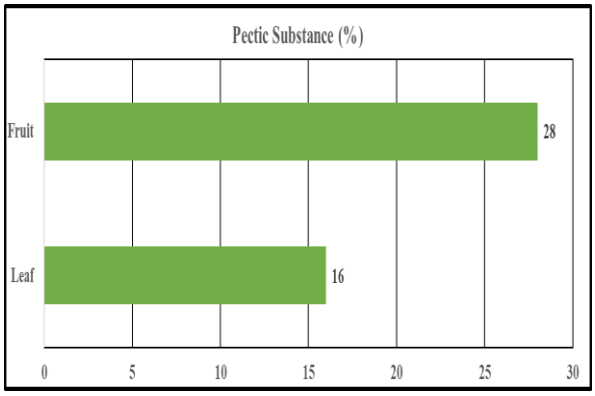


**Fig. 6 Pectic Substances**

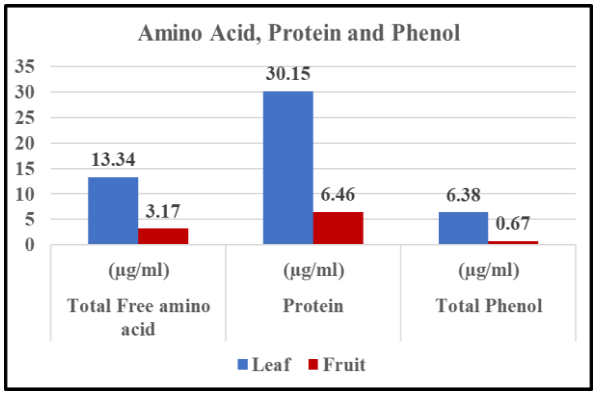


**Fig. 7 Amino acid, Protein, Phenol**

# Plate 2

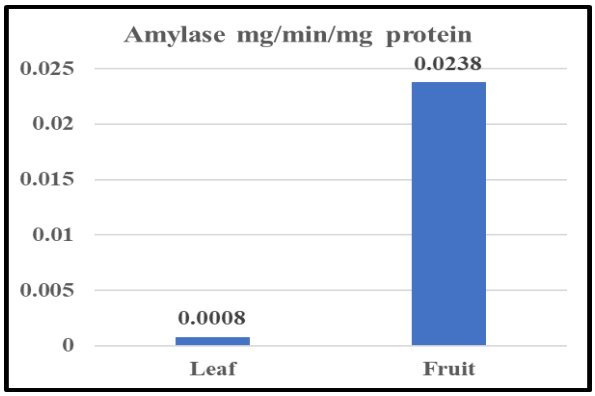


**Fig. 8 Amylase activity**

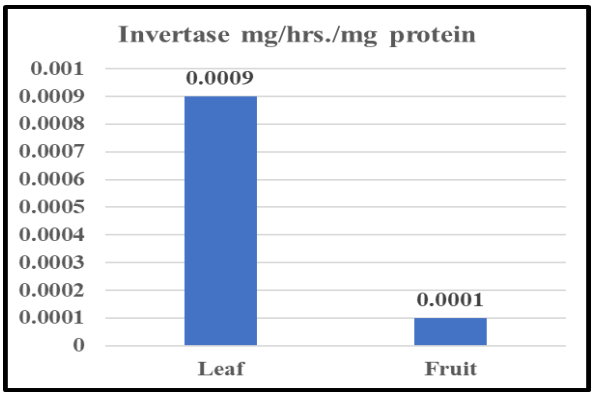


**Fig. 9 Invertase activity**

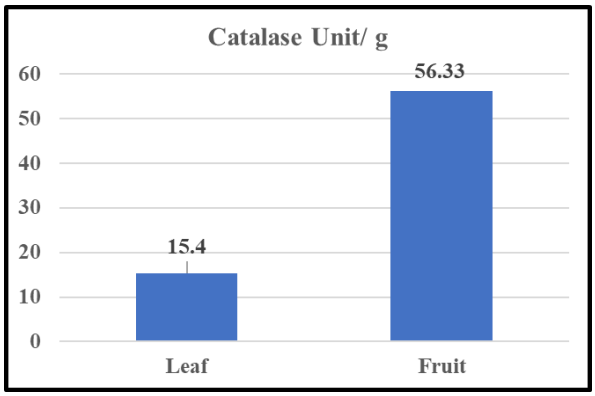


**Fig. 10 Catalase activity**

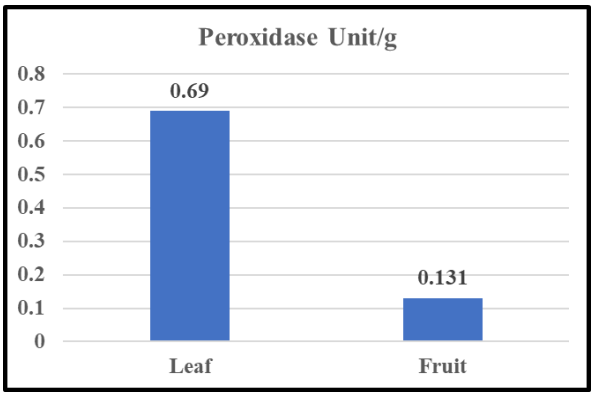


**Fig. 11 Peroxidase activity**