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An analytical review on the nutraceutical importance of superfood: *Actinidia Deliciosa*

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Abstract---Actinidia deliciosa commonly known as kiwi fruit has numerous amounts of health benefits due to the existence of various nutrients and phytoconstituents in it. Literature shows that Actinidia deliciosa due to its constituents such as vitamin c, folate, minerals, sugars, enzymes, proteins, dietary fiber, etc., impart various pharmacological benefits that is why kiwi is considered as a

superfood. Several research have been done on this superfood to evaluate its medicinal and nutraceutical importance scientifically, such as antihypertensive, hypoglycemic, cardioprotective property, and so on. Keeping in view of its pharmacological importance an effort has been made in this review to highlight the bioactive constituents along with the nutraceutical importance of *Actinidia deliciosa*.

Keywords---*Actinidia deliciosa*, nutraceutical, antioxidants, phytoconstituents, anticancer.

Introduction

Actinidia deliciosa or Chinese gooseberry, is a native plant of China (Yangtze valley) and Taiwan though commercially produced in New Zealand, California and other parts of the world. In India Kiwifruit is primarily produced in the hilly area of Himachal Pradesh, Uttar Pradesh, Jammu and Kashmir, Sikkim, Meghalaya, Kerala and abundantly produced in Arunachal Pradesh. *Actinidia deliciosa* primarily contemplated to be having highly nutritive and medicinal value [Ma T, et al, 2019]. Kiwifruit belongs from the family of Actinidiaceae and genus Actinidia. The number of species of Actinidia is 76 but only two species *A. deliciosa* and *A. chinensis* are usually cultivated for commercial purpose [Zhang L et al 2010]. Various species of Actinidia involves *A. arguta* (baby kiwifruit) *A. kolomikta* (Arctic kiwifruit) *A. purpurea* (purple kiwifruit) *A. polygama* (silver vine). As compared from all other species of kiwifruit, *Actinidia deliciosa* having larger fruit size, more productivity, less ethylene sensitivity, and thus longest storage life. It has fuzzy skin, dull brown in color and its flesh is bright green. Kiwi is considered as superfood because of its high nutrient content along with enormous therapeutic uses such as it aids digestive system, supports iron nutrition, has antioxidant effect, reduce the instances of common cold and flu, etc. [Guroo I et al 2017 ; Husain SZ et al 2021] . Multitudinous reviews were written on *Actinidia deliciosa* understudying its medicinal properties along with the responsible phytochemistry which will be scientifically beneficial for further research and the society.



Nutritional components of *Actinidia deliciosa*

Vitamin C

Ascorbic acid is most important nutritional attribute of *Actinidia deliciosa* [Lucas et al 2003] . Their levels vary at different species such as hayward green contains ascorbic acid between 80-120 mg per 100mg and Sungold kiwi contains 161.3 mg per 100 mg[Boland M. 2013] .Vitamin C helps in collagen formation, contributes to proper functioning of metabolism, nervous system, immune system, prevent cells from oxidative stress and helps in reducing tiredness and fatigue[Beever DJ 1990] . Because of high ascorbic acid and low in tannin content, kiwifruit does not develop typically browning reaction which usually seen in most of the fruits . [Richardson DP 2018].

Vitamin E

Vitamin E- various analogs of vitamin E is found in kiwifruit such as tocopherol, tocomonoenol, they are mainly found in seeds of the fruit. Daily consuming of kiwifruit for 8 weeks increases vitamin e concentration in plasma [Lee SK and Kader AA 2000].

Folate

Actinidia deliciosa is considered a reliable source of folate. As folate is unstable, green leafy vegetables contains folate which can be destroyed by cooking, so that's why kiwifruit can be considered as useful source of folate.[Lee SK and Kader AA 2000]. In the time of pregnancy, it is difficult to meet folate requirements *Actinidia deliciosa* can be considered as food supplement [Chang WH and Liu JF 2009].

Minerals

Kiwifruit contains adequate quantity of potassium approximately 301-305 mg per 100gm low in sodium content. Usually, Fresh fruits are reliable sources of potassium but have less sodium content as kiwifruit contains 3mg per 100mg [Richardson DP et al 2015]

Sugars

As *Actinidia deliciosa* ripens its starch concentration decreases and consequently fructose and glucose concentration increase. The predominant sugar present in *Actinidia deliciosa* is fructose, glucose having low content of sucrose in it when fruit is fully ripped and ready for eat. Interestingly as kiwifruit ripens it undergoes marked changes such as decrease in the content of chlorophyll, carotenoids, anthocyanins become predominant [Richardson DP *et al.*, 2015]. For managing blood glucose level kiwi plays significant role as GI (glycemic index) of kiwifruit is relatively low [Hsieh CL *et al.*, 2018].

Proteolytic enzymes and proteins

The fruits of *Actinidia deliciosa* contain various proteins along with cysteine protease, out of which actinidin is the most abundant protein in kiwifruit. Actinidin is found active over a wide range of pH, which mainly involves our GI Tract [Nishiyama II *et al.*, 2008].

Dietary Fiber

Dietary fiber of the fruits of *Actinidia deliciosa* is polysaccharide in nature. The fruits of *Actinidia deliciosa* contain 2-4% of fresh weight complex carbohydrate (polysaccharide) which provide valuable contribution to the formation of dietary fiber in it [Rush E and Drummond LN 2009]. Gold *Actinidia deliciosa* contains less dietary fiber than green *Actinidia deliciosa* [Sun Q *et al.*, 2016]. Lack of dietary fiber is the major responsible factor for contributing constipation among people [Fiorentino *et al.*, 2009]. Literature shows the intake of two to three green kiwifruit per day provides approximately 6 gm of fiber which is around 24% DRV (Dietary Reference Value) which are helpful in maintaining the microflora of gut and proper bowel functioning [18-19]. [Mishra S and Monro JA 2012; Voderholzer WA *et al.*, 1997] *Actinidia deliciosa* has prominent nutritional value with certain proportions as mentioned in Figure 1.

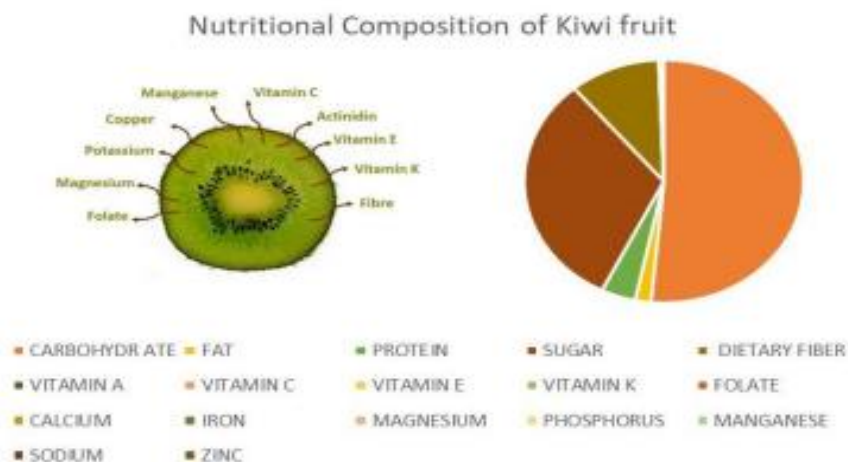


Figure 1. Shows nutritional compositions of Kiwi fruit

Phytoconstituents of Kiwi fruit

Phenolic compounds : Phenolic compounds were identified in *Actinidia deliciosa* fruits by using UPLC system and detection was performed with DAD (Diode Array Detection). Analytical curves were observed using UV-VIS spectroscopy [Carnachan SM *et al.*, 2011]

Tocopherol: tocopherol content was identified by using method depicted by using HPLC with fluorescent detector. Result was expressed in mg per 100gm of flesh weight of fruit [Dias M *et al.*, 2020] .

Organic acids : Pulp of *Actinidia deliciosa* fruits and peel both contains organic acids and can be evaluated by using an Ultra –Fast Liquid Chromatography and a photodiode array detector [Ma T *et al.*, 2017].

Antioxidant: IC₅₀ value determined using dry kiwi pulp extract using ethanol (2.5mg/ml) The amount of antioxidant content of *Actinidia deliciosa* was found to be higher as compared to apple, grapefruit, and pear, but less than raspberry, strawberry, orange and plum [24]. [Almeida D *et al.*, 2018]

Carotenoids : Carotenoids found in kiwifruit include provitamin A beta-carotene, lutein, and zeaxanthin [Wang H *et al.*, 1996].

Alpha linolenic acid: It is an omega 3 fatty acid found in *Actinidia deliciosa* seed oil (approx. 62%) [Beekwilder J, 2005].

Pharmacological and medicinal properties of *Actinidia deliciosa*

Many studies have been done on *Actinidia deliciosa* for their pharmacological response, and it has been reported that it has antidiabetic, anti-inflammation, 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 properties. It responds well to diseases such as cancer, asthma, COPD, HIV/AIDS, and cardiovascular ailments. It aids in the treatment of metabolic disorders, LDL, triglycerides, and improper glucose metabolism. The only irritant in kiwi is oxalates, which are found in the fruit. Due to presence of some important enzymes such as protease (actinidin) and variety of pigments such as chlorophyll, carotenoids, lutein, anthocyanin and polyphenols, it works as a natural antioxidant and that is why it is recommended to eat or process kiwi pulp with their seeds [Soquetta MB *et al.*, 2016] [27]. Research identified the important amino acid of *Actinidia deliciosa* as actinidin which is found to enhance digestion by supporting gastric activity. *Actinidia deliciosa* is well known for its health-benefit properties such as less calorific value, low glycemic index (GI), vitamins (particularly vitamin C), high potassium content, high amount of dietary fiber content, availability of a variety of pigments (named as chlorophylls, carotenoids, lutein, anthocyanin), and presence of the few important enzymes (such as proteases), low allergic response (AR) and finally its richness in natural antioxidants, polyphenols. Its tiny seeds are distributed evenly throughout the whole fruit pulp and having their own importance for their consumption. That is why it is considered to processed fruit without removing its seeds [Dias M *et al.*, 2020] . The roots of *Actinidia deliciosa* have been shown to have powerful antihepatotoxic, anti-pyorrhea, and anti-gingival inflammatory properties [Ma Q *et al.*, 2014]. Due to its high dietary fiber content, *Actinidia deliciosa* is widely observed to have moderate laxative effects [Wang H *et al.*, 1996]. Kiwifruit and their species also show bacteriostatic activity against various strains such as *Streptococcus aureus*, *Streptococcus pyogenes*, *Salmonella typhi*, *Enterococcus faecalis*, *Escherichia coli*, and *Klebsiella pneumoniae*, etc. [He X *et al.*, 2019]. The scientific

investigation to explore *Actinidia deliciosa* continued to get more pharmacological benefits which are represented in Table 1 and Figure 2.

Table 1. Shows some major pharmacological findings of *Actinidia deliciosa*

Plant part	Pharmacological Activity	Key findings
Roots	Antitumor	The roots of <i>Actinidia deliciosa</i> have been shown to have powerful antihepatotoxic, anti-Pyorrhea, and anti-gingival inflammatory properties [Kou L <i>et al.</i> , 2021].
Ripe Fruit	Laxative	Due to its high dietary fiber content, kiwi fruit is widely observed to have moderate laxative effects [Rush EC <i>et al.</i> , 2002].
Fruit pulp	Cardio Protective Property	Kiwifruit pulp extract inhibits ADP-induced, and collagen induced blood-platelet aggregation [Duttaroy AK 2013]
Fruit pulp	Antihypertensive effect	Kiwifruit pulp has shown a decrease in angiotensin converting enzyme (ACE) activity [Svendsen M <i>et al.</i> , 2015] . Due to the presence of high potassium content, it can be helpful in balancing effect on sodium level in body. As intake of low potassium content is a high risk for developing blood pressure as due to high sodium intake.[Tyagi S <i>et al.</i> 2015]
Fruit pulp	Hypoglycemic effect	Kiwifruit extract decreased blood glucose levels when compared to diabetic control group. Due to presence of fiber as a dietary fiber which helps in keeping blood sugar level on control for diabetic patients [Satpal D <i>et al.</i> , 2021 ; Singletary 2012]
Fruit pulp	Reduces the incidence of upper respiratory tract infection	Dietary consumption of Kiwifruit is helpful to reducing severe occurrence of symptoms like sore throat and headache during upper respiratory tract infection. [Hunter DC <i>et al.</i> , 2012]
Fruit slices	Acute burn treatment	Dressing for healing wound prepare from fresh slices of <i>Actinidia deliciosa</i> , it promotes healing of the acute wounds as compared with ointment used for topical burn management [Raman VK <i>et al.</i> , 2020]
Fruit pulp	Vasodilator	Arginine present in kiwi fruit promotes arteriolar dilation which leads to improved bloodstream and important for heart wellbeing [Lal S <i>et al.</i> ,2010]

Kiwi allergy

Pollens and oxalates are the most common causes of *Actinidia deliciosa* allergies. Similarly, as with other food allergies, the only treatment is to avoid kiwi fruit, with rescue medication based on the severity of the symptoms. Because there is a scarcity of research on how to treat a fruit allergy, advice varies from just avoiding the fruit. In the absence of clinical symptoms, SPT and measurement of specific IgE to recognized cross-reacting fruits will result in exaggerated positive test findings in people with an IgE mediated fruit allergy. If partially validated test systems for allergy are used as the basis for recommending elimination diets, unnecessary dietary restriction may ensue [Park YS *et al.*, 2011 ;Offermann LR *et al.*, 2015].

Commercialization of *Actinidia deliciosa*

Kiwi has been commercialized because of its enormous nutritional and health benefits, not just for intake purpose such as kiwi candy but also used in various cosmetics, confectionery, and nutraceuticals. Many research have been needed in this direction so that commercialization of kiwi can be increased [Rush EC *et al.*, 2013] . Commercial plantings of *Actinidia deliciosa* started in New Zealand in the late 1930s, and exports started to the USA started in 1962. Californian *Actinidia deliciosa* made their way onto the US market in 1970, from the last three decades *Actinidia deliciosa* demand has been increasingly available worldwide, with producers now in New Zealand, USA, Japan, Italy, Greece, Spain, Australia, and Chile .[Salinero MC *et al.*, 1995]

Processed food products of *Actinidia deliciosa*

Kiwi candy has number of benefits like it shows antioxidant property, which is helpful in condition of thrombocytopenia, helpful in managing blood pressure, reduces blood clotting, helps to boost immune system, helps to treat asthma, improves skin elasticity, plays an important role in platelet count. There are several advantages of kiwi candy over *Actinidia deliciosa* as *Actinidia deliciosa* cannot stored for 5-6 months in room temperature, but kiwi candies can be stored for longer period even at room temperature. *Actinidia deliciosa* cannot be available in all seasons, but kiwi candies can be available, they are easy to carry easy to be stored. Small children do not like eat tangy fruits or fruits which are more citrus or sour in taste so in that case kiwi candies can be very much useful [Martin-Cabrejas MA *et al.*, 1995] . Kiwi processed food products are widely used because of its enormous health benefits, processed food mainly involve juices, juice concentrates, kiwi puree, kiwi yogurt, kiwi candy, kiwi sliced or diced products, kiwi flavored widely used in dessert markets, processed products are mainly juices, juice concentrates, purees and sliced or diced product, largely for use in the beverage and fruitcandies are more famous and widely accepted by all age group. *Actinidia deliciosa* is selected to manufacture as candy because of its numerous health benefits. As *Actinidia deliciosa* being too tangy in taste, so this somehow decrease its acceptance by many ones so in that case kiwi candy be a considered as useful [Cornelia M *et al.*, 2020]



Figure 2. Shows pharmacological and medicinal benefits of different parts of *Actinidia deliciosa* as depicted by Guroo et al., 2017

Kiwifruit potential in cosmetology

Due to the presence of protease enzyme, which is useful in skin regeneration, cell renewable, improvement in skin wrinkles kiwifruit has potential to be used widely in cosmetic products. Various kiwi facewashes, creams gels, facemasks are available in market and there is a need of research in this area to recognize kiwifruit potential on improving skin radiance and decolorization of skin. Protease enzyme is also helpful in improving texture of hair thus kiwifruit can also be used in manufacturing of hair products and as nutraceutical for improving hair growth and texture [Choi WJ et al., 2012 ; Nagase S et al., 2000]Kiwifruit being potent antioxidant is widely used in manufacturing of anti-ageing creams, serums. Other kiwifruit species such as *Actinidia chinensis* which contain high phenolic and flavonoid content is widely use in anti-ageing products. They work by reducing oxidative stress on cells and thus improve skin radiance, delaying wrinkles occurrence and improves skin texture.[Lee Y *etal* ., 2011]

Valorization of kiwifruit

Due to the phytochemical profile and medicinal benefits kiwifruit can be considered as highly potent for valorization. Valorization of kiwifruit can be done by promoting their applications in nutraceuticals, cosmetics, pharmaceuticals, food industry. In food industry it can be widely use as additives, flavor enhancer, acidifying agent, drinks, and beverages and as alternative to synthetic antioxidants.[Cassano A *et al.*,2008] In nutraceuticals for the manufacture of effervescent tablet, energy powder after workout, imparting various health benefits from improving body digestive system to being a potent immunomodulator, kiwi is a potential for being a fast-growing nutraceutical [Latocha P *et al.*, 2015 ; Cunha CM *et al.*, 2018]

Variation in kiwiplant cultivation methods on fruit quality

Processes like trunk girdling and root pruning shows variation in kiwifruit quality. Root pruning shows hydraulic response such as significant reductions in shoot and leaves of plant [Smart DR et al., 2006]. Hydraulic conductance of kiwi plant is low in bag grown region as compared to orchard grown. Kiwi plant is anisohydric as changes in transpiration process and xylem pressure potentials due to trunk girdling and root pruning does not show decrease in stomatal conductance shows that kiwi fruit is anisohydric [Tardieu F and Simonnaeu, 2006]. More amount of Fruit dry weight increases the customer satisfaction and acceptance rate of fruit. Fruit dry weight is vary by carbohydrate level. Root pruning process stimulates regrowth which has much bigger effect than extra fruit. [Minchin PE et al., 2010]

Conclusion

Kiwifruit is considered as one of the most nutritious fruits, which are particularly rich in vitamin C, E and K, folate potassium and dietary fiber. It has numerous amounts of medicinal properties which makes it a superfood. Its nutritional components make it a potent immunomodulator. Kiwifruit is widely used as a nutraceutical and has been commercialized on a global level. Nowadays various processed kiwi fruits are available globally which are enjoyed by every age groups. The present review revealed the importance of *Actinidia deliciosa* in pharmaceutical applications along with its commercial applications due to its mentioned health benefits. As obtained data *Actinidia deliciosa* is beneficial for central nervous system as well as cardiovascular disorders which are interlinked as risk factors of one another. It shows its dietary supplement in the mentioned disorders will be beneficial for the particular disease maintenance. The study showed its medicinal importance in various cancer management which can further be explored to get less toxic and less costly anticancer agent. The study is a collective representation of its scientific research outcomes which will be beneficial to get extensive research idea to explore its usefulness for the socioeconomic benefits.

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