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Physiological study of Fenugreek at microgreen and well developed stages

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ABSTRACT

The physiological investigation is undertaken to compare the amount of photosynthetic pigments and activity of enzymes in fenugreek at microgreen and well-developed stages. The amount of total chlorophyll is more at the microgreen stage than well developed. At the same time, activity of enzyme nitrate reductase is also enhanced at the microgreen stage. The amount of carotenoids and activity of peroxidase enzyme is slightly low compared to well grown fenugreek Present observations indicate that at initial stages of plant growth, the mechanism of photosynthesis and nitrogen metabolism is significantly high to achieve full growth and development. At the microgreen stage, slight decrease in the defensive metabolite carotenoid and enzyme peroxidase shows disease and stress-controlled phase of a lifecycle of the plant.

Keywords: *Microgreen, Well developed Fenugreek, Photosynthetic pigments, Enzymes*

Introduction

According to [1], Fenugreek (*Trigonella foenum-graecum*), commonly known as methi, is an important annual herb belonging to the family Fabaceae. It is one of the oldest cultivated medicinal plants and has been widely used for centuries due to its nutritional, therapeutic, and culinary significance. The plant typically grows up to 30–60 cm in height and is characterised by trifoliate green leaves, small white to yellowish flowers, and slender pods containing hard, yellowish-brown seeds. Both the leaves and seeds are utilized in various traditional and modern applications.

[2] reported that Fenugreek is believed to have originated in the Near East and Mediterranean region and has been cultivated since ancient times. Archaeological evidence suggests its use as early as 4000 BC, including its presence in ancient Egyptian civilization, where it was used for medicinal and embalming purposes. Historical records also indicate its cultivation and use in Greek and Roman cultures. Over time, fenugreek spread to different parts of the world, especially South Asia, the Middle East, and North Africa, where it became an integral part of traditional medicine and cuisine [3 and 4]. In the present day,

Fenugreek is highly valued for its rich nutritional composition. The leaves and seeds are excellent sources of proteins, carbohydrates, dietary fiber, vitamins (such as vitamin A, vitamin C, and B-complex), and essential minerals including iron, calcium, phosphorus, and potassium. The high fiber content, particularly soluble fibre, plays a crucial role in maintaining digestive health and regulating blood sugar levels. Additionally, fenugreek contains a wide range of phytochemicals and bioactive compounds that are responsible for its medicinal properties [5].

The major phytochemical constituents of fenugreek include alkaloids such as trigonelline and choline, flavonoids like quercetin and luteolin, saponins such as diosgenin (a steroidal sapogenin), phenolic acids including gallic acid and caffeic acid, and steroidal glycosides such as yamogenin and gitogenin [6].

It also contains mucilage and fixed oils, which contribute to its therapeutic effectiveness. One of the notable compounds, sotolone, is responsible for the characteristic aroma of fenugreek and is widely used as a flavouring agent in food products.

Fenugreek has a wide range of applications in different fields. In the culinary domain, it is extensively used as a leafy vegetable (methi leaves), spice (seeds), and flavouring agent in various dishes such as curries, parathas, pickles, and soups, especially in Indian and Middle Eastern cuisines. In the food industry, fenugreek is used in the preparation of imitation maple syrup due to its distinctive aroma. It is also utilized as a food additive and preservative. Nowadays it is also consumed as microgreen.

In traditional medicine systems such as Ayurveda and Unani, fenugreek has been widely used for treating a variety of ailments, including diabetes, digestive disorders, inflammation, skin diseases, and respiratory conditions [7]. Modern pharmacological studies have supported many of these traditional claims and have demonstrated that fenugreek possesses multiple biological activities [8].

Furthermore, fenugreek has been shown to possess hypolipidemic effects by lowering low-density lipoprotein (LDL) cholesterol and triglycerides while increasing high-density lipoprotein (HDL) cholesterol, thereby contributing to cardiovascular health. Its digestive and gastroprotective properties are attributed to mucilage and fibre content, which help in relieving constipation, protecting the stomach lining, and preventing ulcers [9].

Despite its extensive traditional use and promising pharmacological properties, the clinical evidence supporting its effectiveness in humans remains limited. Many studies lack high-quality clinical validation, and therefore, fenugreek is not universally approved for clinical use in modern medicine. Further research is required to establish its safety, efficacy, and mechanisms of action in detail [10].

In conclusion, fenugreek is a highly valuable medicinal plant with significant nutritional, therapeutic, and economic importance. Its wide range of bioactive compounds and diverse applications make it a subject of considerable interest in the fields of pharmacognosy, ethnobotany, and medicinal plant research. Continued scientific investigation is essential to fully explore and validate its potential benefits for human health.

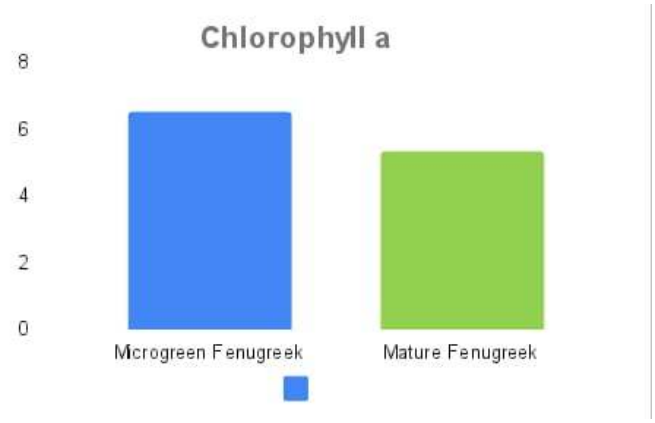
Material

Fresh microgreens and mature fenugreek plants were brought from Thane local market. Leaves were used for further experiments.

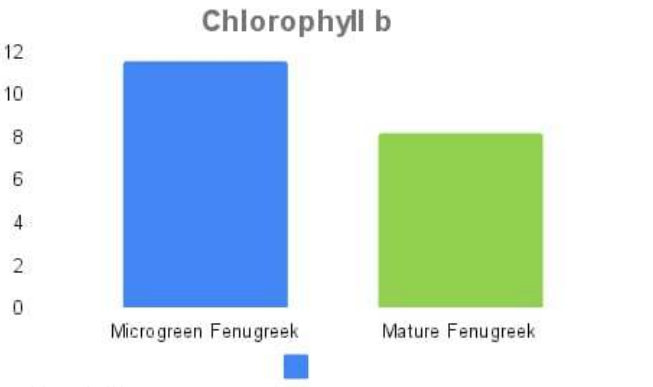
Methodology

Chlorophyll and carotenoid contents of fenugreek samples were estimated by extracting 0.5 g tissue in 80% acetone with a pinch of magnesium carbonate and making the final volume to 50 ml, followed by spectrophotometric readings at 663 nm and 645 nm for chlorophyll and 420 nm for carotenoids [11]. Protein content was determined by homogenizing 0.5 g sample in phosphate buffer (pH 6.8), followed by reaction with 0.5 ml BSA standard and 5 ml Reagent C, incubation for 20 minutes, and addition of 0.2 ml Folin reagent, with absorbance recorded at 660 nm [12]. Peroxidase activity was assayed by extracting 0.5 g sample in phosphate buffer, preparing a 10 ml extract, and reacting with guaiacol, enzyme extract, and distilled water, followed by incubation for 30 minutes, addition of hydrogen peroxide, and measurement of absorbance at 470 nm [13]. Enzyme nitrate reductase was estimated using [14] method.

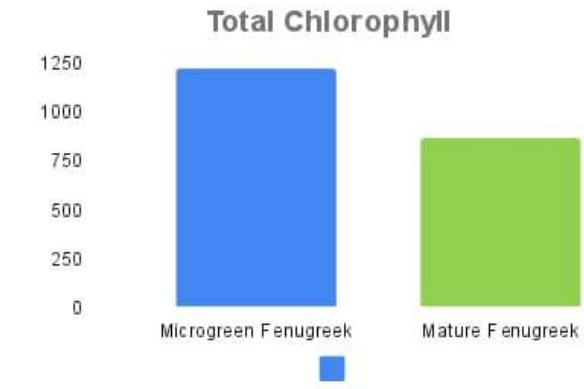
Observation



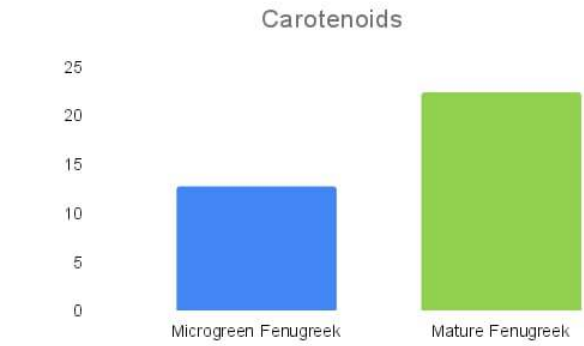
Graph 1: ***Chlorophyll a:***
Microgreen fenugreek: 6.49
Mature fenugreek: 5.28



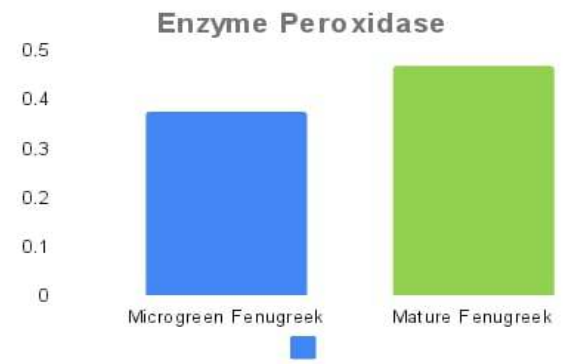
Graph 2: ***Chlorophyll b***
Microgreen fenugreek: 11.56
Mature fenugreek: 8.17



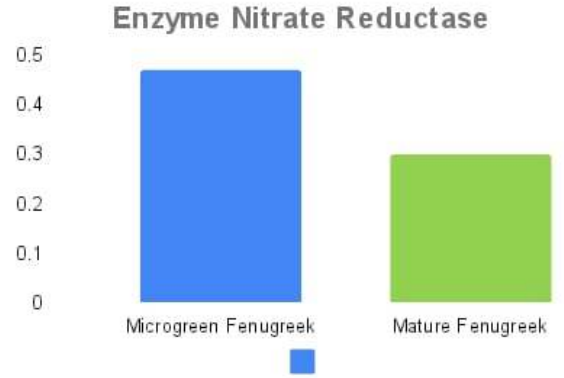
Graph 3: ***Total Chlorophyll***
Microgreen fenugreek: 1221.3
Mature fenugreek: 870.2



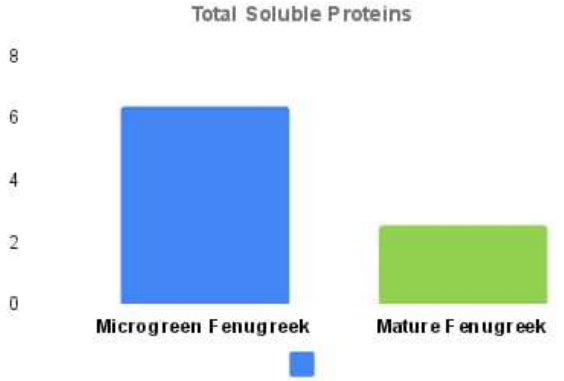
Graph 4: ***Total Carotenoids***
Microgreen fenugreek: 12.68
Mature fenugreek: 22.32



Graph 5: ***Enzyme Peroxidase***
Microgreen fenugreek:0.375
Mature fenugreek: 0.467



Graph 6: ***Nitrate reductase***
Microgreen fenugreek:0.467
Mature fenugreek: 0.299



Graph 7: ***Total Soluble proteins***
Microgreen fenugreek: 6.32
Mature fenugreek: 2.5

Result and Discussion

In present study Graph no. 1, 2 and 3 show presence of more amount of chlorophyll a, b and total chlorophyll present in at microgreen level of fenugreek than mature. This indicates that during developmental stage maximum amount of food is synthesised by the plant through photosynthesis.

Graph no. 4 and 5 indicate that the amount of carotenoid and activity of enzyme peroxidase in microgreen is quite low than mature fenugreek. During developmental stages of a plant carotenoids and peroxidase enzyme are exhibit less role in defence mechanism.

Graph 6 exhibit activity of enzyme nitrate reductase is more in microgreen compared to mature fenugreek. At the early stage of a growth through this enzyme microgreens able to assimilate maximum nitrogen.

Graph 7. reveals the amount of soluble proteins in microgreens and more compared to mature fenugreek. These soluble proteins are helpful to build the structure of a mature plant and to maintain the physico-chemical requirement of the plants.

Conclusion

- Maximum amount of chlorophyll in microgreens may indicator of presence of Mg and Fe minerals.
- As this is a leafy vegetable carotenoid may not be acting as an effective antioxidant. At the same time, activity of peroxidase may also be compensated by other antioxidant enzymes.
- Increase in the activity of nitrate reductase in microgreen is beneficial for the plants to produce maximum N containing compounds.
- Enhancement in the nitrate reductase activity can be correlated with increase in the soluble proteins in the plants.
- According to present results it can be concluded that further investigation is needed to analysed the role of other defence mechanisms and nitrogen metabolism in the microgreen of fenugreek.

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