REVIEW ARTICLE

NUTRITIONAL VALUE AND HEALTH BENEFITS OF KIWI FRUIT (*ACTINIDIA DELICIOSA*) (LIANG AND FERGUSON)

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Abstract:

Actinidia deliciosa (A. Chev.1941, Liang and Ferguson 1984) is a sub-family of the genus *Actinidia*, which is also known as Chinese gooseberry, kiwifruit, yangtao, etc. in China, and consists of 55–60 species. The genus *Actinidia* is a dioecious plant and is widely distributed on the Asian continent. It is also native to China and most of the species are cultured in the southwest of China. Out of all species, only *A. deliciosa* is intensely cultivated all over the world. In addition, the fruit of *Actinidia deliciosa* has been acclaimed for its native and medicinal values. It contains several phytoconstituents belonging to category of triterpenoids, flavonoids, phenylpropanoids, quinones and steroids. The roots of *Actinidia deliciosa* has been used as a traditional drug in China for a long time and are reported as Chinese folk remedy for various diseases, such as hepatitis, pyorrhea, gingivitis, edema, rheumatoid arthritis, and also various forms of cancer. Kiwi fruit has been used as mild laxative and a rich source of vitamins. The fruits, stems and roots are diuretic, febrifuge and sedative. The seeds are used as natural blood thinner. *Actinidia deliciosa* has thereby recently acquired interest due to its attractive potential application in indigenous drugs.

Keywords: *Actinidia deliciosa*, Nutritional Value, Vitamin C, Health Benefits.

Introduction:

The kiwi fruit originated in china. It was known as "Chinese Gooseberry". The roots of kiwi plant found in China, specifically the Yangtze river region. Mory Isabel Fraser brought seeds to New Zealand in 1904. Hayward wright, a nurseryman, developed the 'Hayward' cultiver in the 1920s, which become the dominant commercial variety. kiwi fruit is well known for its flavour and vitamin C content. It is a climacteric fruit and it is very sensitive to ethylene. kiwi fruit are exceptionally high in vitamin C and array of other nutrients, notably nutritionally relevant levels of dietary fiber. Kiwi can help keep your bones strong. Kiwi contains vitamin K which helps prevent osteoporosis and improves the mineral

density of your body, kiwi can good for kidney health due to its potassium content and antioxidant properties, kiwis are rich in antioxidant Which can help reduce inflammation and potentially improve kidney function (Neubauer *et al.,* 2008, Ferguson, 1990).

Berries of *Actinidia chinesis* are smooth, bronze skin with a beak shape at the stem attachment. flesh colour varies from bright green to a clear intense yellow. These Species is sweeter and more aromatic in flavor. The yellow fruit fetches a higher market price and, being less hairy than the fuzzy kiwiteit, is more palatable for consumption without peeling. But it has a short storage life which limits. It's commercialization According to recent revision of toxonomy, *Actinidia* is a member of the Actinidiaceae family and it contains 54 species (Huong *et al.,* 2004) Among the various types of in *Actididia lawi* berry *(Actinidia arguta*) is a relatively new type of commercially grown fecit, which is called the "Mini kiwi" and "Baby kiwi" (Willions *et al.,* 2003), kiwi beries are extremely abundant in phenolics (Fisk *et al.,* 2006), flavonoids (Park *et al.,* 2000), vitamin (Chatocha, 2015) Phenolias reduce the risk of many Phenolics the, flavonoid have anti-inflammatory, anti-allargic, anti-carcinogenic, & anti-ulcer properties (Noyok *et al.,* 2011). The genetic homogeneity amongst the micro propagated plants with mother plant in different chaps has been assessed by PCR based molecular markers such as rondom amplified polymorphic DNA marker (RAPD), inter simple sequence repeat (ISSR) marker, simple sequence repeat (SSR) marker and amplified fragment length polymorphism (AFLP) (Raj *et al.,* 2012; Thakur *et al.,* 2016; Oliyg *et al.,* 2021; Sultana *et al.,* 2022) Kiwi stores an ample amount of vitamin C, which acts as an antioxidant and helps in improving the skin texture. It also helps in the synthesis of collagen protein which favors youthful and flexible skin by preventing the damage caused by harmful UV radiations from skin (Richardson *et al.,* 2018). It is a good source of actinidin which is a proteolytic enzyme favoring the digestion of complex protein structures in stomach as well as small intestine. The bioactive materials present in kiwi fruit brings about a promising change in the humancolonic microbes, changes fecal consistency, reduces abdominal discomfort, and relieves the symptoms of constipation by decreasing intestinal transit time (Richardson *et al.,* 2018; Tyagi *et al.,* 2015).

The phytochemicals present in kiwi (xanthophylls, lutein) aids in maintaining eye health and prevents macular degeneration. Some of the other popular health benefits associated with the consumption of kiwi are that it supports cardiovascular health, promotes better sleep, aids blood clotting, absorption of vitamin D, facilitates iron absorption, reduces stone formation in kidneys, exhibits cytotoxic and antimicrobial activity (Tyagi *et al.,* 2015). It is used for treating and preventing various kinds of cancers, e.g., stomach, lung, and liver cancer (Singh *et al.,* 2018). This review majorly focuses on the nutritional profile, composition, antimicrobial activity, pharmacological and health benefits of kiwi fruit. Several research studies have been conducted by different researchers to explore the pharmacological profile and health benefits of kiwi. It has been reported to exhibit numerous biological activities such as anti-oxidant, anti-diabetic, anti-inflammatory, anti-hypertensive, anti-carcinogenic, antifungal, antiviral, anti-asthmatic, hepatoprotective, anti-platelet, anti-nociceptive, anti-HIV, anti-microbial, anti-constipation, cytotoxic, anti-tumor and anti-thrombin (Chawla *et al.,* 2016). It possesses various health benefits owing to its rich pharmacological profile. It protects against cancer,

diabetes, asthma, HIV-AIDS, and cardiovascular disorders. It plays a significant role in improving metabolic abnormalities such as dyslipidemia, low-density lipoprotein, triglycerides, hypertension, abnormal glucose metabolism, vascular inflammation, and hemostatic disorder (Stonehouse *et al.,* 2013).

The only irritant factor present in kiwi is the oxalates. These oxalates can cause oral mucosal irritation in some individuals. The consumption of this fruit should be avoided by patients of nephrolithiasis and urolithiasis due to the high oxalate content of the fruit (7.8 to 45 mg/100 g in golden kiwi fruit and 12.7 to 84.3 mg/100 g in green kiwi fruit). Oxalate in high concentrations can also reduce the bioavailability of calcium, magnesium, and iron in the body (Perera *et al.,* 1990).

China (Origin): As the native home of the kiwi, China is the largest producer in the world, accounting for over 50% of global output. Major production hubs are in the mountainous regions of Sichuan and Shaanxi provinces.

Iran: The country is a significant producer, with cultivation concentrated in the northern provinces near the Caspian Sea.

Japan and South Korea: These countries also have established commercial kiwi farming. India: Commercial cultivation is expanding in the country's mid-hills, particularly in the north eastern state of Arunachal Pradesh and regions like Himachal Pradesh.

Oceania New Zealand: Although not the native home, New Zealand pioneered the commercial industry and is the world's largest exporter of kiwifruit, marketing its products under the global brand Zespri. The primary growing region is the Bay of Plenty.

Europe Italy: Italy is the largest kiwi producer in Europe and consistently ranks among the top global producers, just behind China and New Zealand. The main growing areas are Lazio, Emilia-Romagna, and Piedmont.

Greece: A major European producer and exporter, Greece primarily grows kiwi in the plains of Central Macedonia and Thessaly.

France: As a long-time kiwi cultivator, France has a mature market and grows kiwis for both domestic consumption and export.

Portugal and Turkey: These countries also have established kiwi industries.

North and South America: With a growing season opposite to the Northern Hemisphere, Chile is a major producer and exporter of kiwifruit.

United States: Commercial crops are grown in California.

Canada: Some kiwi farming, particularly of hardy "kiwiberry" varieties, takes place in British Columbia.

Morphology:

Actinidia deliciosa is a woody, vigorous, climbing shrub reaching approximately 9 m, being a perennial climber it requires strong support for its growth. Its leaves are long petioled, alternate, deciduous, heart-shaped at the bottom, and have 8–13 cm length. Young leaves are coated with red coloured hairs; mature leaves are dark-green in colour and smooth appearance on the upper side, and downy-white with distinguished, light-coloured veins beneath. The scented, dioecious or sexual flowers

are borne singly or in groups of three among the leaf axils. Each sex has a centre tuft of numerous stamens, and the petals are originally white before becoming buff-yellow Honey bees *(Apis mellifera L.)* and wind are regarded as essential pollinators in kiwi fruit. Some floral characteristics of kiwifruit, such as the pendulous nature of flowers, absence of pollen kit and high ovule: pollen ratio. The plant is characterized by fleshy roots, very branched and with a tendency to distribute in the upper substrate of the soil. It has flexible stem. The kiwi is a berry, gathered in clusters of ovoid shape, spherical or elongated, depending on the cultivation of species. It has brownish green colour on outside surface and outside layer is so intact with the flesh. Its flesh is green and small black seeds are arranged in a circle about the centre. The oblongated fruit is up to 7-8 cm long (Q Xie 2019, H Qin 2025).

Phytochemical Properties of Whole Kiwi Plant:

The whole kiwi plant, including the fruit, peel, seeds, and leaves, contains a variety of bioactive metabolites with potential health benefits. These include vitamins (like Vitamin C), polyphenols (such as flavonoids, phenolic acids, and tannins), carotenoids, and other compounds with antioxidant and anti-inflammatory properties. The fruit's flesh, peel, and seeds all contribute to this diverse profile.

Here's a more detailed look at the bioactive metabolites found in different parts of the kiwi plant:

Kiwifruit:

- Vitamins: Rich in Vitamin C, with smaller amounts of Vitamin A, E, and K.
- Polyphenols: Abundant in compounds like gallic acid, chlorogenic acid, catechin, and quercetin.
- Carotenoids: Contains lutein and beta-carotene.
- Other: Includes organic acids like citric and malic acid, as well as actinidin, an enzyme with digestive properties. Kiwifruit are a nutrient-dense fruit and extensive research over the last decade on the health benefits of kiwifruit has linked their regular consumption to improvements not only in nutritional status, but also benefits to digestive, immune and metabolic health. The health benefits of consuming fruit are well documented.
- Kiwifruit are exceptionally high in vitamin C and contain an array of other nutrients, notably nutritionally relevant levels of dietary fibre, potassium, vitamin E and folate, as well as various bioactive components, including a wide range of antioxidants, phytonutrients and enzymes, that act to provide functional and metabolic benefits. The contribution of kiwifruit to digestive health is attracting particular attention owing to a growing body of evidence from human intervention studies. There are several plausible mechanisms of action that are likely to act together including the fibre content and type, the presence of actinidin (a natural proteolytic enzyme unique to kiwifruit which breaks down protein and facilitates gastric and digestion, and other phytochemicals which may stimulate motility.

Kiwifruit Peel: Often contains higher concentrations of certain polyphenols than the flesh. May have superior antioxidant properties compared to the flesh. May be a valuable source of dietary fiber. Eating kiwi skin provides significant benefits, including increased fiber intake (up to 50% more), a higher concentration of antioxidants like vitamins C and E, and additional nutrients such as folate and potassium. These benefits support better digestion, a stronger immune system, and overall health,

although the fuzzy texture can be unpleasant for some people (Richardson, 2018).the analysis of crude extract from the peel of kiwi led to the isolation of vitamin E, alpha and delta –tocopherol and 2,8 – dimethyl-2-chroman -6-ol,natural antioxidant that inhibit oxidation of the lipid in biological systems by the stabilization of and other free radicals.(EF EL AZAB 2021, D Pinto, 2020).

Kiwifruit Seeds: Contain unsaturated fatty acids and phenolic compounds. May be a source of bioactive compounds that could be utilized in functional foods. Kiwi seeds benefit digestion by providing both soluble and insoluble fiber and they contain omega-3 fatty acids that are good for heart and brain health. Eating kiwi seeds can also aid in weight management by promoting fullness and supporting digestive regularity. The seeds, along with the fruit's enzyme actinidin, also help break down proteins, which can reduce bloating (Latocha, 2017).

Kiwi Plant Leaves: Contain bioactive compounds, though their specific profile may vary. May be a source of compounds with antioxidant and anti-inflammatory properties. Kiwi leaves are edible and can be used for their potential antioxidant, anti-inflammatory, and antimicrobial properties. Research suggests extracts from kiwi leaves may help with glucose tolerance, potentially benefiting those with diabetes, and may also be useful in treating obesity and cognitive issues. They are also a source of beneficial compounds like polyphenols, carotenoids, and vitamins (Silva, 2021).

Bioactivities and Potential Uses:

- Antioxidant and Anti-inflammatory: Many of the bioactive compounds in kiwi have antioxidant and anti-inflammatory properties, which may contribute to overall health and protection against certain diseases.
- Potential in Functional Foods: The by-products of kiwi (peel, seeds, and leaves) can be a valuable source of natural compounds for enriching functional foods and nutraceuticals.

Health Benefits of Kiwi Fruit:

Skin Health: Vitamin C contributes to the production of collagen, which helps to hydrate and supple skin as well as delay the premature emergence of wrinkles. Thus, include kiwis in your diet on a regular basis to help maintain youthful, healthy skin. Once more, kiwifruit contains vitamin E, commonly known as tocopherol, an antioxidant that guards the skin from sun damage and to some extent prevents skin disease and skin cancer. Additionally, it has certain amino acids that shield the skin from sun damage. Vitamin C supports collagen production, aiding in skin elasticity and repair. Antioxidants help protect skin from aging and damage. It includes vitamin C and E and polyphenols is highly effective. They can fight free radicals, reduce dullness and support collagen production (Richardson, 2018).

Bone Health: For those who are more susceptible to osteoporosis, such as the elderly and expectant mothers, kiwifruit is a great fruit choice. The body has low levels of potassium, phosphate and calcium, just like in these two target groups. Calcium and phosphorus traces found in kiwis support healthy bones. Additionally, vitamin K is essential for the development of bone mass (Kruger, 2018). Isoflavones play a role in calcium homeostasis during the calcium uptake process by mobilizing bone calcium into the circulation.

Heart Health and Blood Pressure:

Kiwifruits are high in vitamin C, antioxidants, and phytochemicals, all of which are good for heart health. A study indicated that participants who consumed 100g of kiwifruit every day for eight weeks had significantly higher HDL levels. Additionally, Suksomboon *et al*. (2019) found that eating two or three kiwifruits a day for 28 days decreased the level of Triacylglycerol by 15% when compared to the control group. Once more, one can monitor elevated salt levels due to the high potassium content (Smith, 1987). Intake, hence maintaining blood pressure management. The fiber and potassium in kiwis support the heart health. Potassium helps regulate blood pressure. Fiber and antioxidants reduce LDL cholesterol. Anti-inflammatory properties support cardiovascular function. The researcher found that the consuming two to three kiwifruits a day for 28 days significantly reduced triacylglycerol level by 15 % compared to a control group, contributing to better cardiovascular health.

Digestive Health:

A good source of fiber is kiwifruit. Additionally, actinidin, a unique proteolytic enzyme found only in kiwifruit, aids with digestion by dissolving proteins. Consequently, promoting a seamless digestive system. Fights insomnia: Due to its high antioxidant and serotonin content a hormone essential for mood stabilization and sleep induction. Kiwifruit eating can help prevent insomnia. Contains actinidin, an enzyme that helps break down proteins. High fiber content promotes regular bowel movements and gut health. Can relieve constipation naturally. kiwi contains both soluble and insoluble fiber.it support gut health and help support healthy gut bacteria. The fiber found in kiwis can retain water and more than other types of fiber, like apple fiber and wheat bran. In study of 75 people with chronic constipation found that eating two kiwis per day for 4 weeks helped improve stool consistency and frequency and help to decrease staining during bowel movements (Jerlyn Jones, 2025; Cundra, 2020).

Anti-Cancer:

High antioxidant content helps neutralize free radicals, potentially lowering the risk of cancer. Kiwifruits are a great source of dietary fibre, which can lower the risk of colon cancer. Additionally, it has catechin, which increases bone marrow proliferation and decreases the production of harmful Reactive Oxygen Species (ROS), which can lead to malignant growth or damage to cells (Kim, 2024; Geetha, 2024).

Anti-Diabetes:

With a glycemic index of 39, kiwifruit is classified as "low" GI foods (GI < 55). Not only is it GI, but its accessible carbohydrate content is only around 12%. Once more, the fiber could postpone the breakdown and absorption of carbohydrates. kiwi show insulin resistance and reduce insulin level (El-Demerdash, 2024; Ozden, 2023).

Aids in Weight Management:

Low in calories, high in fiber. Promotes satiety and healthy metabolism. Studies in effect on digestion, blood sugar control and fat metabolism as the main mechanisms for weight management (Yang, 2020). It shows to improve lipid metabolism levels (Qu, 2019).

Anti-Depression:

Kiwifruit contains serotonin and inositol, which may help cure depression. kiwifruit are an outstanding source of vitamin B, E and K, carotenoids and the minerals Cu and Mg. Since many of these micronutrients have been associated with improved mood (Car, 2013).

Anti-Anaemia:

Its high vitamin C content makes it easier for iron to be absorbed into the blood, preventing anaemia. Kiwi helps in absorb iron more effectively pairing kiwi with iron rich food can significantly improve iron status (Khafaji, 2023). Ascorbic acid in kiwi enhances iron absorption (Beck, 2010).

Boost Immunity:

It is clear that individuals who consume less vitamin C have higher bronchitis and wheezing symptoms, which are more severe in asthmatic and bronchitis vulnerable patients. In older and younger people as well as children, kiwis boost the immune system and lessen the severity of cold and flu-like illnesses. The little kiwi fruit is rich in B6, B12, vitamin C, vitamin K, zinc, fiber, folate, and other elements that work together to promote immunity. Rich in vitamin C, which enhances immune function and helps to reduce the duration and severity of common colds and infections. The vitamin C content, which stimulates white blood cell production, and its rich antioxidants that protect cells from oxidative damage. It is the immunity powerhouse (Skinner, 2012).

Good for vision:

Kiwis guard against the main cause of visual loss, muscle degeneration. The main causes of vision loss are thought to be age, macular degeneration, and retinal degradation. A cup of kiwis contains 220 mg of zeaxanthin and lutein, which help to rebuild the macula and prevent many eye illnesses (Martin, 2007). Zeaxanthin and lutein are components of the retina and the macula. Contains lutein and zeaxanthin, which protect against age-related macular degeneration. The antioxidant in this fruit such a lutein and zeaxanthin, support retinal health and protect against macular degeneration (Moysidou, 2024).

Nutritional Values of Kiwi:

Kiwi has a high concentration of nutrients. Kiwi fruit has the highest nutrient content per calorie of any other fruit. It also has a significant quantity of dietary fiber, natural sugar, minerals, and vitamins (Ma, 2019). It also has zero sodium, low cholesterol, and very little fat. The receives the ideal nutrients from vitamins and minerals. It keeps the body's digestive system in equilibrium (Drummond, 2013).

Essential Dietary Minerals:

The human body contains 2–4 g of iron (Bothwell *et al,* 1979). The majority of this iron is found in haemoglobin, the erythrocyte protein responsible for transporting oxygen from the lungs to the body's tissues. Much of the remaining iron in the body is found in myoglobin, a protein important for the storage of oxygen in muscle tissue. Iron acts as a transport medium for electrons in cells and is an important component of many enzymes, playing a role in oxidative metabolism and Mineral Absorption in the Digestive System. The pH of the digestive system differs in each compartment, and the mechanisms and locations of a mineral's absorption are partly determined by the pH at which the mineral is soluble. Some minerals, such as magnesium and calcium, are soluble within a wide pH range

and thus remain as free ions through the entire digestive system. Others, such as iron and copper are soluble only under acidic conditions and form insoluble precipitates in nonacidic compartments of the digestive system (Wolber, 2013). Iron Dietary iron is found in two well characterized forms: heme and nonheme iron. Heme iron is found in red meat, chicken, and fish. Heme iron is well absorbed (15–35% absorbed from meals), with dietary factors and an individual's iron status having only a small effect on absorption (Gibson *et al.,* 1997). Most dietary iron is in the form of nonheme iron, which is present in meats, eggs, cereals, legumes, pulses, fruit, and vegetables. However, the absorption of nonheme iron is poor.

Minerals in Kiwi Fruit:

Kiwifruit is popular with consumers because it has a pleasant taste and texture, and because, being approximately 90% water, it is low in energy. It is also viewed as a "healthy" food: it is nutrient dense, containing complex carbohydrates and dietary fiber, as described in earlier chapters of this volume. Kiwifruit are relatively rich in minerals and other nutrients compared with other fruits. (Note: In this chapter "kiwifruit" generally refers to green kiwifruit, *Actinidia deliciosa* cv). Kiwifruit components facilitate mineral uptake for an individual to obtain all the essential nutrients; it is recommended that nutrient-dense foods are included in the diet. Components in food may influence dietary mineral absorption. Ideal foods are both nutrient dense and contain bioactive factors that enhance mineral absorption. The mechanism by which ascorbic acid enhances iron absorption is well established (Fairweather-Tait, 1995).

Propagation of Kiwi:

Kiwi fruit is almost exclusively propagated asexually by grafting fruiting varieties onto seedling (Tonimoto, 1994). Small tip of meristem tips or optical shots can be used for micropropagation of kiwi (Hartmann *et al.,* 2011).

Vegetative Propagation:

It ensures the desired traits of the parent plant are passed on and allows for fast fruiting. Male and female plants:kiwi plants are the dieocious (separate sexes). So, both male and female plants are needed for pollination and fruit production.

Sexual Propagation:

To grow kiwifruit rootstock seedlings, collect seeds from well ripened soft fruit in November. Blend fruit in a blender, push the resulting slurry through a fine mesh sieve and place seeds in a drying oven for two weeks (Tanimoto, 1994). After 2-3 weeks alternate temperatures to mimic day/night cycles (Hartman *et al.,* 2011). To germinate seeds place them on moist. After 10-14 days seedlings will germinate and should be planted into greenhouse pots containing sterile, well drained potting mix. Maintain seedlings for 3-4 months in the greenhouse, then harden seedlings outdoors under a shade cloth before planting in the field (Tanimoto, 1994).

Seed Propagation:

Seed propagation is sexual propagation. Seeds can be germinated in media. This is an *invitro* process. To grow a kiwi from seeds, extract and dry the seeds, then germinate them by placing them in a damp paper towel inside a sealed bag in a warm dark place. Once sprouts appear, plant the seeds in

well-draining soil, keep the soil moist and provide a sunny spot. As the seedlings grow, transplant them into larger pots and eventually move them to a location with a strong support structure for the vine to grow on (Griffiths, 2021).

Asexual Propagation:

Grafting:

Kiwi fruit growers typically obtain plants from licensed nurseries, to optimize desirable plant and fruit qualities. Commercial plants are grafted onto seedling rootstock, typically cultivars Bruno or Hayward (Beutel, 1990). Bruno is a more frequently used as a rootstock because it is believed to have superior rooting ability when compared to Hayward (Tanimoto, 1994). Rootstock seedlings are grown from seeds extracted from the ripe fruit. These plants grow for one year in the nursery before grafting. In California dormant scion wood should be collected in January and scion wood should be grafted to seedling rootstock in early spring (mid to late April). Collect scion wood from vigorous shoots produced in the previous season with well-developed buds. Although grafts can be done using t-budding, whip grafting is most commonly used (Tanimoto, 1994).

***In-vitro* Micropropagation:**

This technique used to rapidly multiply the plants under controlled condition. It involves using small pieces of plant tissue, such as shoot tips or nodal segment, to generate new plants in a sterile environment. This method allows for the large –scale production of plants that are true to type, meaning they have the some genetic charecteristics as the parent plant. The first report of *invitro* micropropagation of kiwi plant was done by Harada in 1975. The *invitro* micropropagation done by using nodal segment, shoot and seeds. To micropropagate the kiwi from seeds, sterilize the seeds from mature fruit, then germinate them on a Murashige and Skoog (MS) medium supplemented with growth regulators. The germinated seedlings can be used for shoot multiplication on a similar medium, followed by rooting in a medium with auxins and finally acclimatizing the plantlets to soil (Sekhukhune, 2025; Bourrain 2018).

Biological and Genetic Drawbacks of *invitro* Micropropagation of Kiwi:

Generating plants indirectly from callus tissue, significantly increases the risk of soma clonal variation or genetic or phenotypic changes that occur during the tissue culture. The plant micropropagate from nodal segment, can have poorly developed root system thet die off after being transplanted into soil (Sota, 2025). The problem with micropropagation of kiwi from seeds that are a high risk of contamination during the sterilization and germination process and genetic variability among the resulting seedlings.

Advantages of Micropropagation of Kiwi:

The micropropagation of kiwi, it an efficient and commercially viable alternative to traditional propagation methods like cutting and seeds. This advanced tissue culture technique allows for the rapid and large –scale production of genetically uniform, disease-free, high-quality kiwifruit plants (Tripodis, 2021).

Result and Discussion:

It contains vitamins, phenolic acids, flavonoids, tannins, and saponins. Vitamin E is a fat-soluble antioxidant that plays a role in immune health. Vitamin K is essential for blood clotting and bone health. Carotenoids are the pigments responsible for the colour of the fruit.

Enzymes and other compounds:

1. Actinidin – helps in breaking down proteins, aiding digestion.
2. Dietary fibre – crucial for maintaining gut health.
3. Saponins, tannins, glycosidases, and terpenoids have potential anticancer, antidiabetic, and hypolipidemic properties.

Kiwi plants are typically propagated through asexual methods like grafting and cuttings rather than seeds. The kiwi plant produces a wide range of metabolites, which can be broadly categorized into primary and secondary metabolites. These compounds play an important role in the plant's growth, defence, and nutritional value.

1. Primary Metabolites:

These are essential for the growth and development of the plant.

- **Carbohydrates** – Glucose, fructose, and sucrose are the main sugars responsible for the sweet taste of the fruit and are important for energy storage and metabolism.
- **Amino acids and proteins** – Glutamic acid, aspartic acid, and arginine are common amino acids in kiwi. They contribute to protein synthesis and enzyme activity.
- **Lipids** – Small amounts of fatty acids are found in kiwi seeds. Linoleic acid and oleic acid are predominant.
- **Organic acids** – Citric acid, malic acid, and quinic acid give kiwi its characteristic tangy flavour and also contribute to energy metabolism (Krebs cycle).

2. Secondary Metabolites:

These are not directly involved in growth but help in defence, signalling, and interaction with the environment.

- **Flavonoids** – Quercetin, kaempferol, and rutin act as antioxidants, anti-inflammatory agents, and UV protectants.
- **Phenolic compounds** – Include chlorogenic acid, caffeic acid, and other polyphenols. They help defend against pathogens and oxidative stress.
- **Tannins** – Present mainly in leaves and unripe fruit; they have antimicrobial and antifungal properties.
- **Alkaloids** – Present in low concentrations; exact types in kiwi are less well studied.
- **Terpenoids** – Found in essential oils of kiwi leaves and skin and may have antifungal and insect-repelling properties.

Seed propagation is used for breeding new cultivars or rootstocks but results in plants with uncertain characteristics and a long juvenile period. The propagation or cultivation of kiwi is mostly done by grafting and cutting.

Kiwi plant can be propagated through several methods:

1. **Vegetative propagation** – This is crucial for maintaining the desired fruit quality and for guaranteeing the correct ratio of male and female plants needed for pollination. It includes cutting, softwood cutting, and hardwood cutting.
2. **Seed (sexual) propagation** – Seeds are separated from the fruit and allowed to germinate in media; this is an in vitro process.
3. **In vitro micropropagation** – This is micropropagation done under sterilized laboratory conditions. The micropropagation of kiwi plant is a very critical process because its seeds are very small in size and difficult to inoculate.

The kiwi plant tissue cannot be cultivated all over India because suitable environmental conditions are not available everywhere. Uttarakhand, Jammu and Kashmir, Sikkim, Arunachal Pradesh, Nagaland, and Meghalaya are some states where the necessary chilling and well-drained acidic soils are available for kiwi. The micropropagation of kiwi plant in India is a promising technique for producing large numbers of disease-free, true-to-type plants, especially for commercial cultivation and export-quality fruit production, but it faces several challenges and limitations under Indian conditions.

The micropropagation and cultivation of kiwi plant in India is necessary to grow disease free plants reduces early losses in humid conditions. The kiwi fruit consumption in India is increasing due to rising health consciousness. It's rich in vitamin C, antioxidant, potassium. India currently imports a large portion of its kiwi mainly from New Zealand, Iran, Italy which are leading to high prices. In India if farmers are getting production of kiwi fruit and plant, they will get economic opportunity. Kiwi is the high value horticultural crop. Can provide better income compared to traditional crops like wheat, rice, maize with proper training, small and marginal farmers can earn profits from kiwi farming. Kiwi has health benefits. Kiwi can increased local production to a nutrient rich fruit. It helps to improves dietary diversity and urban and semi urban areas.

Conclusion:

Kiwi fruit is not available throughout the year; therefore, attempts can be made in the development of kiwi-based processed foods. It's processing as well as preservation can be used as a weapon in the enhancement of employment opportunities for the rural population. Various studies have revealed the excellent pharmacological profile of kiwi fruit. Further research is still required in this field to attract the food industrialists for the value-addition and development of kiwi-based food products. It might help in the development of in- credible pharmacological products and nutritional supplements for the welfare of mankind. The result obtained suggests that our regeneration protocol can be used for in vitro propagation of *Actinidia deliciosa* cv Hayward for the commercial production of true-to-type plants and genetic transformation studies in the future. This protocol will help to supply large number of quality saplings (mother plants) for commercial cultivation of kiwifruit which is expected to replace the conventional plant production approach. Moreover, the use of healthy rootstock for plant production minimizes the cost of production and increase the productivity, which will help to meet the supply constrain and economic development of the country. Therefore, the high percentage of regeneration, good restoration of the plant in nature and genetic stability by combined marker system are reliable

reasons to suggest that the method can substantially assist propagation in vitro and benefit economically valued fruit crop *Actinidia deliciosa* breeding programs. Kiwifruit (*Actinidia deliciosa*) is a highly nutritious, multifunctional fruit that offers a wide range of health benefits due to its rich composition of vitamins, minerals, fiber, and bioactive compounds.

It is exceptionally dense in vitamin C, vitamin E, potassium, folate, and antioxidants, making it a powerful functional food with numerous physiological advantages. Regular consumption of kiwifruit supports skin health by promoting collagen synthesis and protecting against oxidative damage, bone health through its calcium, phosphorus, and vitamin K content, and cardiovascular health by regulating blood pressure, reducing LDL cholesterol, and improving lipid profiles. Its digestive benefits are attributed to its high fiber content and the unique enzyme actinidin, which enhances protein digestion and relieves constipation. Morever, kiwifruit exhibits significant antioxidant, anti-inflammatory, anti-diabetic, and anti-cancer properties. Its low glycemic index and high fiber make it suitable for diabetic and weight-conscious individuals. The fruit also aids in iron absorption, preventing anemia, and boosts immunity due to its abundance of vitamin C and other immune-enhancing nutrients. Additionally, the lutein and zeaxanthin content contribute to eye health, reducing the risk of age-related macular degeneration. Beyond the edible flesh, the whole kiwi plant including peel, seeds, and leaves contains valuable bioactive compounds with antioxidant, anti-inflammatory, and potential medicinal properties, suitable for use in functional foods and nutraceuticals. The peel is rich in fiber and antioxidants, the seeds contain omega-3 fatty acids, and the leaves provide additional polyphenols and carotenoids. From an agricultural perspective, kiwifruit can be propagated through sexual, asexual, and *in vitro* micropropagation techniques, ensuring genetic consistency and large-scale production. Overall, kiwifruit stands out as a nutrient-dense super food that contributes to overall wellness by improving digestive, immune, metabolic, cardiovascular, and skin health, while also offering potential therapeutic value against chronic diseases. Its diverse bioactive profile underscores its importance not only as a dietary fruit but also as a promising source for future health-promoting and functional food applications.

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